SR/H--862

REPORT

OF

MATERIAL & EQUIPMENT

SECTION'S

ACTIVITIES

AT

NEW YORK SHIPBUILDING CORP.
DURING FABRICATION

OF

AXC 167 1/2

STARTING MAY 18, 1951
PART VII - SECTION I
PARAGRAPHS 1 THRU 14

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FEB. 28, 1954

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INSPECTIONS PERFORMED BY DU PONT ON "R", "P" AND "L" UNITS

PART VII - SECTION I

R, P & L PLENUM CHAMBERS

PARAGRAPHS 1 THRU 14

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SKIRT WELD INSPECTION

(12) Establishing Preliminary X & Y Axes on Bottom of Plenum Chamber and Top of Top Tube Sheet

Preliminary X & Y axes were established on the bottom of the plenum chamber and on the top of the top tube sheet assembly in an identical manner described in Section 14B-(11) of this manual.

"R", "P", & "L" UNIT DRAWING LIST BY SUB-ASSEMBLY

The following list covers all du Pont prints pertaining to fabrication released to the M & E Group located at New York Shipbuilding Corporation.

This list was prepared from existing drawing files at the latter location on January 14, 1954. For reference purposes and convenience, drawings are listed by sub-assembly, drawing number, title, and revision number.

A. "R" Unit

1. Plenum Chamber

Drawing No.	Title	Revision #
W130909	Sections & Details Sheet #2 Arrangement	10
W130910	Plenum Chamber Plan Arrangement	11
W130911	Sections and Details Sheet #1 Arrangement	20
W133194	Sections & Details Sheet #3 Arrangement	15
W134272	Sections & Details Sheet #4 Arrangement	0
D110121	Centering Tongue & Groove Block	7
D110126	Pre-machined Finish of Rod Tube	3
D110136	Rod Tube Liner	16
D110275	Hood for TTS Lifting Lugs	2
D112647	Pre-machined Finish of Bearing Tube	0
D112648	Pre-machined Finish of Non-bearing Tube	0
D112919	Nozzle Staybolts & Ferrules for Solid Vanes	0

B. "P" Unit

1. Plenum Chamber

Drawing No.	Title	Revision #
W131155	Plenum Chamber Plan Arrangement	11
W131156	Plenum Chamber Sections & Details Sheet #1 Arrangement	18
W131407	Title same as above Sheet #2	6
W131407	Plenum Chamber Sections & Details Sheet #1 Arrangement	6
W133305	Plenum Chamber Sections & Details Sheet #3 Arrangement	25
W134273	Plenum Chamber Sections & Details Sheet #4 Arrangement	10

Drawing No.	Title	Revision #
D110134	Pre-machined Finish of Rod Tube in Plenum Chamber	
D110142	Plenum Chamber Rod Tube Liner	15
D110148	Centering Tongue & Groove Block	4
D110283	Plenum Chamber Hood for Top Tube Sheet Lifting Lugs	2
D112644	Pre-machined Finish of Non-bearing Tube in Plenum Chamber	4
D112771	Plenum Chamber Instrument Hood Plate	5
D112894	Plenum Chamber Test Nozzle Staybolts & Ferrules	
D112899	Solid Vanes for Plenum Chamber Test Nozzle	
D112918	Plenum Chamber Nozzle Staybolts & Ferrules for Solid Vanes	

C. "L" Unit

1. Plenum Chamber

Drawing No.	Title	Revision #
W132841	Plenum Chamber Section & Details Sheet #2 Arrangement	3
W132842	Plenum Chamber Plan Arrangement	7
W132843	Plenum Chamber Section & Details Sheet #1 Arrangement	1
W133609	Plenum Chamber Section & Details Sheet #3 Arrangement	18
W134200	Plenum Chamber Section & Details Sheet #4 Arrangement	10
D110232	Pre-machine Finish of Rod Tube in Plenum Chamber	0
D110273	Centering Tongue & Groove Block	2
D110274	Plenum Chamber Rod Tube Liner	1
D110298	Plenum Chamber Hood for Top Tube Sheet Lifting Lugs	10
D112762	Pre-machined Finish of Non-bearing Tube in Plenum Chamber	4
D112763	Pre-machined Finish of Bearing Tube in Plenum Chamber	5
D112873	Plenum Chamber Instrument Hood Plate	2

PART VII - SECTION I - PLENUM CHAMBER

INSPECTIONS PERFORMED BY DU PONT ON "R", "P", AND "L" UNITS

1. Plate Preparation

A. "R" Unit

(1) Plate Inspection

The type 304 stainless steel plate material for the top and bottom tube sheets was inspected identically to those for NYX as discussed in Part II-A, section 1-a.

(2) Plate Fit-up, Welding, and Radiograph Inspection

After 1" thick stainless steel plates were inspected for thickness, surface cracks, laminations, and other mechanical defects, each of the three plates that make up a tube sheet bland were laid out to drawing dimensions with excess material to allow for tube weld shrinkage. The three plates that make up a tube sheet were then laid on a flat slab and checked for levelness and straightened where necessary using a 150 ton deep throat press. Each plate was then planned square on an edge planer and beveled on both sides for welding. The angle of bevel was checked by inspectors at random on each plate edge using an adjustable angle square.

The three plates were then laid on a flat slab and butts mated until they were flush. After the plates were properly fitted, the two joints were tacked welded with 1" tacks spaced approximately 10" on center. The weld tacks were wire brushed and defects ground out. These operations were witnessed by a du Pont inspector.

The tube plate edges were then clamped to the slab and an aircomatic track welding machine and tracks were set up for welding the joint. Suitable weights were placed on the tube plate blank at established locations to minimize weld buckle. Both joints (between any two plates) on each side of the tube plate blank were welded using the established welding procedure adopted for this job.

After all welding was completed, the welds were ground flush. (See Part II-A, section 1, photo serial number 4 for view of grinding operation.) Welding was then inspected for undercutting, cracks and other mechanical defects. Necessary repairs were made, reinspected and then the two tube sheet blanks released for x-raying.

Tube sheet welds were then x-rayed 100%. Radiographs were examined and interpreted in accordance with the non-destructive test as specified in paragraph U-68 (h) (2) to (10) inclusive of the A.S.M.E. Code for Unfired Vessels, 1949 Edition. Unacceptable defects were repaired and re-x-rayed.

After all x-ray work was completed, each tube sheet blank was set up on suitable supports for burning the outside diameters. Each tube sheet was then burned with a stainless steel cutting torch and flux to a nominal diameter, and then the tube sheet edges were straightened on a 350 ton press. Weld joints were straightened on a 70 ton deep throat press.

B. "P" Unit

(1) Plate Inspection

This inspection was performed identical to that on "R" Unit as discussed above in section A-(1).

(2) Plate Fit-up, Welding and Radiograph Inspections

These inspections were performed identical to that on "R" Unit as discussed above in section A-(2).

C. "L" Unit

(1) Plate Inspection

This inspection was performed identical to that on "R" Unit as discussed above in section A-(1).

(2) Plate Fit-up, Welding and Radiograph Inspection

These inspections were performed identical to that on "R" Unit as discussed above in section A-(2), except as follows:

It was requested by the du Pont Inspection Department that New York Ship stencil x-ray identification numbers on the outside of all tube sheets on "L" and subsequent units in such a manner that they would stay there. Heretofore, x-ray numbers on tube sheets were stenciled on the inside of all tube plates. In some cases after assembling of a unit, x-ray numbers on tube plates were on the inside of the unit and there was no way to match the radiograph with the weld seam. New York Ship complied with this request on "L" and subsequent units and put x-ray numbers on the outside.

Five grain x-ray film was used in lieu of course grain film on this unit. This change was a result of difficulty in reading x-rays on "P" unit expansion ring. All x-ray film for this unit ("L") was interpreted according to the revised x-ray reading technique discussed in "P" unit expansion ring inspections.

2. Tube Inspection (pre-assembly)

A. "R" Unit

Inspection of pre-machined plenum tubes was performed identical to that on the NYX unit as discussed in Part II-A, section 2a through 2e. The latter sections also cover tube inspections (pre-assembly) performed on the top tube sheet and bottom tube sheet tubes for this unit, except as follows: All large tubes and rod tubes for the plenum chamber and top tube sheet and all large tubes for the bottom tube sheet were not subject to 1000# hydrostatic test at New York Ship prior to assembly into a unit. These tubes were hydrostatically tested at vendor's shop and considered satisfactory.

In addition to the above, the pre-machined design of the "R" Units rod tubes was changed. This came about due to the successful development of an automatic feed "Airco-matic" welding unit for the small rod tubes similar in principle to that used in welding large tubes. Also, a line boring operation of the plenum rod tube with respect to the top tube sheet rod tube was planned for units subsequent to NYX to allow sufficient metal for line boring.

On the new drawing issued by Design Division, (D110126-"R" Unit) the following rod tube design changes were noted as compared with NYX plenum chamber:

a. Plenum tube was lengthened 3/8" at the top end and 1/4" at the bottom end or a total of 5/8".

b. The O.D. was increased to 1.990" - 1.995".

c. A pre-machined 7/8" straight bore was provided to facilitate fixture alignment.

The "R" unit top tube sheet rod tubes were lengthened by 1/4" at both top and bottom or a total of 1/2". Pre-machined detail drawing D110135 covers these changes.

The above pre-machined rod tube changes on the "R" plenum and top tube sheet assemblies was also made on all subsequent units. ("P", "L", and "C")

B. "P" Unit

After inspecting tubes (all types) for the NYX and "R" Unit sub-assemblies at New York Ship, it was decided by the

Inspection Department that inspection given tubes at vendors' shop was accurate enough, and that 100% re-inspection of tubes was not considered necessary; therefore, the following reparations were made by the du Pont Inspection Department at New York Ship to facilitate the expediting and completion of tube re-inspection:

(1) 20% of all large tubes and rod tubes for the plenum chamber were given a 100% re-inspection.

(2) 20% of all large tubes and rod tubes for the top tube sheet assembly were given a 100% re-inspection.

(3) 20% of all large tubes for the bottom tube sheet assembly were given a 100% re-inspection. All large tubes were hydrostatically tested at 1000 p.s.i. for 10 minutes.

The above listed tube types were inspected in an identical manner as outlined in above section 2-A.

C. "L" Unit

Tube inspection (all types) for this unit reverted back to 100% visual and dimensional inspection as outlined in above section 2-A. Several reasons contributed to this change in inspection and they are discussed in the following paragraphs.

Of paramount importance was the finish (RMS) and condition of the bottom tube sheet tube counter-bores prior to assembly into "L" Unit. This came about after close visual inspection on "P" Unit bottom tube sheet tube counter-bores after assembly of tubes into the unit. Here it was discovered that all counter-bores had scratches and gouges in the O-ring seating area. Tube bores in this condition were not acceptable, and consequently required additional re-working to bring them within required specifications. Since this discrepancy was of major concern on "P" Unit, it was decided by the du Pont Inspection Department that all bottom tube sheet tubes would receive a 100% dimensional and visual inspection prior to assembly into the "L" Unit bottom tube sheet. Along with conventional inspection methods heretofore established as outlined above in section 2-A, checking of the counter-bore finish with a profilometer was incorporated into the "L" bottom tube sheet tube inspection procedure to prevent a re-occurence of the conditions encountered on "P" Unit bottom tube sheet.

Also, another reason which prompted the du Pont Inspection Department to revert back to 100% tube inspection was as follows: Upon receipt of field reports pertaining to

the acceptability or rejection of various tubes received here at New York Ship, it was noted after inspection and comparing field tube inspection results with New York Ship results that rejected tubes (in field) were being reclassified at New York Ship as acceptable. Since inspectors at New York Ship knew what dimensions could deviate from allowable tolerances and still not adversely affect final quality, it was decided by the du Pont Inspection Department that all tubes received from the field would receive a 100% visual and dimensional inspection to determine their final disposition.

3. Revised Drill Jigs for "R" and Subsequent Units

A. Development of Drill Jigs

The expanded center-to-center spacing of NYX unit tubes and the development of jigs for the tube sheets had to await the completion of welding on the 8-foot mock-up, and an analysis of measurements taken of shrinkage. Tube sheets of the mock-up had been pilot drilled using an 8-foot long carbon-steel strip jig with two rows of holes. Tube sheet holes were then trepanned to full size. A similar procedure was chosen for the NYX unit.

The mock-up shrinkage indicated that an expanded center spacing of 7.021 inches would result in the desired 7-inch tube pattern after welding. Du Pont authorized the drilling of NYX tube sheets to this dimension. Then, New York Ship fabricated a two-piece stainless steel strip jig to the 7.021 inch centers.

The jig was made of stainless steel to prevent errors that would result if carbon steel, with a different coefficient of expansion, were used under the wide range of temperatures in the shops. The jig was 18 feet 7-3/4 inches long, 18.124 inches wide and 1-1/4 inches thick. Holes were lined with hardened steel bushings into which drill and reamer slip bushings were inserted. Drill bushings were 1.21875 inches inside diameter and reamer bushings 1.250 inches.

The jig was used in conjunction with a tube pattern layout to drill the plenum sheets of the NYX unit. Plenum sheets were then used as jigs in drilling the tube sheets of the top and bottom tube sheet assemblies.

After trepanning operations on the tube sheets had been completed, variations in tube center spacing in the NYX unit were discovered and traced in part to the drill jig. Measurements by du Pont Inspectors using vernier calipers put the accumulative error of the jig as .080 inches in an overall length of 16 feet.

The resulting error in tube sheet pattern was not considered serious enough to warrant scrapping the sheets, and fabrication of the NYX unit was not interrupted, but a new 7.021-inch jig was bored with bushings more accurately centered.

Tube welding on the NYX unit made additional jigs necessary because of the varying shrinkage in the assemblies. Analysis of the results gave new expanded center distances as follows:

Plenum	7.027 inches
Top Tube Sheet	7.017
Bottom Tube Sheet	7.010

The new stainless steel strip jig with 7.021 centers represented a considerable investment. In order to use the jig, approval of the du Pont Atomic Energy Division was obtained to increase the expanded center spacing of the top tube sheet by .004 inches. Tube spacing of plenum and bottom tube sheet was increased by the same amount.

Jig spacings were, therefore, established as 7.031 inches for plenum, 7.021 inches for top tube sheet and 7.014 inches for the bottom tube sheet.

Fabrication of the new jigs caused a delay of approximately 30 days in the schedule of the first production unit (R Unit). In order to prevent an even longer delay because of slow delivery of stainless plate, the existing 7.000-inch jig was converted to 7.031-inch centers so that work could proceed on the "R" plenum. The original, out-of-tolerance 7.021-inch jig was utilized to make the 7.014-inch jig for bottom tube sheet assembly tube sheets. Jig drilling was done on a special Swiss jig borer at the du Pont Wilmington Shops.

In December, 1951, after the drilling of top tube sheet assembly tube sheets for the "R" Unit, the 7.021-inch jig was sent to the Wilmington Shops for checking on the Swiss jig borer. Seven holes at the end of one of the jig sections were found to be beyond average dimension variance of the other jigs. These holes were re-bushed and bored by du Pont.

When stainless plate was delivered, a new set of 7.000-inch center jigs was bored at the Wilmington Shops.

The four sets of jigs were then used without further modification on "R" and subsequent units.

4. Trepanned Tube Sheet Inspections

A. "R" Unit

(1) Plenum Chamber

a. Radial and Chord Measurements

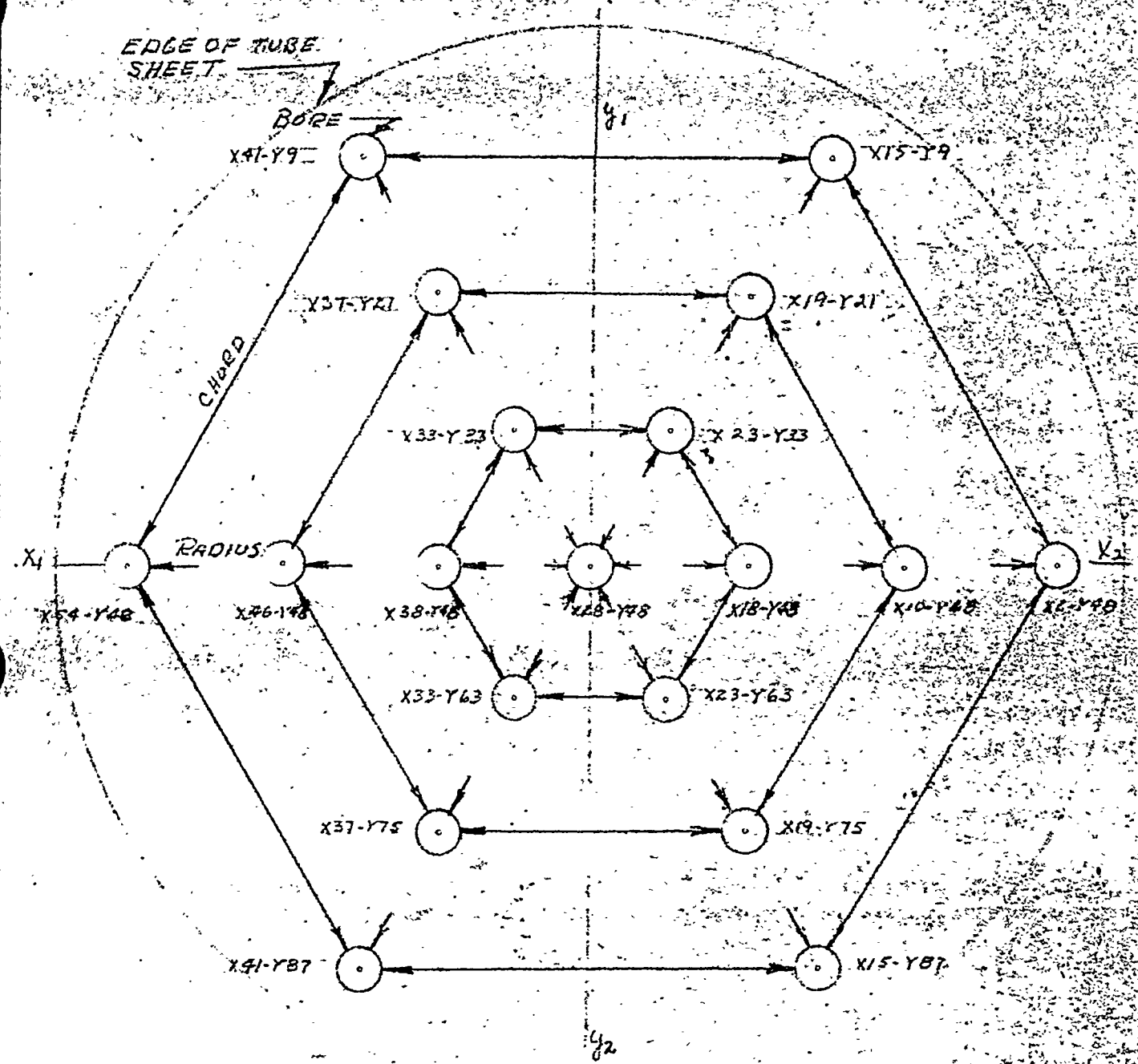
After the two tube sheets were drilled, reamed, trepanned, and chamfered, radius and chord measurements were taken on each plate. These measurements were taken to check the accuracy of tube hole location and to provide base measurements for later computation of weld shrinkage. Six radial measurements were taken from the center tube bore to six outside tube bores that formed the hexagonal patterns. (See Sketch #1) Chord measurements were taken around the periphery of the hexagonal patterns. All measurements were made from bore-to-bore of trepanned holes, which were checked with a bore gage and ring gage. A wood beam, equipped with a dial indicator on one end and a fixed point on the other, was used to take radial and chord measurements. (See Part I - Photo Serial #184) Pin gages were used to set the instrument to a predetermined basic length. Results of these measurements for the top plate are shown in Sketch #2. Results for the bottom plate are shown in Sketch #3. The bore diameters measured in the spider web tube pattern were not used to correct radius and chord measurements. In all cases, these holes were within the required tolerance; therefore, they were neglected when calculating the initial shrinkage pattern.

An example illustrating the mathematical method used for computing the initial shrinkage pattern for the top plate of the "R" Unit plenum chamber will be presented as follows:

(1) To Calculate the Average Radius:

First, add all six measurements from the center tube (X28-Y48) to each of the outboard tubes that form the largest hexagonal pattern, then divide by 6 to obtain average radius:

TOP SIDE OF TUBE SHEET



SKETCH #1

ENGINEERING SKETCH SHEET E. I. DU PONT DE NEMOURS & CO.	PROJ. No. 8980	SIGNATURE: J. Ray Lloyd
PROJ. TITLE: TREPANNED TUBE SHEET PATTERN MEASUREMENT DIAGRAM		DATE: 3-4-53
SUBJECT:		No. E-42319

Sheet P.C. 2-1

Date 12/19/51

"R" UNIT

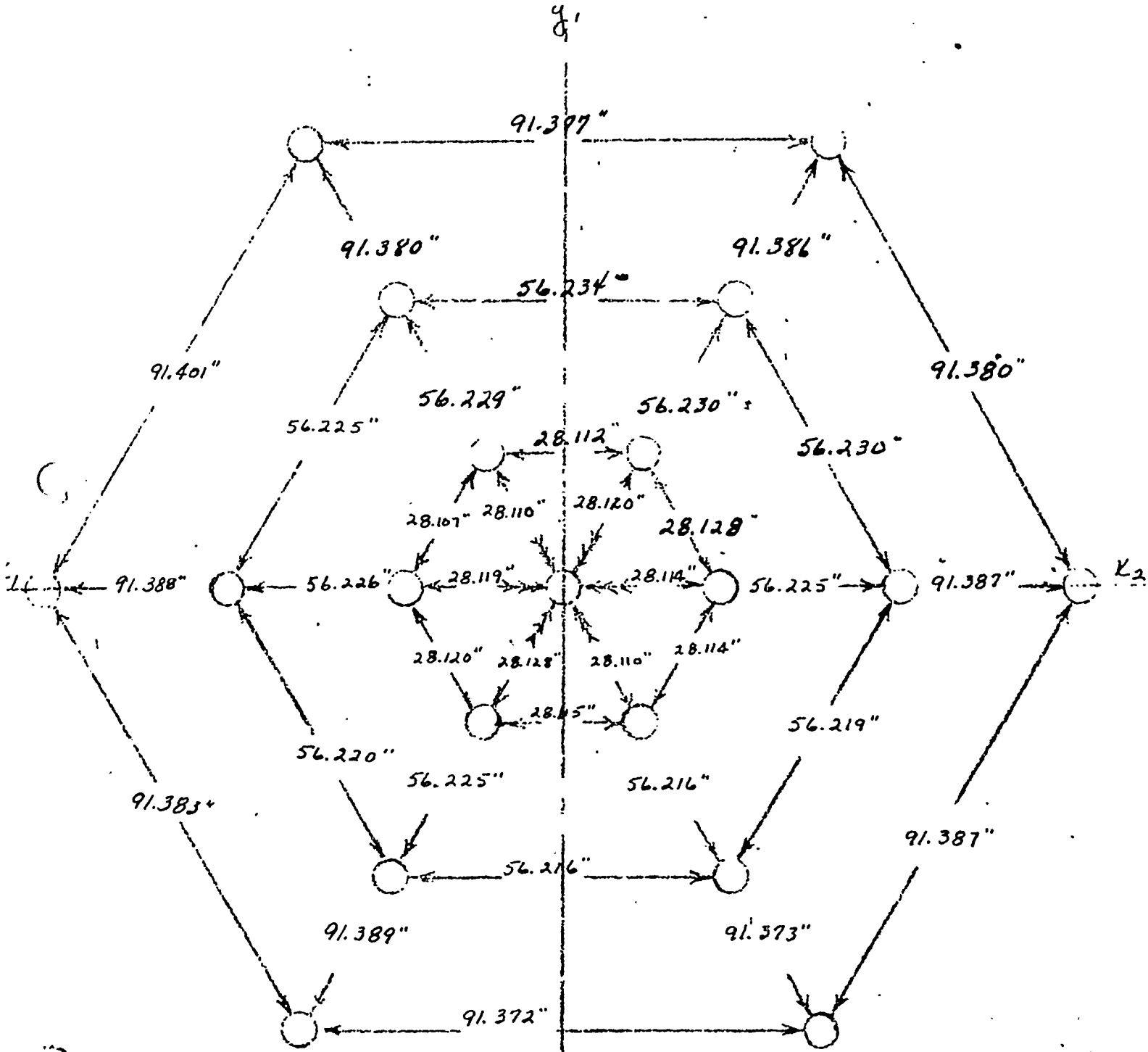
Basic Bore Meas: 5.250"

Basic Ligament Meas. 1 86.125"

2 51.031"

3 22.875"

TOP PLATE:



AV. RAD.	AV. CHORD	AV. OVERALL
91.383"	91.383"	91.383"
56.223"	56.224"	56.223"
28.116"	28.116"	28.116"

E:
LIGAMENT MEASUREMENTS MADE FROM INBOARD ADJACENT I.D'S. ON TREPANNED PLATE. THEY ARE NOT CORRECTED FOR TEMP.

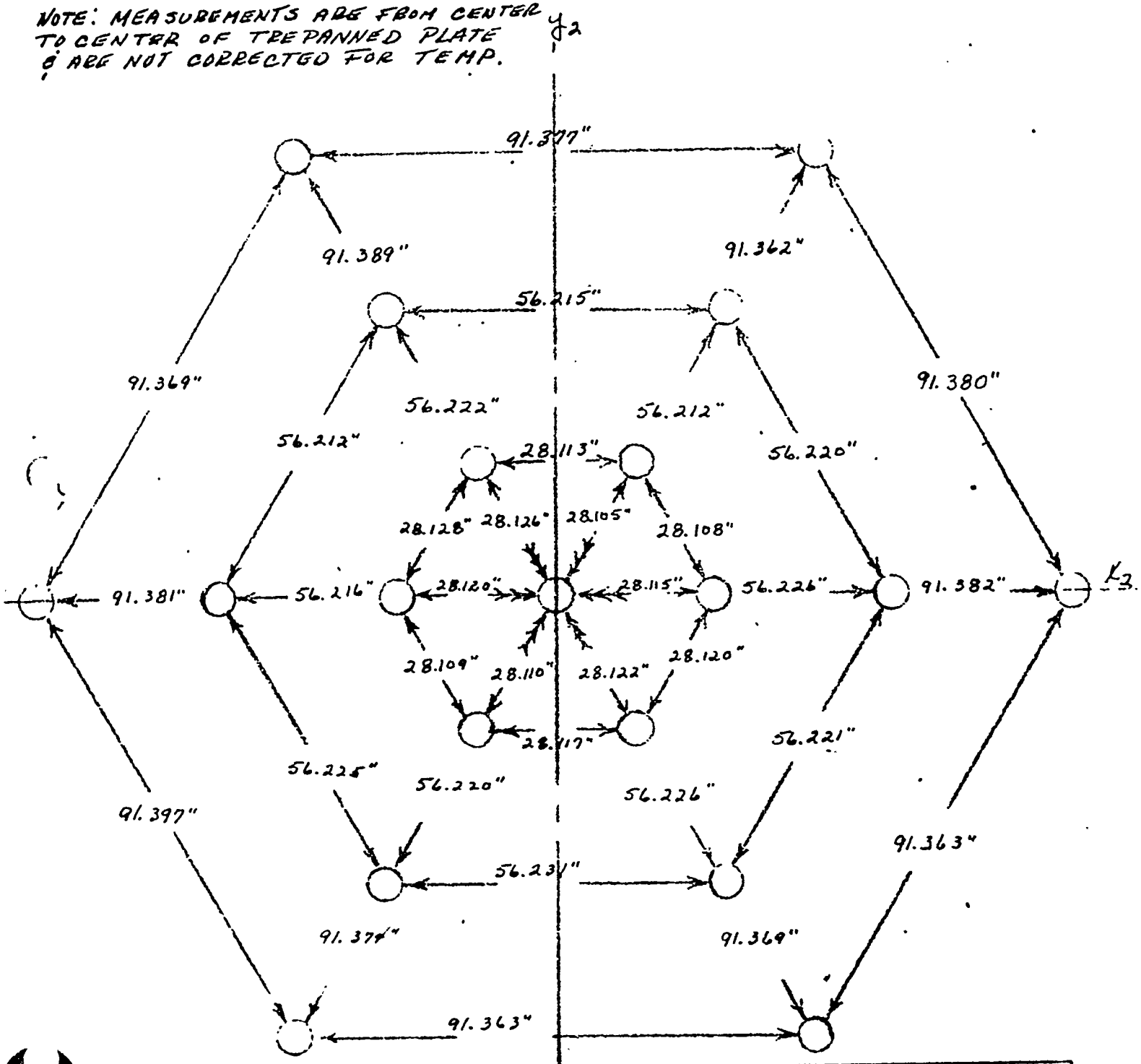
SKETCH #2

Sheet P.C. 2-2
Date 12/31/51
[illegible] "R" UNIT
[illegible]ument

Basic Bore Meas. 5.250"
Basic Ligament Meas. 1 86.125"
2 51.031"
3 22.875"

BOTTOM PLATE:

NOTE: MEASUREMENTS ARE FROM CENTER TO CENTER OF TREPANNED PLATE & ARE NOT CORRECTED FOR TEMP.



THEORETICAL
91.403"
56.248"
28.124"

AV. CHORD	AV. RAD.	AV. OVERALL
91.374"	91.376"	91.375"
56.220"	56.220"	56.220"
28.115"	28.116"	28.116"

SKETCH #3

Radial Distance From Coordinate

X28 - Y48 to X41 - Y87 = 91.389"

X28 - Y48 to X54 - Y48 = 91.388"

X28 - Y48 to X41 - Y9 = 91.380"

X28 - Y48 to X15 - Y9 = 91.386"

X28 - Y48 to X2 - Y49 = 91.387"

X28 - Y48 to X15 - Y87 = 91.373"

6)548.303

Average Radius = 91.383"

(2) To Calculate the Average Chord:

Second, add all six chord measurements on the outboard hexagon, then divide by 6 to obtain the average chord:

Chord Distance From Coordinate

X15 - Y87 to X41 - Y87 = 91.372"

X41 - Y87 to X54 - Y48 = 91.383"

X54 - Y48 to X41 - Y9 = 91.401"

X41 - Y9 to X15 - Y9 = 91.377"

X15 - Y9 to X2 - Y48 = 91.380"

X2 - X48 to X15 - Y87 = 91.387"

6)548.300

Average Chord = 91.383"

Since the outboard hexagonal pattern is symetrical, the radius equals the chord. To obtain an average overall figure, the average chord and average radius is added and then divided by 2. Thus,

91.383" Average Radius

91.383" Average Chord

2)182.766

91.383" = Average Overall

However, since all shrinkage measurements are based on diametrical measurements, which are more easily measured physically, the average overall figure is multiplied by 2.

Therefore,

$$91.383" \times 2 = 182.766"$$

which is the average diameter of the top plate. Likewise, the middle and inboard hexagonal patterns are calculated in a similar manner outlined above using the data on Sketch #2. However, these figures are of no significant value other than to check the accuracy of the trepanned tube sheet.

b. Repair of Plenum Chamber Plates

New York Ship drilled a rod tube hole in location X32 Y76 by mistake in both top and bottom plates. They notified the du Pont Inspection Department of this error and requested the latter to advise the method of repair required that was satisfactory. These holes were closed off with a cup-shaped plug as shown in Sketch #3A, 3" long, 1/4" wall thickness and O.D. the same as other rod tubes. These cups were faced off in the same manner as other rod tubes during the line boring operation.

(2) Top Tube Sheet

a. Radial and Chord Measurements

Same as Section 4A-(1)a above, except for results. See Sketches #4 and #5.

(3) Bottom Tube Sheet

a. Radial and Chord Measurements

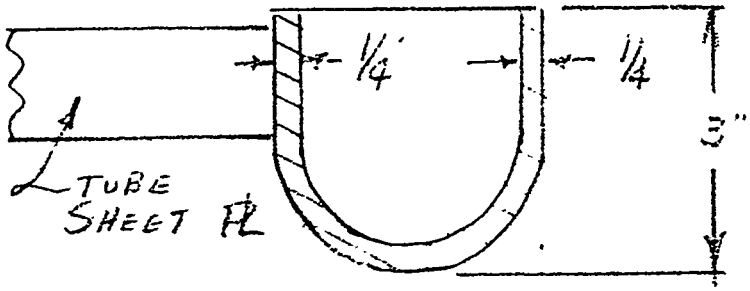
Same as Section 4A-(1)a above, except for results. See Sketches #6 and #7.

B. "P" Unit

(1) Plenum Chamber

a. Radial and Chord Measurements

Same as Section 4A-(1)a above, except for results. See Sketches #8 and #9.



CROSS SECTION
OF
CUP SHAPED PLUG

NOTE: BEFORE WELDING PLUG TO TUBE SHEET IT WAS HYDRO TESTED @ 1000 PSI FOR TEN MIN. & OK'ed.

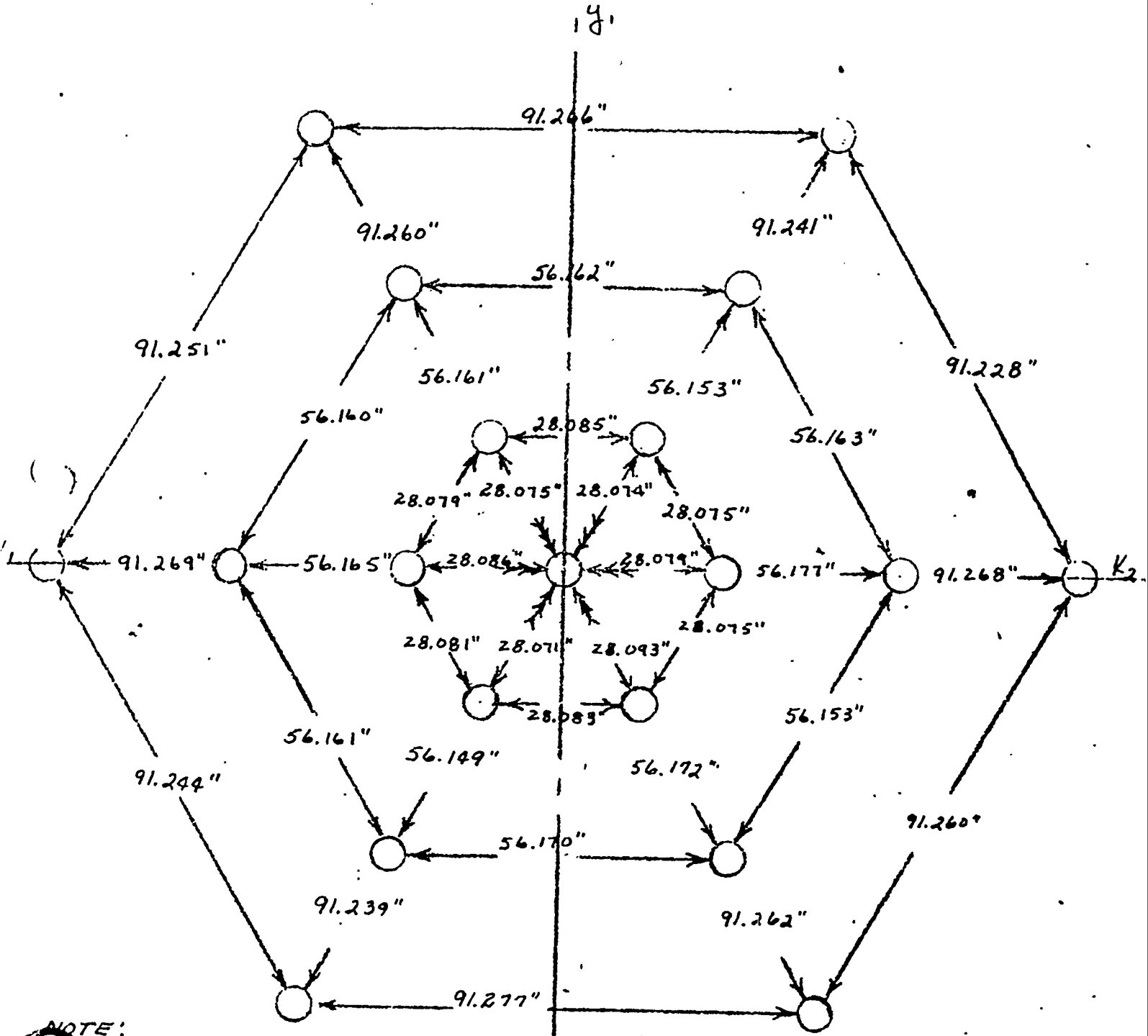
SKETCH # 3A

ENGINEERING SKETCH SHEET E. I. DU PONT DE NEMOURS & CO.	PROJ. No.	SIGNATURE:
PROJ. TITLE		DATE
SUBJECT:		No. E-42458 -

Sheet TTS 2-1
Date 12/4/51
Recorder "R" UNIT
Instrument

Basic Bore Meas. 5.000"
Basic Ligament Meas. 1 86.262"
2 51.125"
3 23.125"

TOP PLATE:



NOTE:
AMENT MEASUREMENTS MADE
M INBOARD ADJACENT I.D'S.
TREPANNED PLATE. THEY ARE
NOT CORRECTED FOR TEMP.

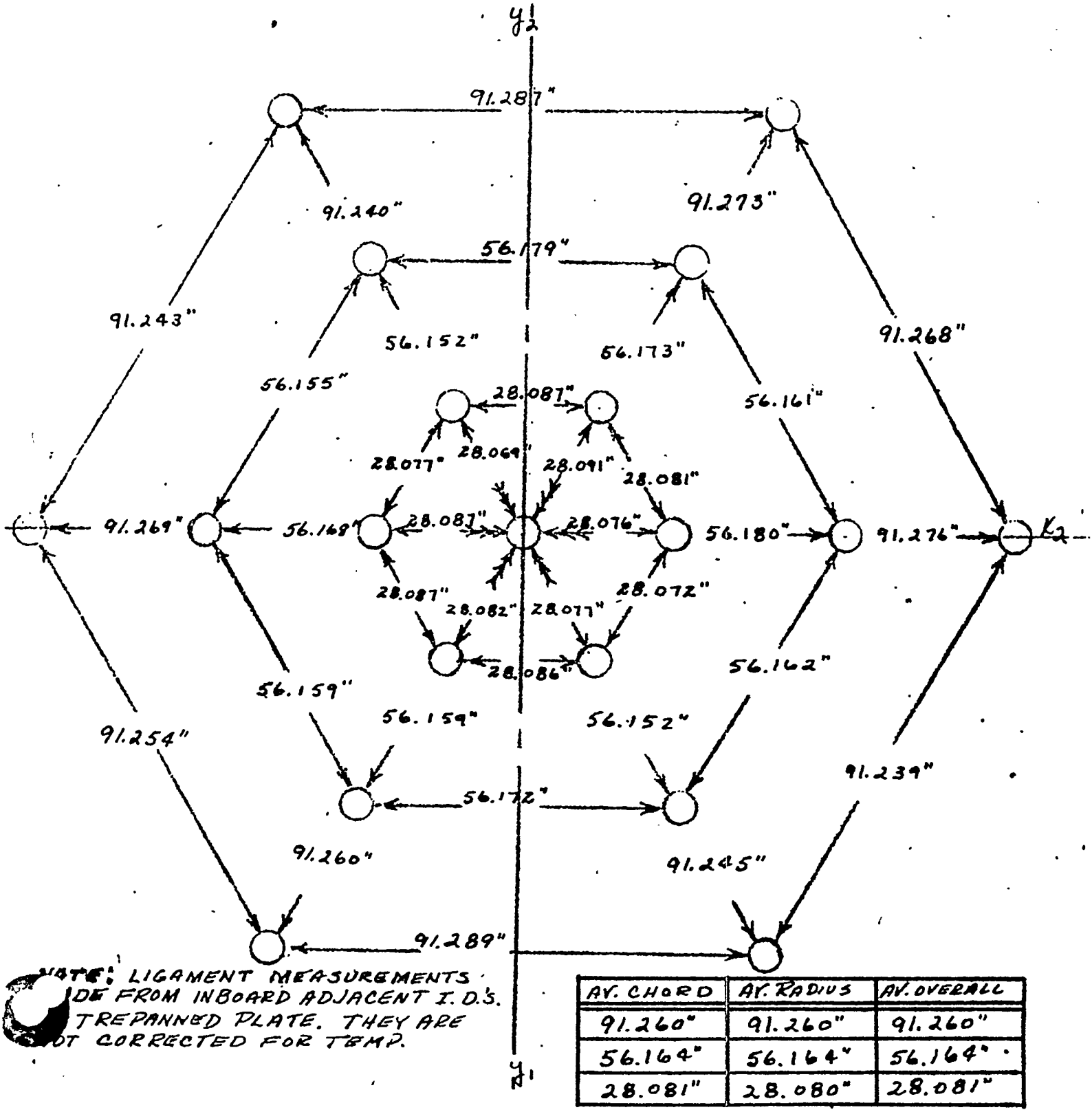
AV. RADIUS	AV. CHORD	AV. OVERALL
91.256"	91.254"	91.260"
56.162"	56.161"	56.164"
28.079"	28.079"	28.081"

SKETCH #4

Sheet TTS 2-2
Date 12/29/51
Recorder "R" UNIT
Instrument

Basic Bore Meas. 5.000"
Basic Ligament Meas. 1 86.187"
2 51.187"
3 23.062"

BOTTOM PLATE:



NOTE: LIGAMENT MEASUREMENTS MADE FROM INBOARD ADJACENT I.D.'S. OF TREPANNED PLATE. THEY ARE NOT CORRECTED FOR TEMP.

AV. CHORD	AV. RADIUS	AV. OVERALL
91.260"	91.260"	91.260"
56.164"	56.164"	56.164"
28.081"	28.080"	28.081"

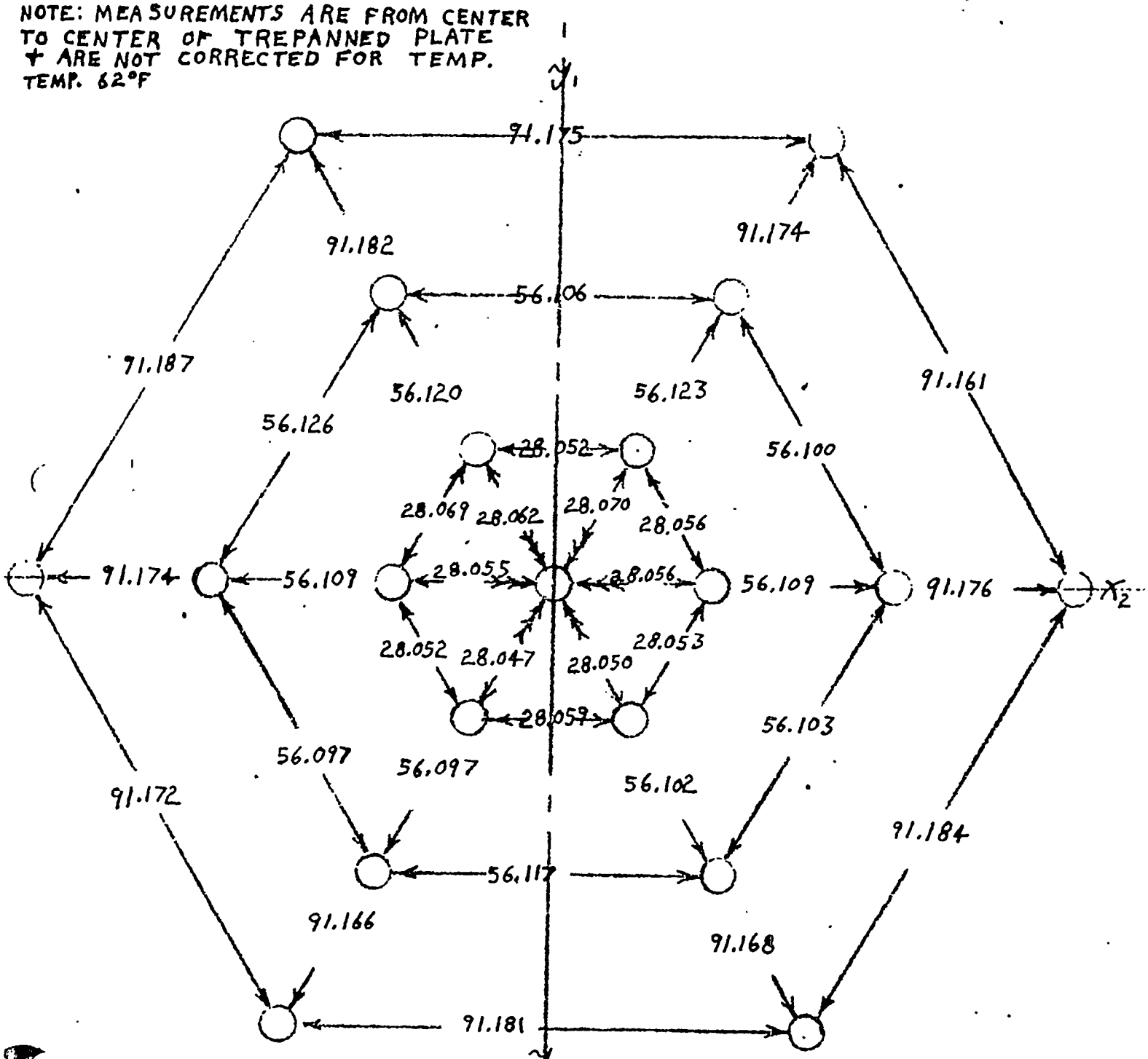
SKETCH #5

Sheet BTS 2-1
Date 12/27/51
Recorder "R" UNIT
Instrument

Basic Bore Meas. 3.906"
Basic Ligament Meas. 1 87.250"
2 52.250"
3 24.187"

TOP PLATE

NOTE: MEASUREMENTS ARE FROM CENTER TO CENTER OF TREPANNED PLATE + ARE NOT CORRECTED FOR TEMP.
TEMP. 62°F



THEORETICAL
91.182
56.112
28.056

AV. CHORD	AV. RAD.	AV. OVERALL
91.173	91.176	91.175
56.110	56.108	56.109
28.056	28.056	28.056

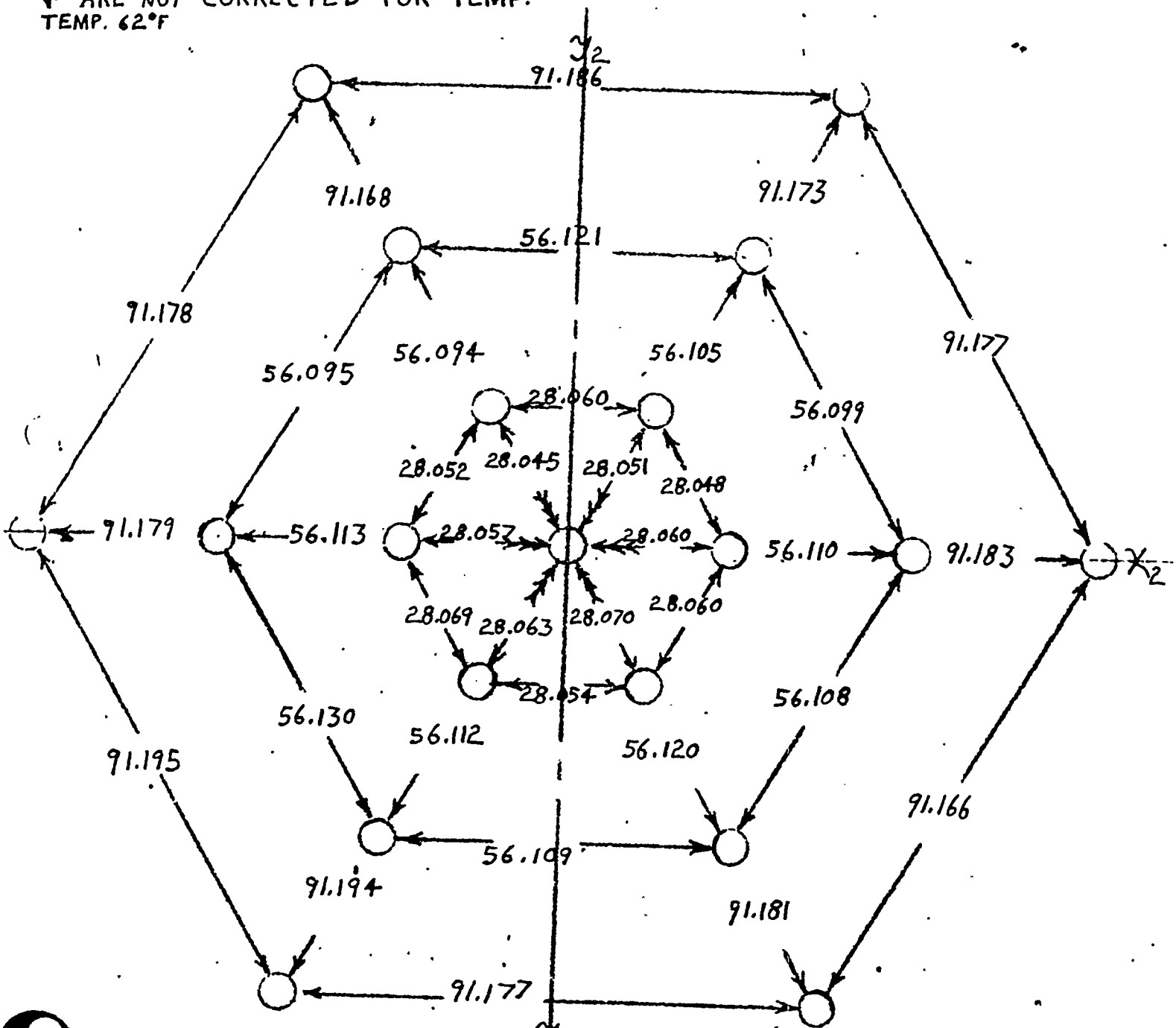
SKETCH #6

Sheet BTS 2-2
Date 12/29/51
Recorder "R" UNIT
Instrument

Basic Bore Meas. 3.940"
Basic Ligament Meas. 1 87.250
2 52.250
3 24.187

BOTTOM PLATE

NOTE: MEASUREMENTS ARE FROM CENTER TO CENTER OF TREPANNED PLATE + ARE NOT CORRECTED FOR TEMP. TEMP. 62°F



THEORETICAL
91.182
56.112
28.056

AV. CHORD	AV. RAD.	AV. OVERALL
91.179	91.179	91.179
56.110	56.109	56.109
28.057	28.057	28.057

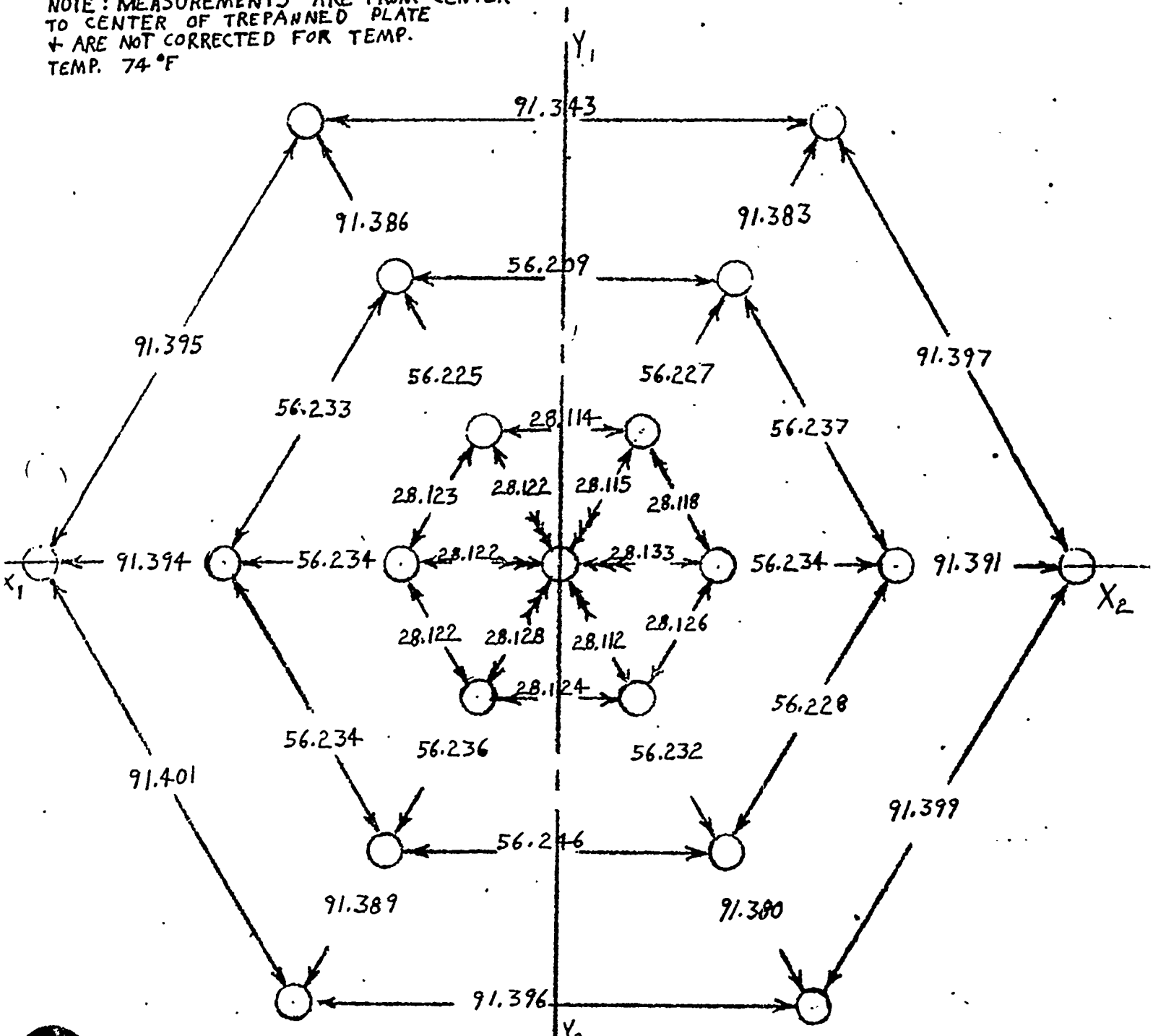
SKETCH #7

Sheet PC 3 - 1
Date 5/10/52
Recorder "P" UNIT
Instrument

Basic Bore Meas. 5.250"
Basic Ligament Meas. 1 22.875
2 51.031
3 86.125

TOP PLATE

NOTE: MEASUREMENTS ARE FROM CENTER TO CENTER OF TREPANNED PLATE + ARE NOT CORRECTED FOR TEMP.
TEMP. 74 °F



THEORETICAL
.
.
.

AV. CHORD	AV. RAD.	AV. OVERALL
91.388	91.387	91.388
56.231	56.231	56.231
28.121	28.122	28.122

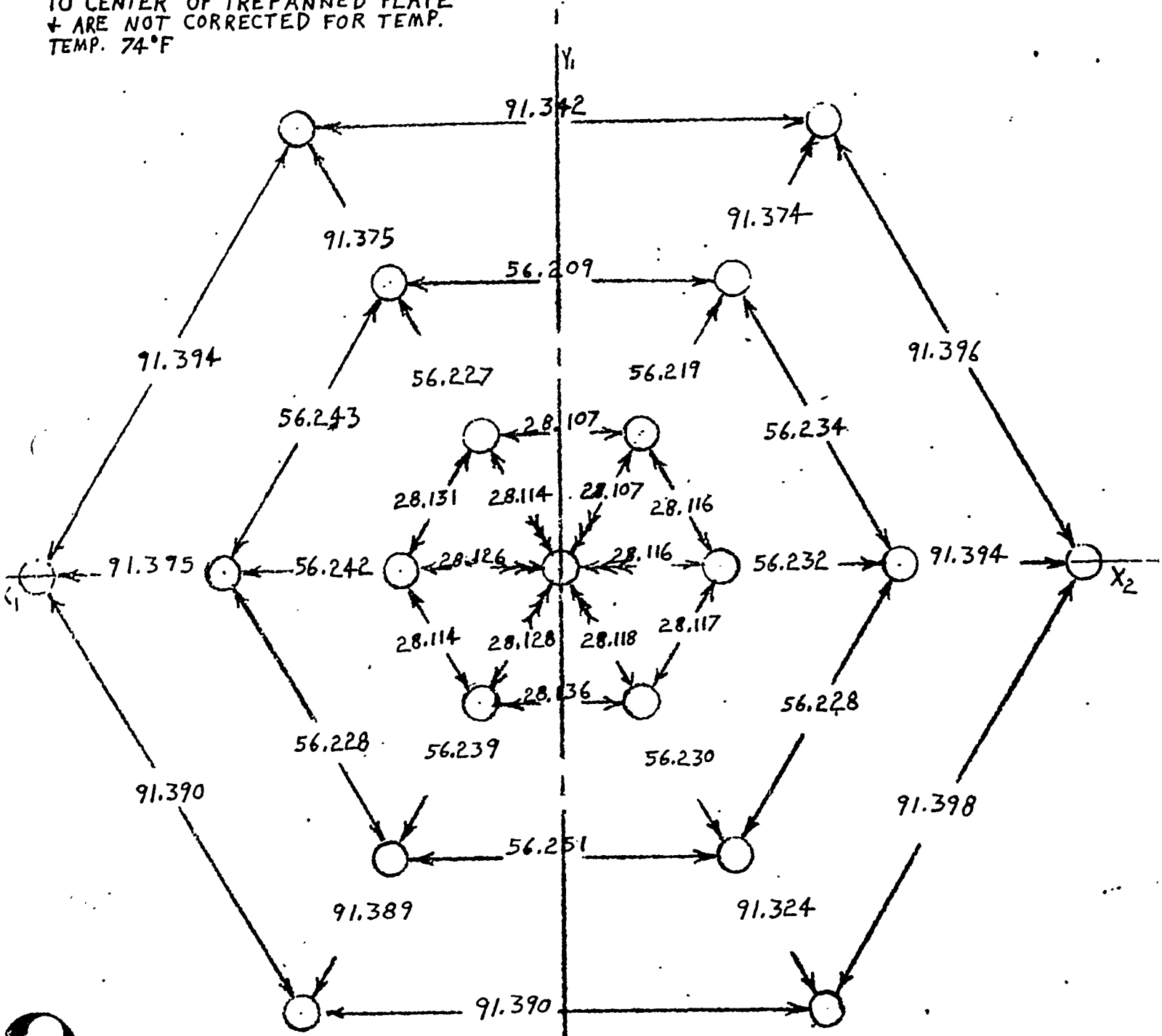
SKETCH # 8

Sheet PC 3-2
Date 5/10/52
Order "P" UNIT
Instrument

Basic Bore Meas. 5.250"
Basic Ligament Meas. 1 22.875
2 51.031
3 86.125

BOTTOM PLATE

NOTE: MEASUREMENTS ARE FROM CENTER TO CENTER OF TREPANNED PLATE + ARE NOT CORRECTED FOR TEMP. TEMP. 74°F



THEORETICAL
.
.
.

AV. CHORD	AV. RAD.	AV. OVERALL
91.385	91.375	91.380
56.233	56.232	56.233
28.120	28.118	28.119

SKETCH # 9

(2) Top Tube Sheet

a. Radial and Chord Measurements

Same as Section 4A-(1)a above, except for results. See Sketches #10 and #11.

(3) Bottom Tube Sheet

a. Radial and Chord Measurements

Same as Section 4A-(1)a above, except for results. See Sketches #12 and #13.

C. "L" Unit

(1) Plenum Chamber

a. Radial and Chord Measurements

Same as Section 4A-(1)a above, except for results. See Sketches #14 and #15.

(2) Top Tube Sheet

a. Radial and Chord Measurements

Same as Section 4A-(1)a above, except for results. See Sketches #16 and #17.

(3) Bottom Tube Sheet

a. Radial and Chord Measurements

Same as Section 4A-(1)a above, except for results. See Sketches #18 and #19.

5. Dimensional Check of Tube Sheet Ligaments and Bores

A. "R" Unit

(1) Plenum Chamber Tube Sheets (Top & Bottom)

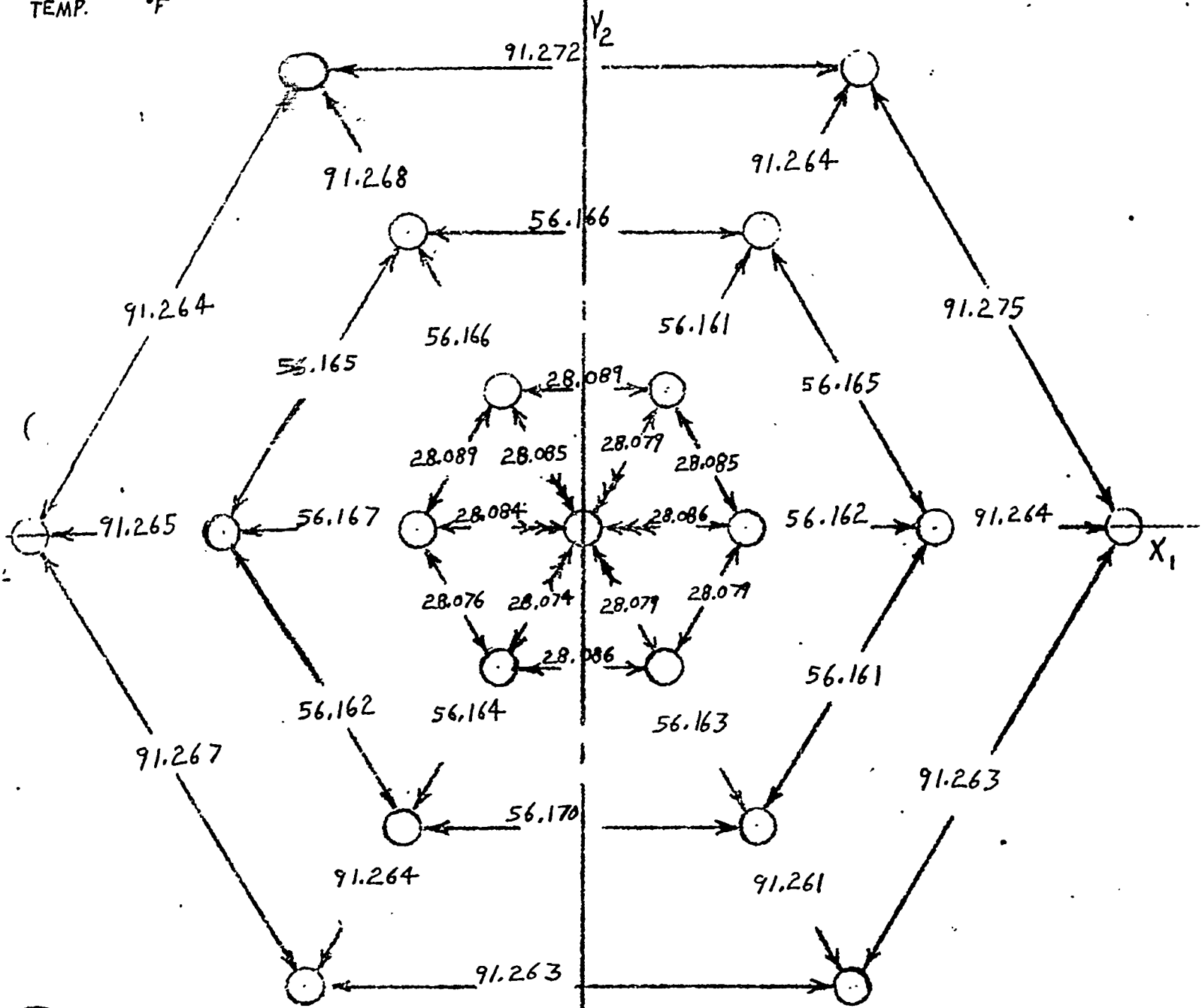
Ligament measurements on both the top and bottom tube sheets for this unit were taken to determine if the center-to-center distance between any two holes was within tolerance, and also to determine if the trepanned tube holes measured were in proper relation to one another. Ligament measurements were taken in that portion of the tube sheet pattern shown in Sketch #20. These measurements were taken using the newly developed ligament gage (Item #1, Photo Serial #282) for "R" and subsequent units. It was found through use of this ligament gage that it was more accurate and that tube sheet ligaments could be measured in a

Sheet TTS-3-1
Date 4/22/52
Order "P" UNIT
Instrument

Basic Bore Meas. 5.000
Basic Ligament Meas. 1 23.125
2 51.031
3 86.300

TOP PLATE

NOTE: MEASUREMENTS ARE FROM CENTER TO CENTER OF TREPANNED PLATE + ARE NOT CORRECTED FOR TEMP.
TEMP. °F



THEORETICAL
91.273
56.168
28.084

AV. CHORD	AV. RAD.	AV. OVERALL
91.267	91.264	91.265
56.164	56.163	56.164
28.084	28.081	28.082

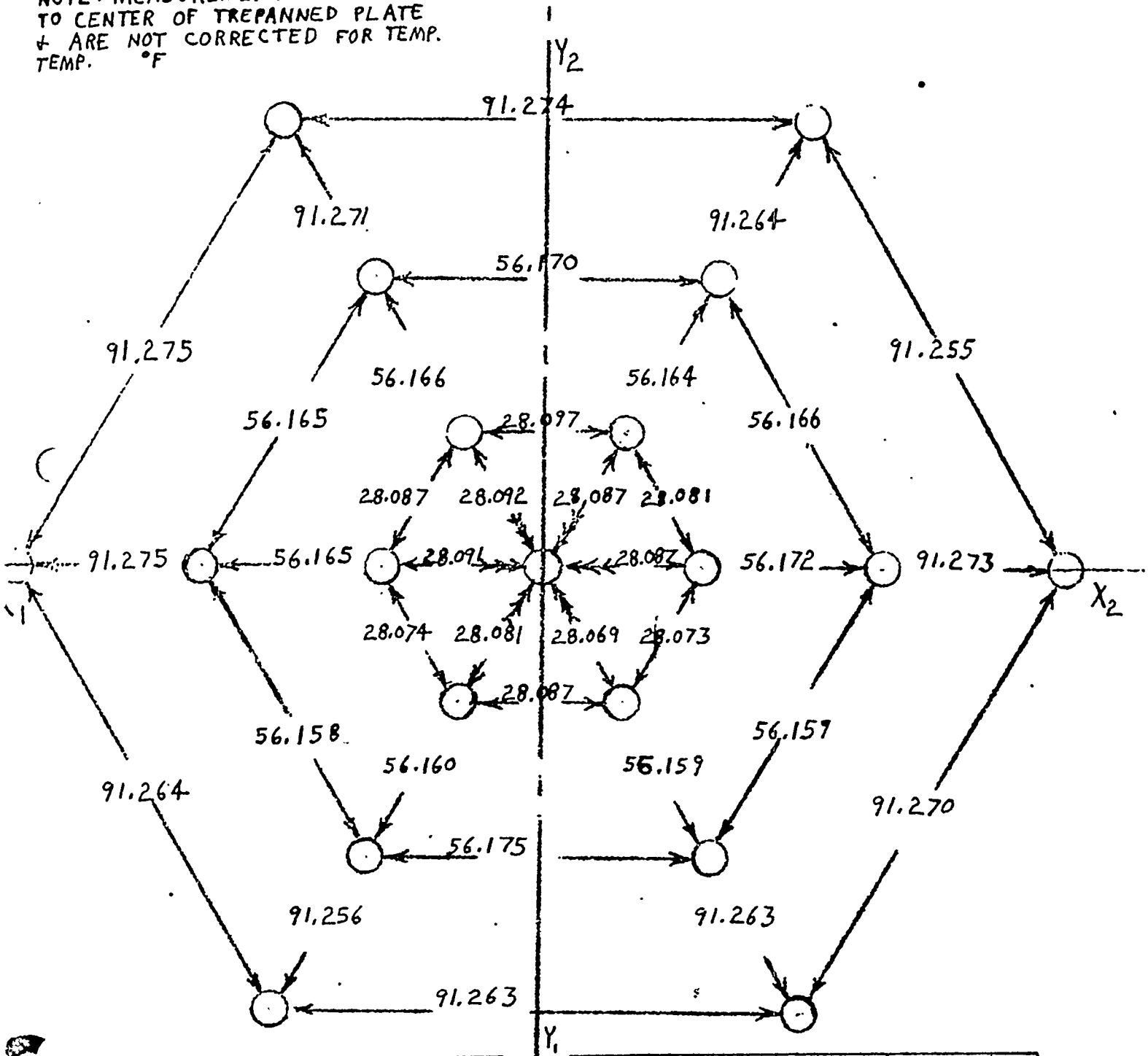
SKETCH # 10

Sheet TTS 3-2
Date 5/3/52
Recorder "P" UNIT
Instrument

Basic Bore Meas. 5.000
Basic Ligament Meas. 1 86.275
2 51.125
3 23.125

BOTTOM PLATE

NOTE: MEASUREMENTS ARE FROM CENTER TO CENTER OF TREPANNED PLATE & ARE NOT CORRECTED FOR TEMP.
TEMP. °F



THEORETICAL
91.273
56.168
28.084

AV. CHORD	AV. RAD.	AV. OVERALL
91.266	91.267	91.266
56.164	56.164	56.164
28.083	28.084	28.083

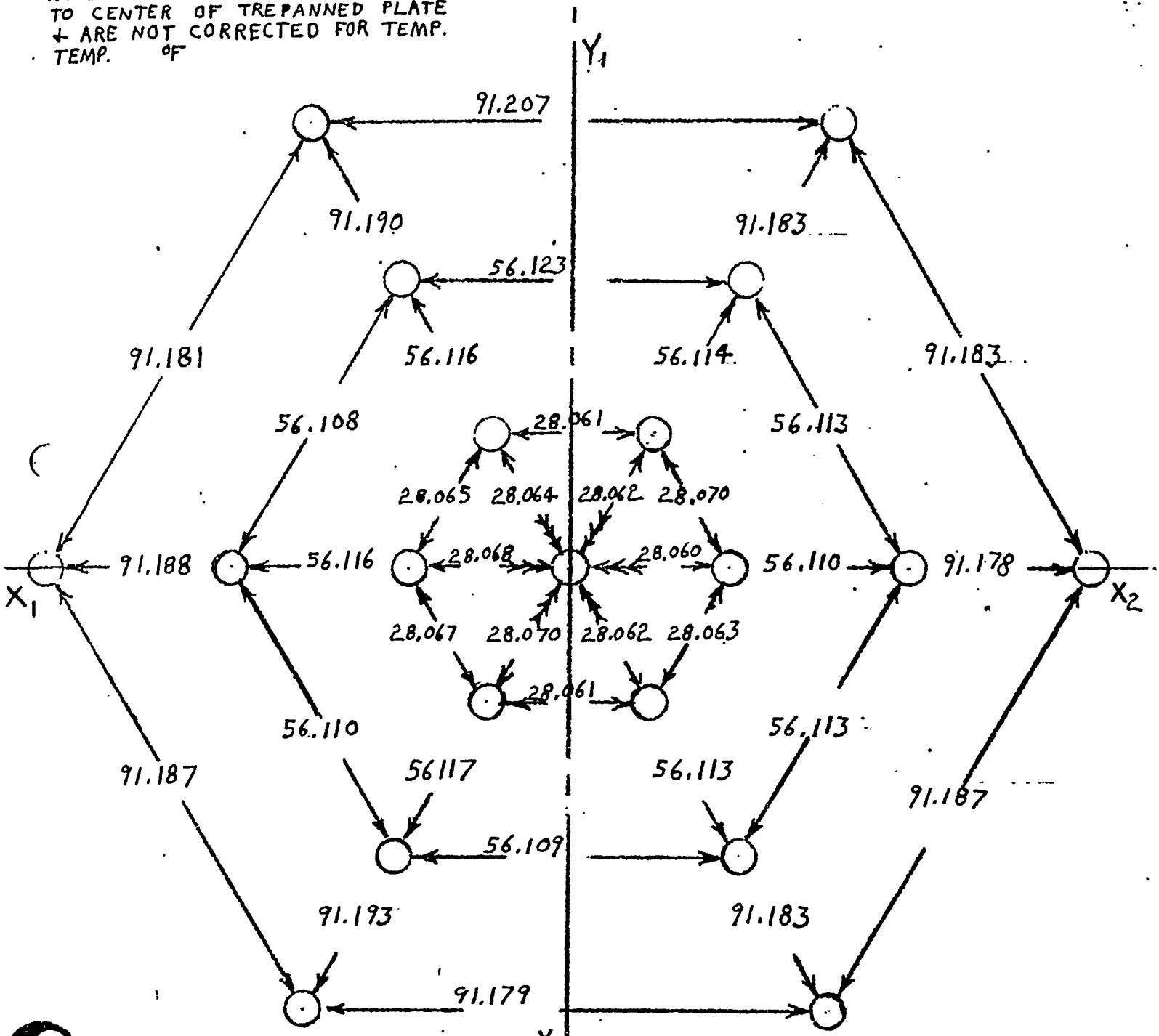
SKETCH # 11

Sheet BTS 3-1
Date 4/10/52
Order "P" UNIT
Instrument

Basic Bore Meas. 3.936
Basic Ligament Meas. 1 87.250
2 52.250
3 24.217

TOP PLATE

NOTE: MEASUREMENTS ARE FROM CENTER TO CENTER OF TREPANNED PLATE + ARE NOT CORRECTED FOR TEMP.
TEMP. °F



THEORETICAL
91.182
56.112
28.056

AV. CHORD	AV. RAD.	AV. OVERALL
91.187	91.185	91.186
56.112	56.114	56.113
28.064	28.064	28.064

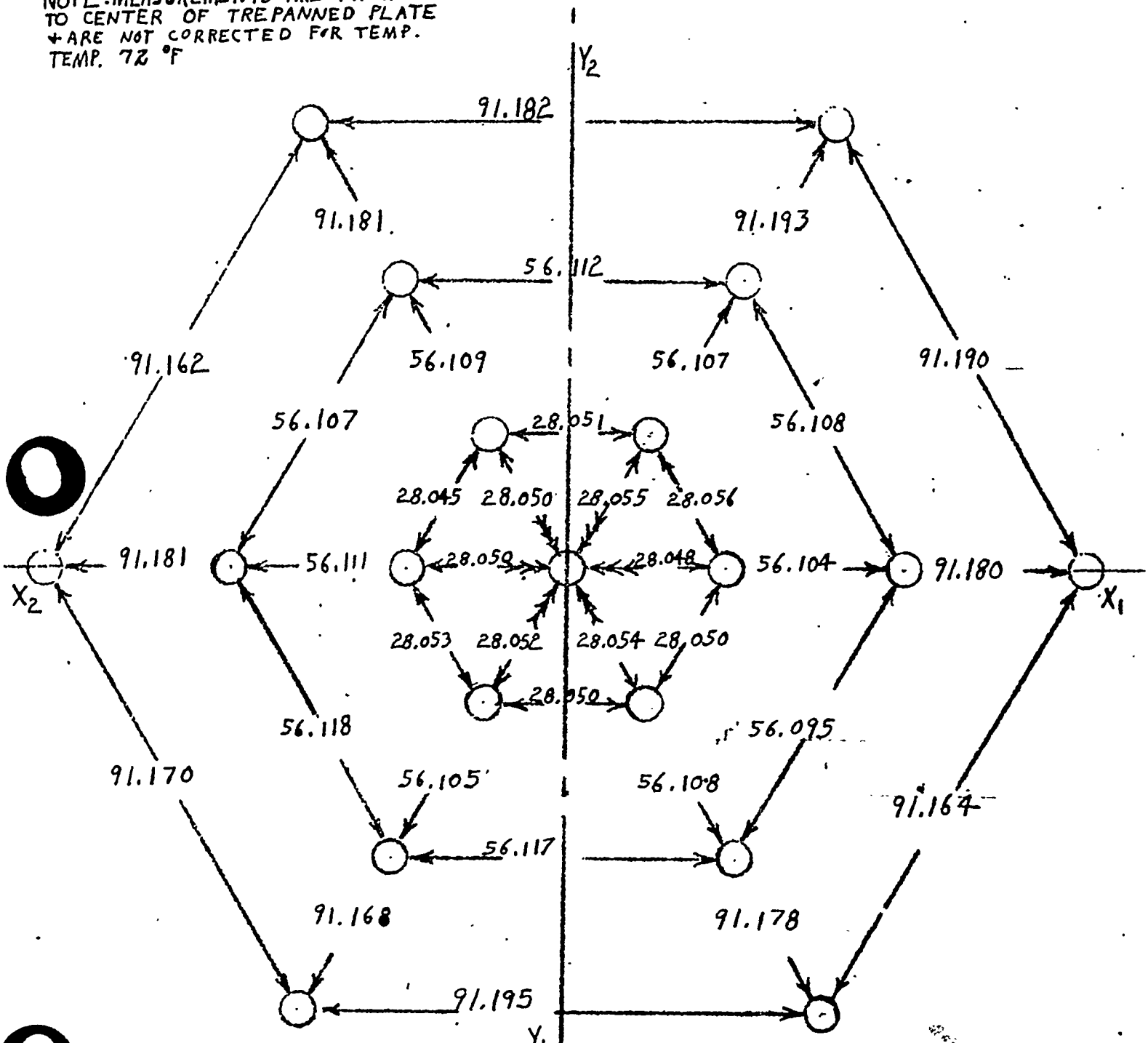
SKETCH #12

Sheet BTS 3-2
Date 4/14/52
Order "P" UNIT
Instrument

Basic Bore Meas. 3.936
Basic Ligament Meas. 1 87.234
2 52.170
3 24.114

BOTTOM PLATE

NOTE: MEASUREMENTS ARE FROM CENTER TO CENTER OF TREPANNED PLATE + ARE NOT CORRECTED FOR TEMP. TEMP. 72 °F



THEORETICAL
.
.
.

AV. CHORD	AV. RAD.	AV. OVERALL
28.051	28.052	28.051
56.110	56.107	56.108
91.177	91.180	91.179

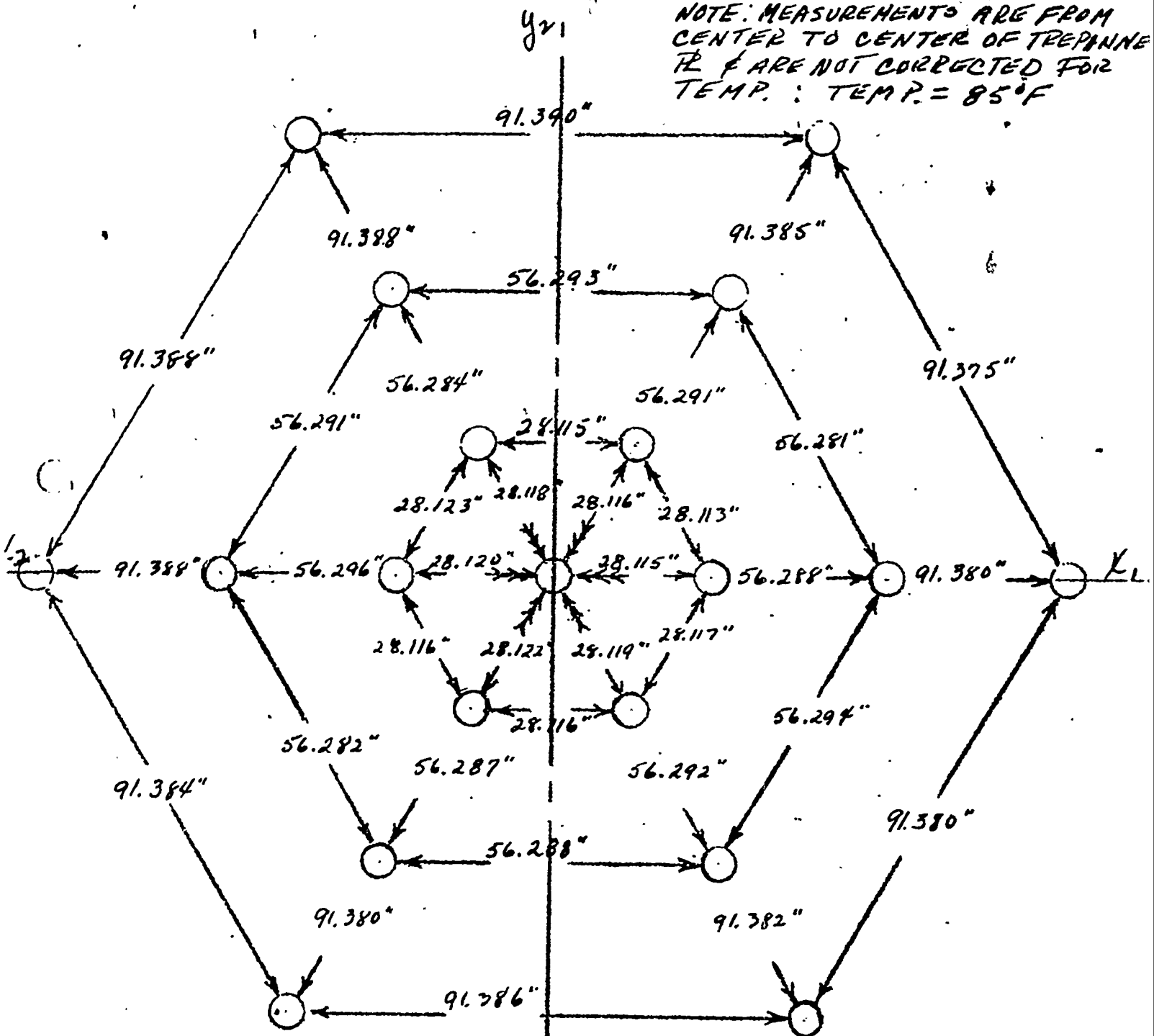
SKETCH #13

Sheet P.C. 4-1
Date 7/22/52
Recorder "L" UNIT
Document

Basic Bore Meas. 5.250"
Basic Ligament Meas. 1 22.875"
2 51.023"
3 86.124"

TOP PLATE:

NOTE: MEASUREMENTS ARE FROM CENTER TO CENTER OF TREPHINE
R & F ARE NOT CORRECTED FOR TEMP. : TEMP. = 85°F



AV. RADIUS	AV. CHORD	AV. OVERALL
28.118"	28.117".	28.118"
56.290"	56.288"	56.289"
91.384"	91.384"	91.384"

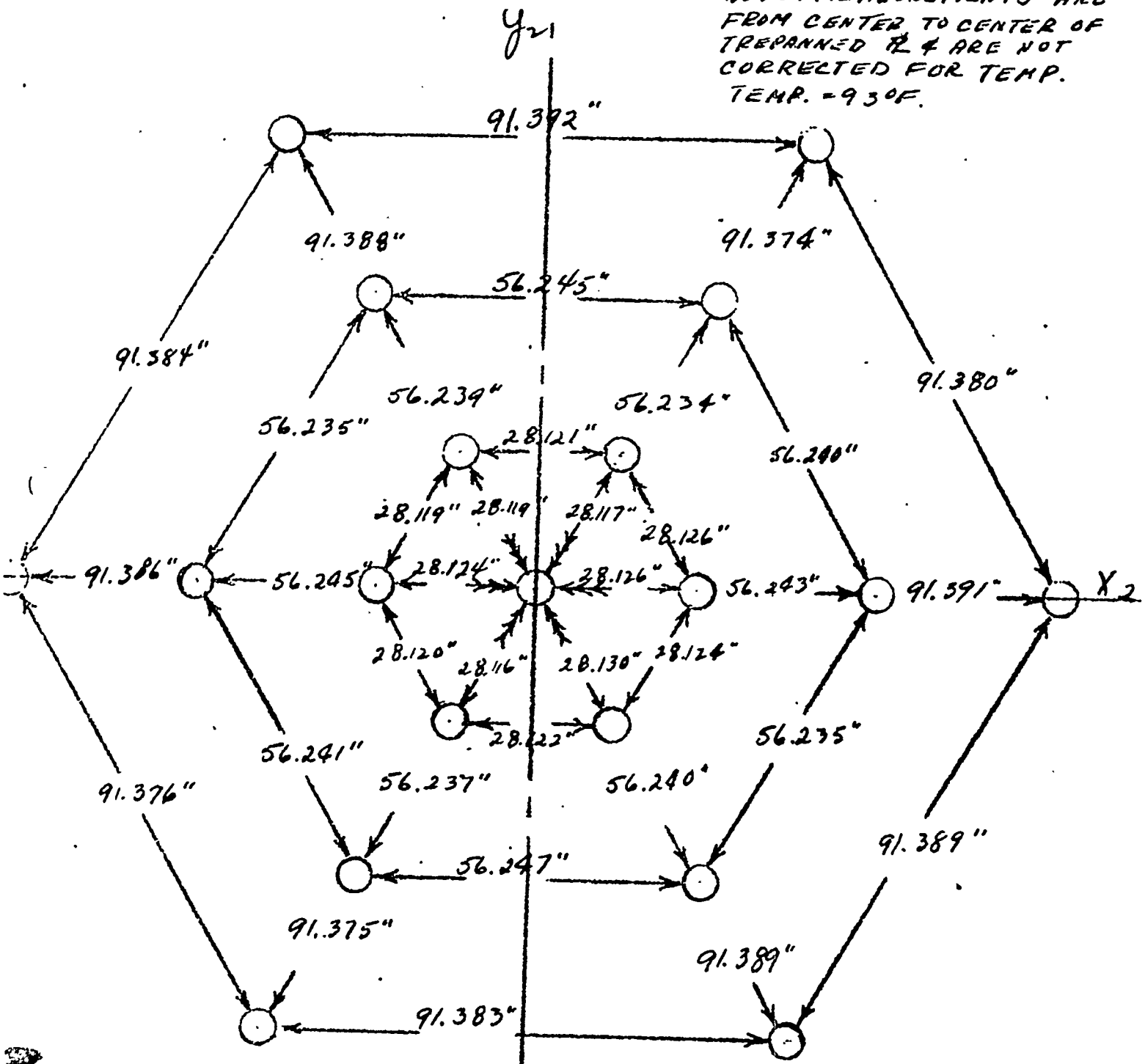
SKETCH #14

Sheet P.C. 4-2
Date 7/23/52
Recorder "L" UNIT
Instrument

Basic Bore Meas. 5.250"
Basic Ligament Meas. 1 22.875"
2 51.031"
3 86.130"

BOTTOM PLATE

NOTE: MEASUREMENTS ARE FROM CENTER TO CENTER OF TREPANNED ℄ ARE NOT CORRECTED FOR TEMP. TEMP. = 93°F.



AV. RADIUS	AV. CHORD	AV. OVERALL
28.122"	28.122"	28.122"
56.240"	56.241"	56.241"
91.384"	91.384"	91.384"

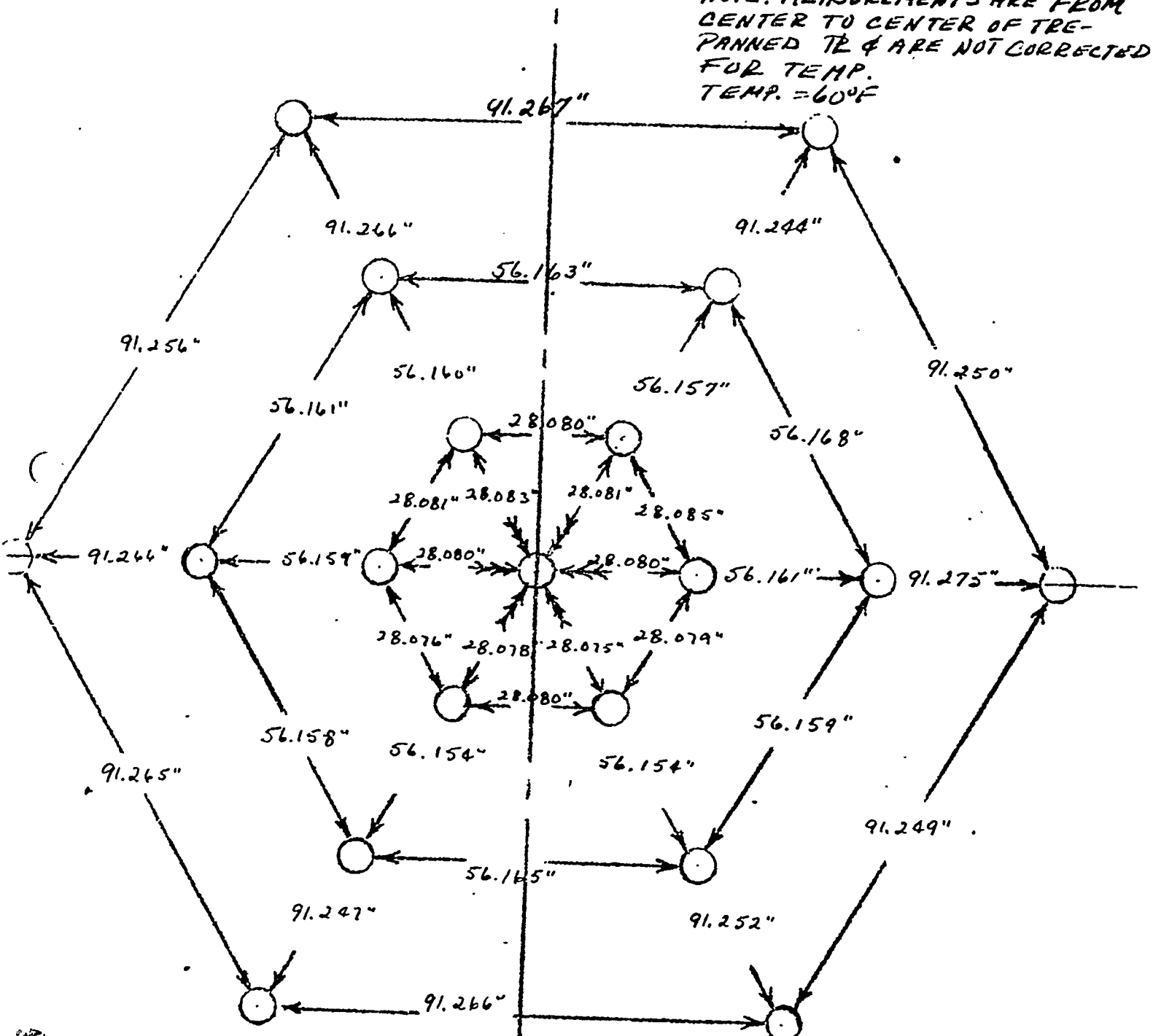
SKETCH #15

Sheet TTS4-1
Date 8/1/52
Recorder "L" UNIT
Instrument

Basic Bore Meas. 5.000"
Basic Ligament Meas. 1 86.250"
2 51.031"
3 23.125"

TOP PLATE:

NOTE: MEASUREMENTS ARE FROM CENTER TO CENTER OF TRE-PANNED TR & ARE NOT CORRECTED FOR TEMP.
TEMP. = 60°F



AV. RADIUS	AV. CHORD	AV. OVERALL
28.080"	28.080"	28.080"
56.158"	56.162"	56.160"
91.258"	91.259"	91.259"

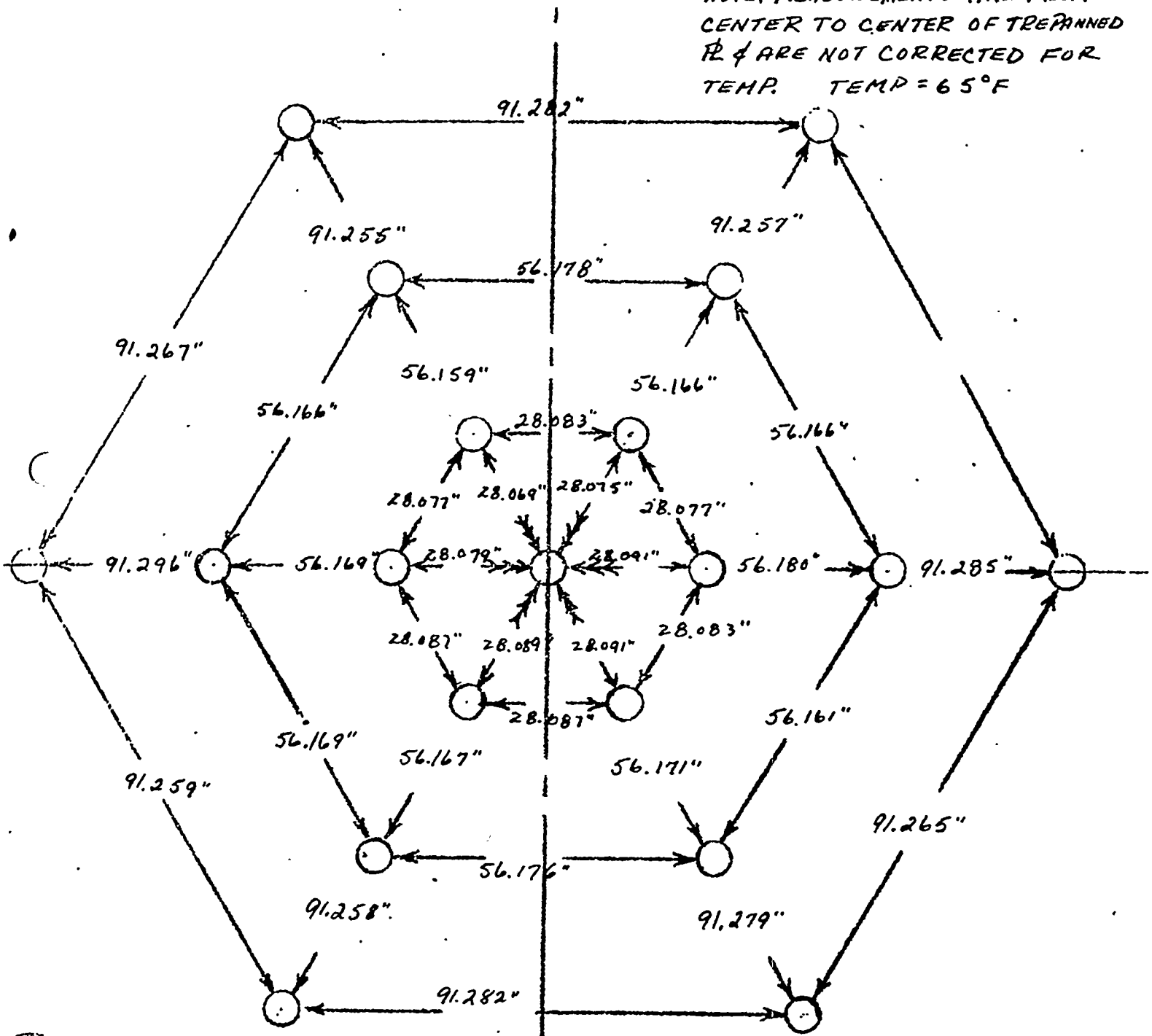
SKETCH #16

Sheet TTS 4-2
Date 8/21/52
~~Order~~ "L" UNIT
~~Instrument~~

Basic Bore Meas. 5.000"
Basic Ligament Meas. 1 23.125"
2 51.031"
3 86.300"

BOTTOM PLATE:

NOTE: MEASUREMENTS ARE FROM CENTER TO CENTER OF TREPANNED ℄ & ARE NOT CORRECTED FOR TEMP. TEMP = 65°F



AV. RADIUS	AV. CHORD	AV. OVERALL
28.082"	28.082"	28.082"
56.169"	56.169"	56.169"
91.272"	91.270"	91.271"

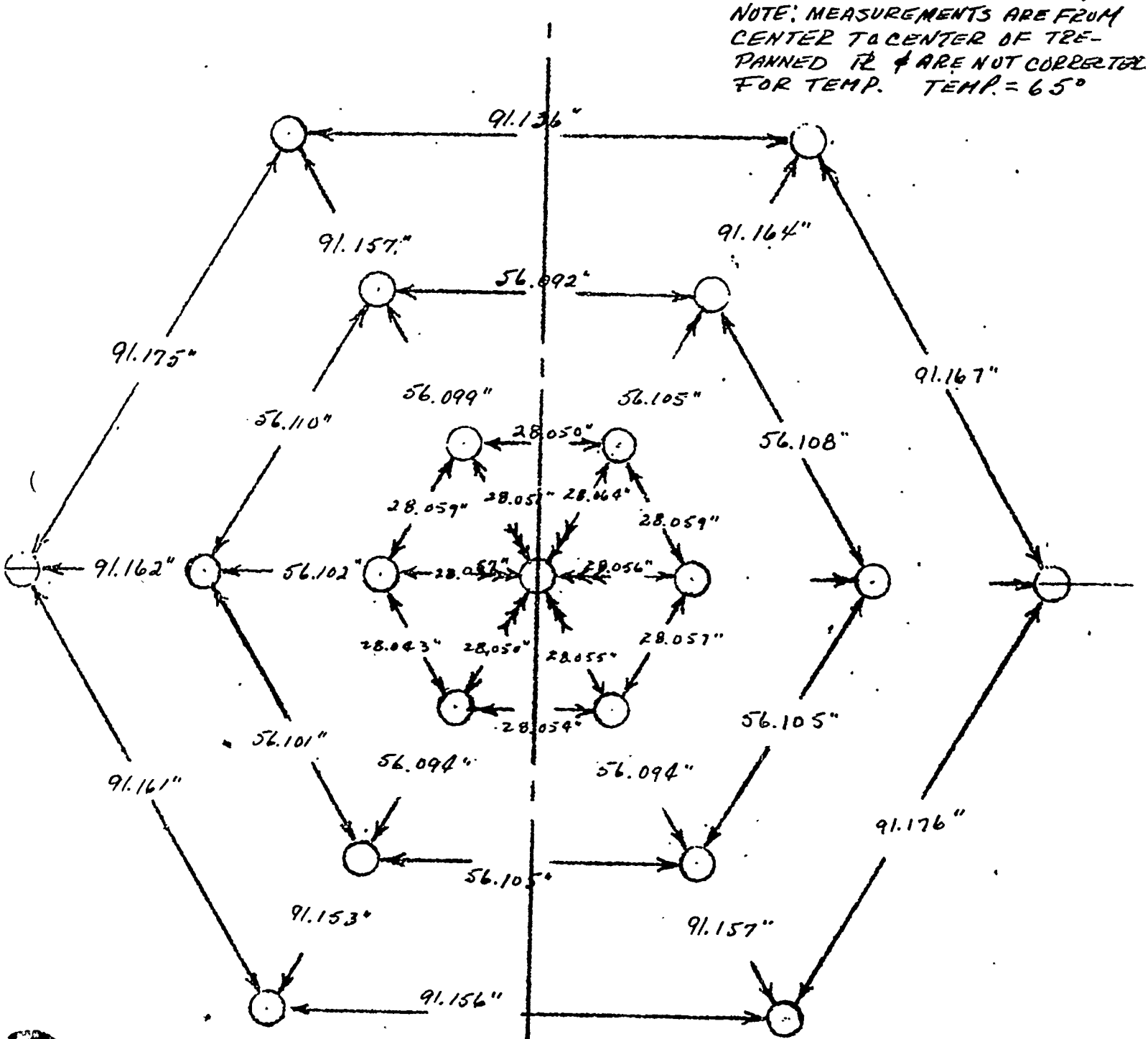
SKETCH # 17

Sheet BTS-4-1
Date 7/4/52
Recorder "L" UNIT
Instrument

Basic Bore Meas. 3.938
Basic Ligament Meas. 1 87.250"
2 52.250"
3 24.125"

TOP PLATE

NOTE: MEASUREMENTS ARE FROM CENTER TO CENTER OF TRE-PANNED Ø & ARE NOT CORRECTED FOR TEMP. TEMP. = 65°



AV. RADIUS	AV. CHORD	AV. OVERALL
28.056"	28.054"	28.055"
56.100"	56.104"	56.102"
91.160"	91.162"	91.161"

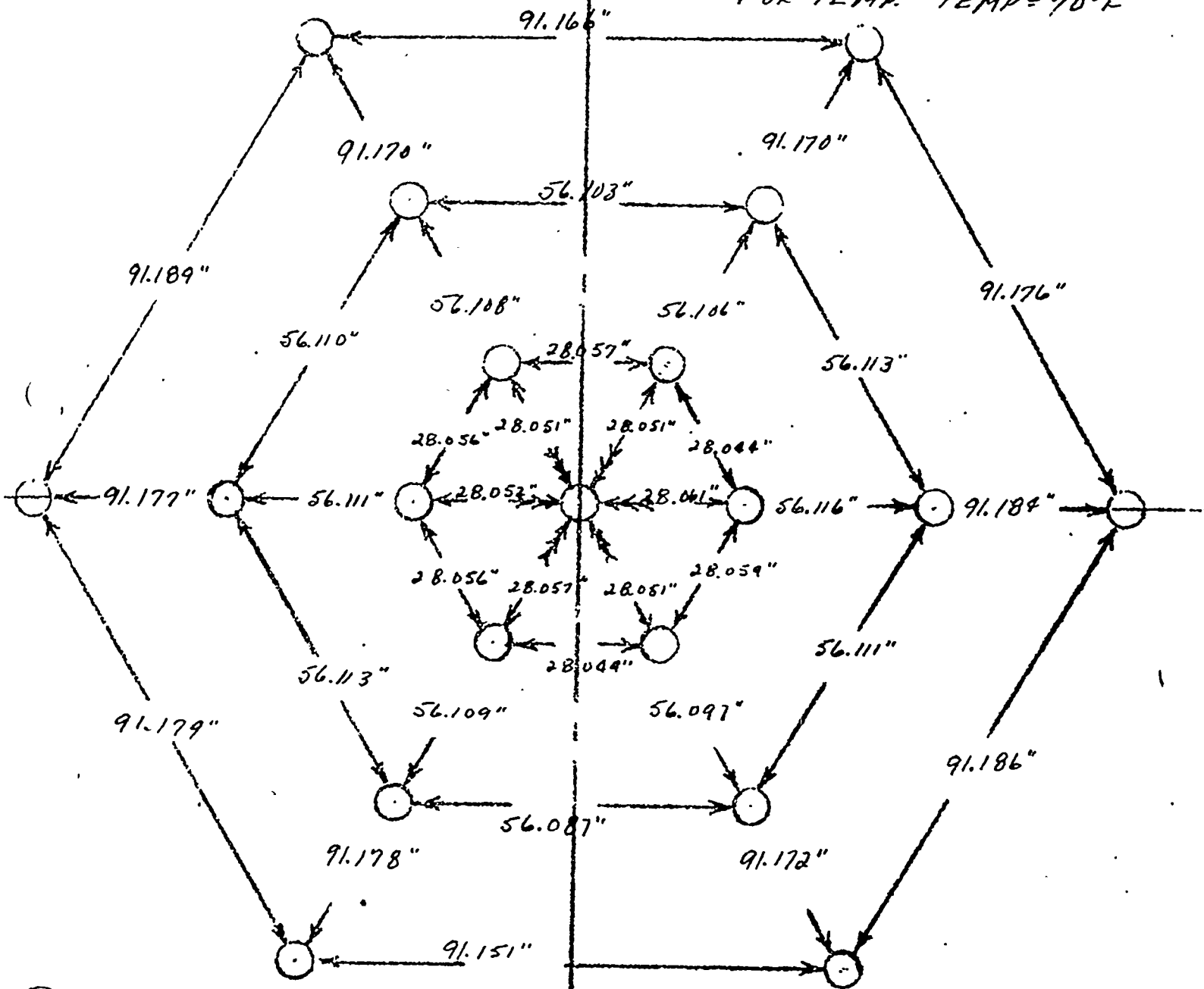
SKETCH #18

Sheet BTS 4-2
Date 7/10/52
Recorder "L" UNIT
Instrument

Basic Bore Meas. 3.938"
Basic Ligament Meas. 1 87.250"
2 52.250"
3 24.125"

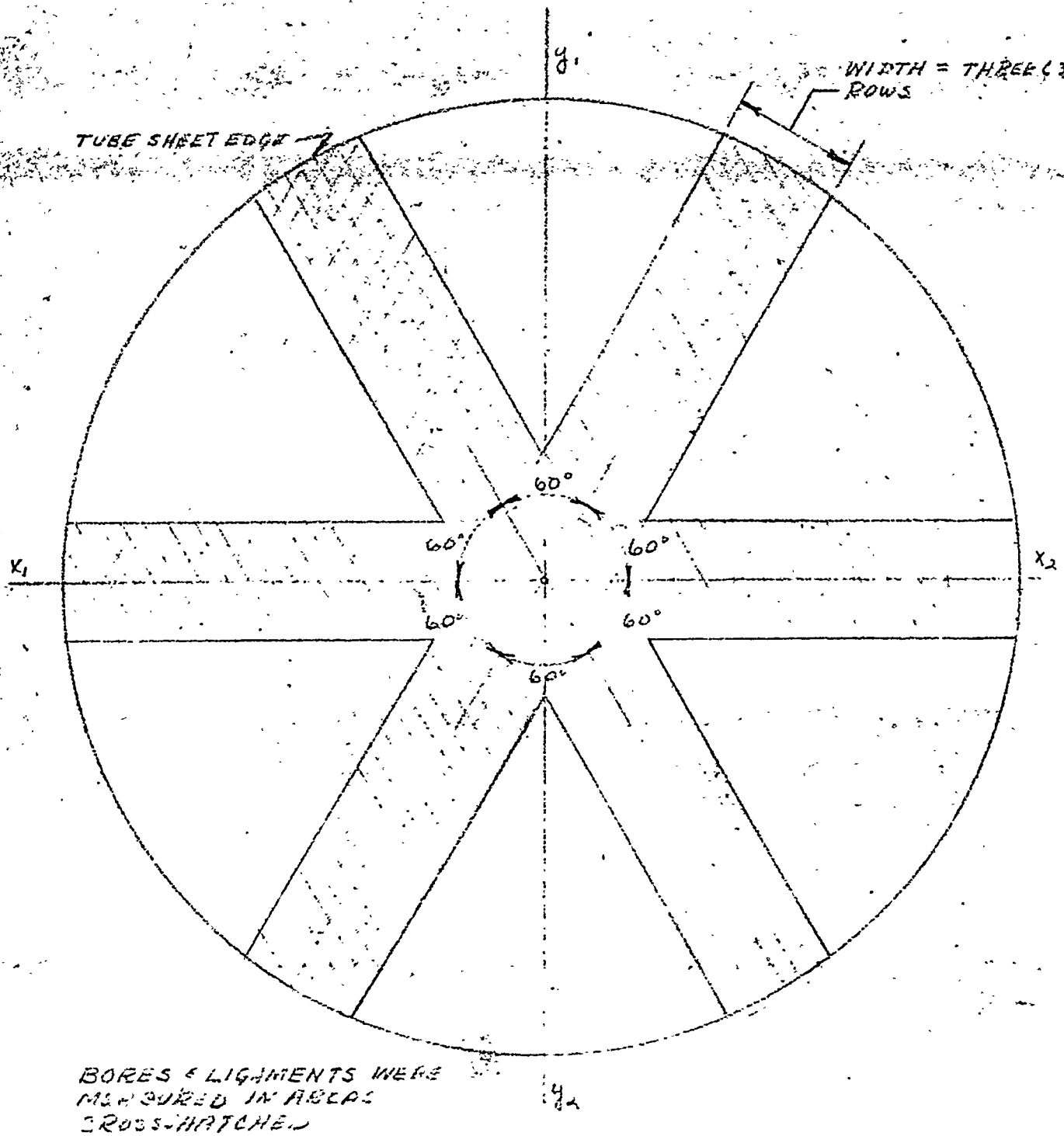
BOTTOM PLATE

NOTE: MEASUREMENTS ARE FROM CENTER TO CENTER OF TRE-PANNED ℄ & ARE NOT CORRECTED FOR TEMP. TEMP = 70°F



AV. RADIUS	AV. CHORD	AV. OVERALL
28.054"	28.054"	28.054"
56.108"	56.106"	56.107"
91.175"	91.176"	91.175"

SKETCH #19



BORES & LIGAMENTS WERE MEASURED IN AREAS CROSS-HATCHED

NOTE: SEE PHOTO SERIAL # 282

SKETCH #20

ENGINEERING SKETCH SHEET E. I. DU PONT DE NEMOURS & CO.	PROJ. No. 8980	SIGNATURE: J. Ray Dixon
PROJ. TITLE BORE & LIGAMENT DIAGRAM		DATE 3-25-53
SUBJECT:		No. E-42310

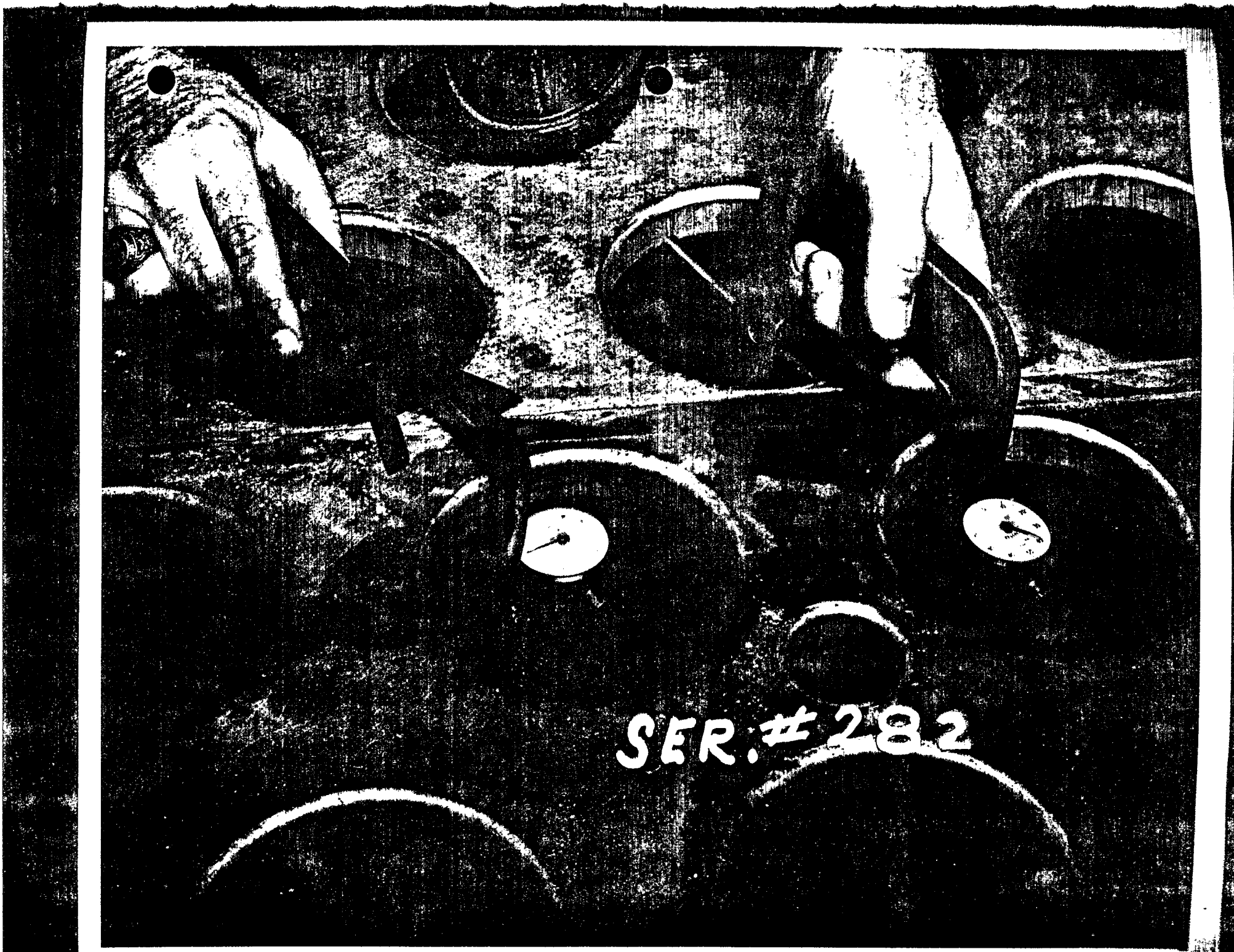
Serial #282

New York Shipbuilding Corporation
Camden, New Jersey
September 2, 1953

PROJECT 8980 - SAVANNAH RIVER PLANT

#1 Ligament gage for measuring tube sheet ligament pattern. It was devised by M & E Inspection which replaced Gage #2.

#2 Snap gage, $1\frac{1}{2}$" to $2\frac{1}{2}$" diameter range, for measuring tube sheet ligament pattern. This gage was replaced by #1 above. Snap gage identified as equipment piece #790-19.


SER. # 282

shorter length of time. The original method (Item #1, Photo Serial #282) necessitated the locating of two centers, horizontal and vertical, before a reading could be made. By virtue of the new ligament gages construction, it was only necessary to locate the horizontal center, thus eliminating human error and shortening the time originally required to take these measurements.

The bores in the ligament pattern were checked using a standard dial indicator bore gage.

The above measurements completed the dimensional check of the trepanned tube sheets. Both tube sheets were accepted and released for further fabrication.

B. "P" Unit

(1) Plenum Chamber Tube Sheets (Top & Bottom)

Inspection of top and bottom tube sheet ligaments and bores was performed as discussed above in Section 5A-(1). Both tube sheets were accepted and released for further fabrication.

C. "L" Unit

(1) Plenum Chamber Tube Sheets (Top & Bottom)

Inspection of top and bottom tube sheets ligaments and bores was performed as discussed above in Section 5A-(1). Both tube sheets were accepted and released for further fabrication.

6. Inspection of Tube Sheets After Grinding and Acid Washing

A. "R" Unit

This inspection was performed in a similar manner to that discussed in Part II-A, Section 3-C.

B. "P" Unit

Same as Section 6A above except as follows: Grinding of tube plates on both sides was partially discontinued and sandblasting was incorporated into the fabrication schedule for removal of mill scale, free iron, and other surface defects. Spot grinding was done first to dress the plates and also to remove burrs around the trepanned holes. Following this, the sheets were sandblasted on both sides and then acid washed, ferroxyl tested and released for further fabrication.

C. "L" Unit

Same as Section 6B above.

7. Assembling of "R", "P", & "L" Plenum Chambers

A. "R" Unit

(1) Verticality Check After Placing Tube Sheets in Circumferential Handling Jig

This inspection was performed as outlined in Part II-A, Section 4, except as follows: During tube sheet layout, the "X" and "Y" axis were extended to the edges of both tube sheets. After aligning the top and bottom tube sheets in the circumferential handling jig to the best verticality, these extended axes or match marks were checked for vertical alignment with a surface gage and box level by New York Ship mechanics and witnessed by du Pont Inspectors. Since this inspection was performed in a similar manner on "R" and subsequent unit sub-assemblies fabricated at New York Ship, Photograph Serial #323 illustrates how this inspection was performed on the "C" unit bottom tube sheet.

(2) Tube Weld Inspection

a. Rod Tube Assembly and Weld Inspection

After the tube sheets in the circumferential handling jig had been leveled and mated for best verticality, 165 pre-machined rod tubeswere cleaned with CCl_4 on the outside,inserted into the unit, and tack welded. After tack welding all rod tubes, they were fully welded using three Aircomatic Automatic Rod Tube Welders working 120° apart. Tubes were welded in accordance with a sequence set-up for keeping distortion to a minimum and unit turned as required to balance welding.

Rod tube welding sequence established for all sub-assemblies was performed in the following manner:

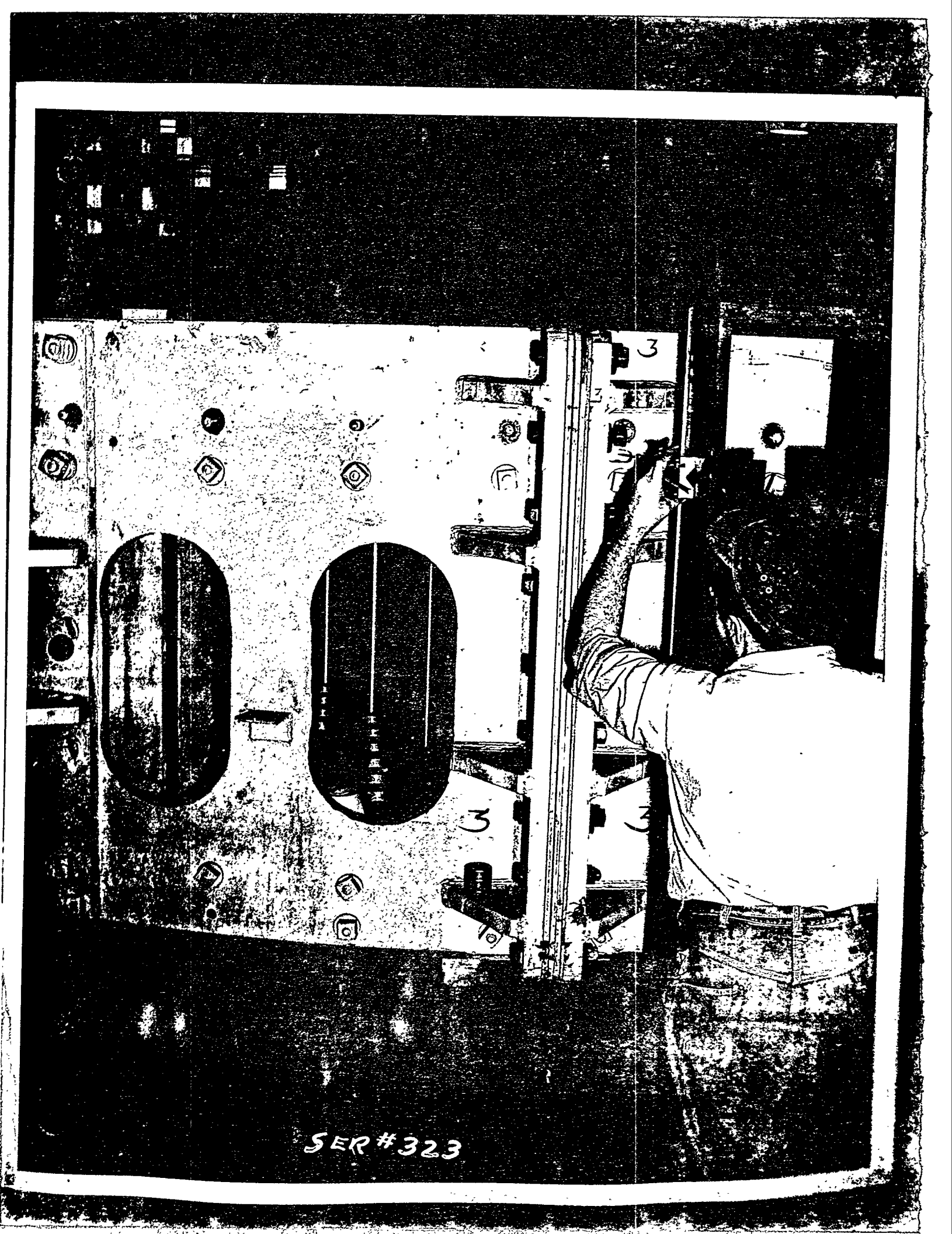
1. With the top side of the unit up, fifteen (15) tubes are welded (Group #1)
2. Unit turned and tubes in Group #1 are welded plus fifteen (15) additional tubes (Group #2)
3. Unit turned and tubes in Group #2 are welded plus fifteen (15) additional tubes (Group #3), etc.

Serial Number 323

New York Shipbuilding Corp.
Camden 4, New Jersey
October 31, 1953

PROJECT 8980 - SAVANNAH RIVER PLANT
CHECKING TOP & BOTTOM TUBE PLATE ALIGNMENT ON THE "C" UNIT BOTTOM TUBE SHEET

After the circumferential holding and handling fixture, "Pot Chuck", is bolted in place, the alignment of the upper plate centerlines with respect to the lower plate centerlines are checked with a surface gage and a box square. The box square is set vertical with a box level, it has a vertical machined back stop so that it is not necessary to align the surface parallel with the centerlines. The surface gage pointer is set to the lower plate centerline through a cut-out in the pot chuck plate (not visible under the lower right gusset of the chuck vertical flange) then it is moved to the top plate and the displacement of the centerline is checked through a cut-out at the upper plate O.D. The lower plate is clamped in the pot-chuck, the upper plate is moved so that the best average alignment results at the four centerline locations (90° apart) on the O.D.'s of the plates. The assembly is set bottom side up with the bottom tube plate in the "upper" position.


3
3
3
3
SER #323

The above welding sequence was followed until all rod tubes in the unit were welded. Some trouble was experienced with the automatic welding equipment which had been developed for "R" and subsequent unit rod tube welding; however, the welding was satisfactory and accepted.

"R" Unit rod tubes differed from NYX in that rod tubes were not finished machined on installation and had only a 7/8" I.D. The knowledge and experience gained on NYX rod tube welding necessitated a change in design of the tube from finished machine to pre-machined in order that all rod tubes in a plenum chamber be welded better using the automatic welding equipment. (NYX rod tubes were welded using hand-operated aircomatic welding machines) and, in addition to this, it was realized that the probability of all plenum chamber rod tubes functional gaging after all welding was completed could be brought about by using pre-machined rod tubes and boring them concentric with the top tube sheet rod tubes. (See Drawing 2-2)

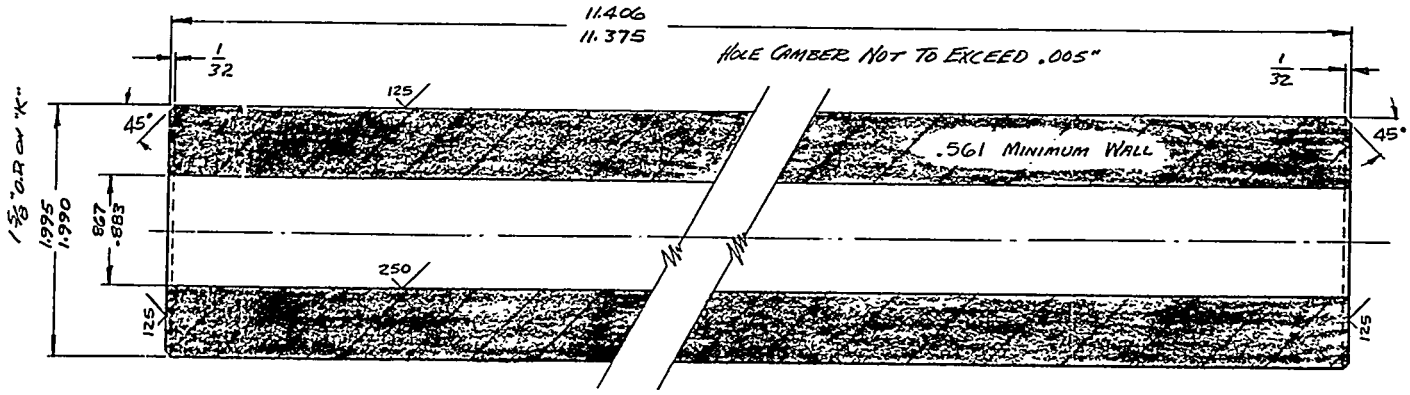
As experienced on the NYX plenum chamber, the 5.250" trepanned holes in the vicinity of the rod tubes on "R" were distorted from rod tube welding. The trepanned holes were measured with a standard dial indicator bore gage to determine the amount of distortion. An average of these measurements indicated that the holes went out-of-round 0.019" at the top (same surface on which weld was made) and 0.012" on the bottom. In order to assemble large tubes into the unit, portable drill presses were set up and the holes were reamed to original size (5.250") using a reamer ground to approximately 5.252". The reaming operation was successful in rounding up the holes to the limit of the reamer O.D., and produced a push fit for a 5.250" plug-gage (final check).

All rod tube welding was then visually inspected for cracks, porosity, and undercutting and necessary repairs made.

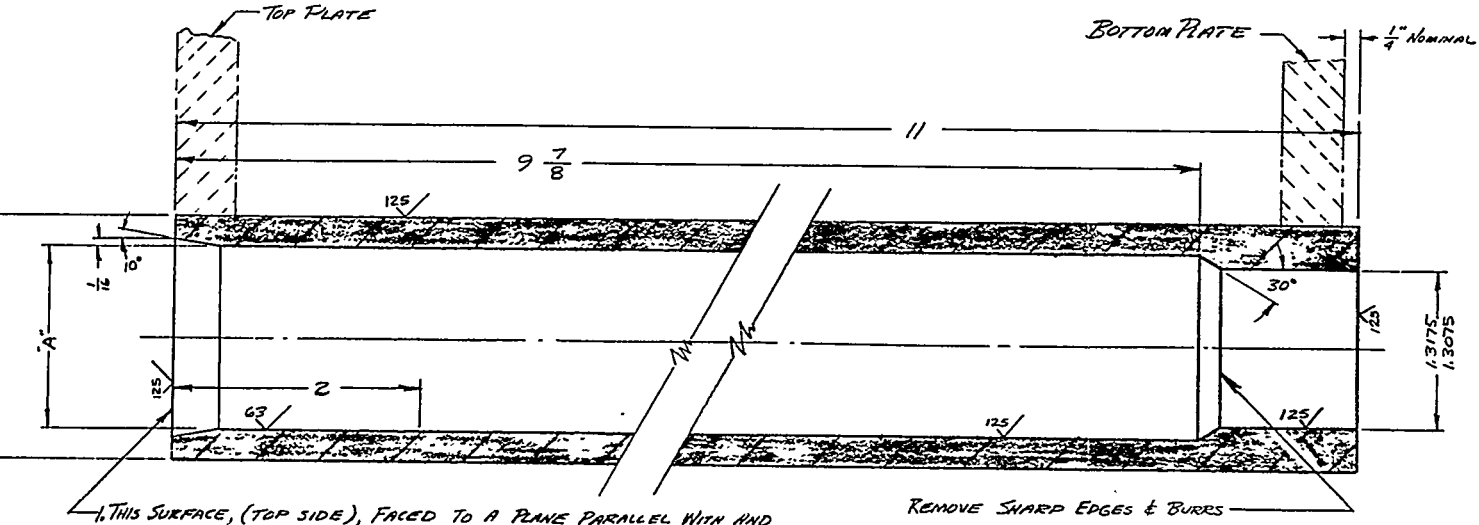
b. Preliminary Cleaning

Before inserting and tacking large tubes, the unit was given a preliminary cleaning externally and internally to remove dirt, oil and other foreign material which had collected during fabrication. This was done by first air jetting the unit at approximately 100 p.s.i. to remove all

PLENUM CHAMBER – ROD TUBE



PRE-MACHINED ROD TUBE, (PRIOR TO INSTALLATION)



DIMENSION "A"	
BORE TO	1.500 - 1.505
HONE TO	1.505 - 1.510

FINISH MACHINED ROD TUBE, (ALL MACHINING COMPLETE).

NOTES:
1. ALL DIMENSIONS ARE IN INCHES
2. 165 REQUIRED FOR "R"; "P", "L"; 162 FOR "K"; 178 FOR "C"
3. TYPICAL FOR "R", "P" & "K"
4. "L" & "C" ARE OF DIM. "A" FOR ENTIRE LENGTH OF TUBE.
5. "K" UNIT TUBES WERE INSTALLED FINISH MACHINED.

NOTE:
SEE DW'G. 1-2 FOR LOCATION OF "O" RING SEALS.

M & E SECTION
GOV'T CONTRACTS

DW'G. 2-2

BY: S.R. COCHRAN
MAR-53

loose material. After this, the top and bottom sides of each plate and all rod tubes were wiped clean using a clean cloth saturated in CCl_4. After cleaning the unit was inspected, accepted and released for further fabrication.

c. Large Tube Assembly and Tack Weld Inspection

Starting in the center of the unit and working out, large tubes (5.250" O.D.) were progressively cleaned with CCl_4, inserted into the unit, aligned, and tack welded to the inside of the bottom tube sheet. Tube assembly was witnessed by du Pont Inspectors. Concurrent with the assembling of tubes in the unit, tack welding was visually inspected for weld penetration and undercutting and necessary repairs made.

d. Types of Tubes in Plenum Chamber

The approximate number of each type of pre-machined 5.250" O.D. tubes assembled in "R" plenum chamber was as follows:

Tube Type	Number of Each in Assembly
Cast	421
Seamless	63
Welded	189

The number of cast tubes (which are slightly magnetic) was determined by checking all tubes in assembly with a magnet; the other figures were obtained from existing records kept for other purposes and are only approximate.

The locations of the different tube types in the assembly could not be easily determined except for cast tubes since such records were not previously made and no pre-determined method of assembling tubes as to type was followed.

e. Measurements Before and After Large Tube Welding to Determine Unit Shrinkage

I. Measurements After Welding Rod Tubes and Before Welding Large Tubes

After all large tubes had been inserted into the unit, aligned and tack welded, initial shrink measurements were taken across three major diameters. Part II-A, Section 5-c, describes the method incorporated to take

these measurements. In the case of the "R" plenum chamber, measurements were not taken on the bottom side of the unit; however, since no measurements were taken, shrinkage was figured from the "before weld" measurements made on the top side. Results of these measurements (before welding large tubes) for the top side are shown in Sketch #21. The average measurement was calculated to be 182.667" (bore-to-bore).

II. Measurements After All Tubes Had Been Welded

All large tubes were welded in the unit using the same procedure discussed in Part II-A, Section 5-d.

After all large tube welding was completed, measurements were again taken using the procedure discussed in paragraph I. above. Results of these measurements for the top and bottom sides are shown in Sketches #22 and #23. The average measurement for the top side was calculated to be 182.146". The average measurement for the bottom side was calculated to be 182.036".

Since Design Division specified that the top and bottom side measurements (after welding) had to be within 0.0321" of each other or less, it can be seen by analyzing the results that the measurements are not within this amount, i.e.,

Top Side 182.146"
Bottom Side 182.036"

.110" Difference

Therefore, since the top side was the larger of the two, it was necessary to shrink the top side to match the bottom within the limits specified by Design. This was done by welding an additional bead around 50% of the tubes on the top side. After this additional welding, measurements were again taken (using same procedure discussed in paragraph I) to determine if the top and bottom sides were within the specified tolerance of .0312". Results of shrink welding the top side was as follows:

Sheet PC-2-1
Date 1-26-52
Recorder Piatek & Quillen
Instrument Piatek & Quillen

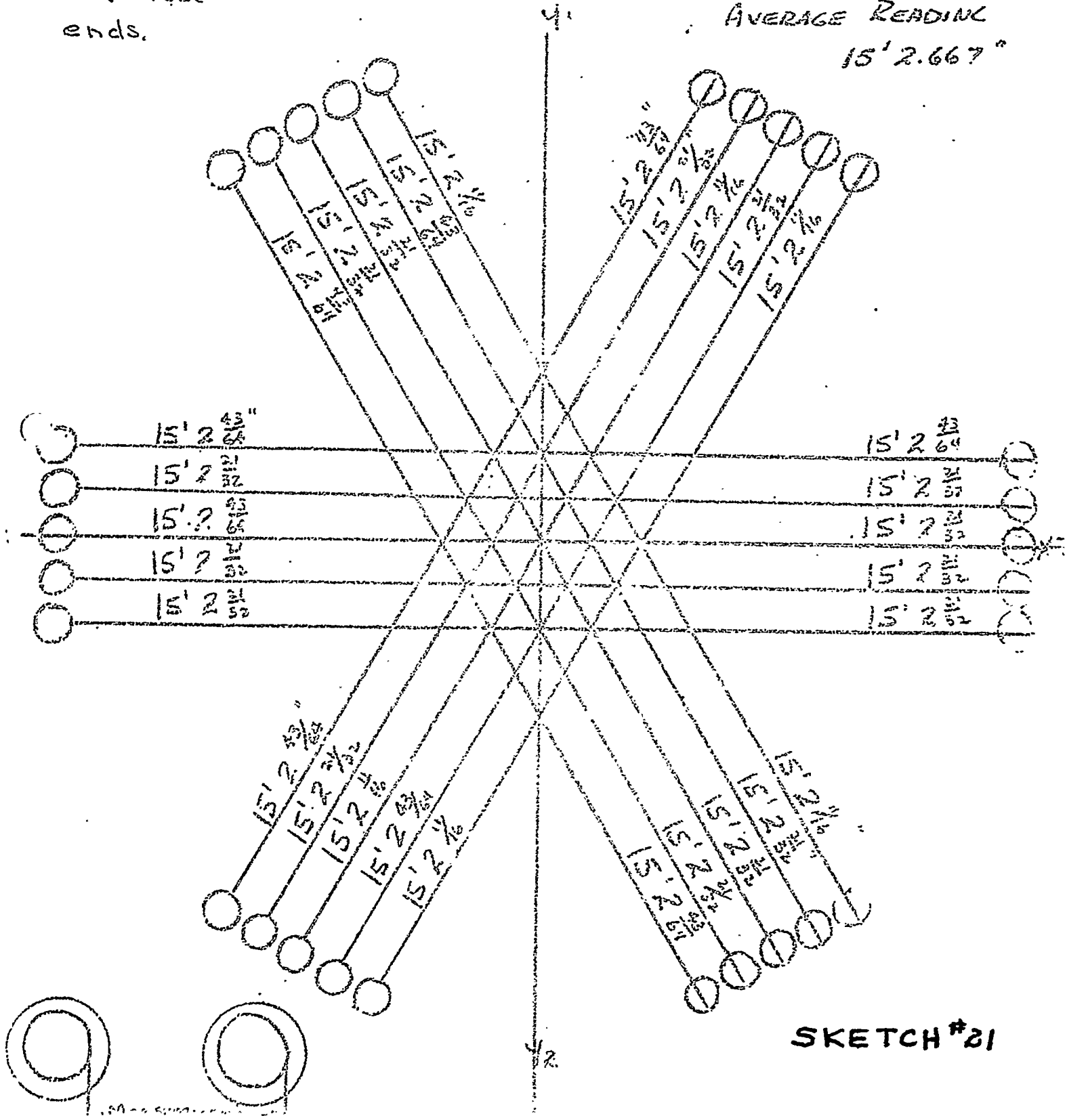
Ambient Temp 72°F
Stainless Steel Tape.

"R" unit

Measurements taken after all Plenum tubes were tack welded to the Bottom Sheet, and ALL rod tubes Welded on both ends.

EXHIBIT "A"

AVERAGE READING
15' 2.667"



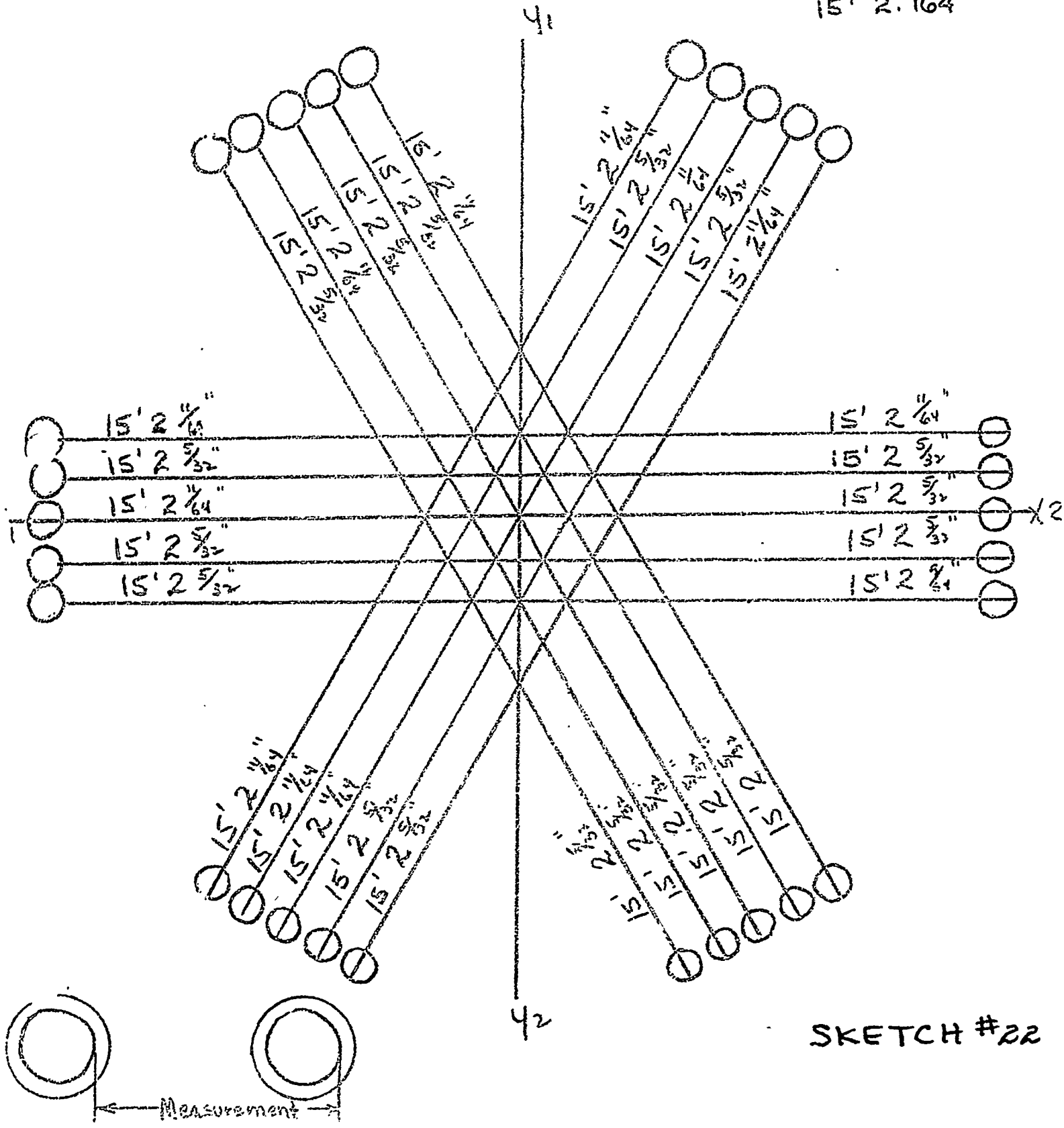
SKETCH #21

Date 1-31-52
Recorder Piatek & Quillen
Instrument Piatek & Quillen

Measurements taken after all tubes were welded on both sides

Ambient Temp 54°F
stainless Steel tape
"R" unit
EXHIBIT "C"

AVERAGE READING
15' 2.164"



SKETCH #22

Sheet Pr. 2-2
Date 2-6-52
Recorder Pintek & Quillen
Instrument Pintek & Quillen

Bottom Side of Bottom Plate
Ambient Temp 65°F
Plenum Chamber "R" unit
Stainless Steel tape

Measurements after all tubes had been welded on both sides.

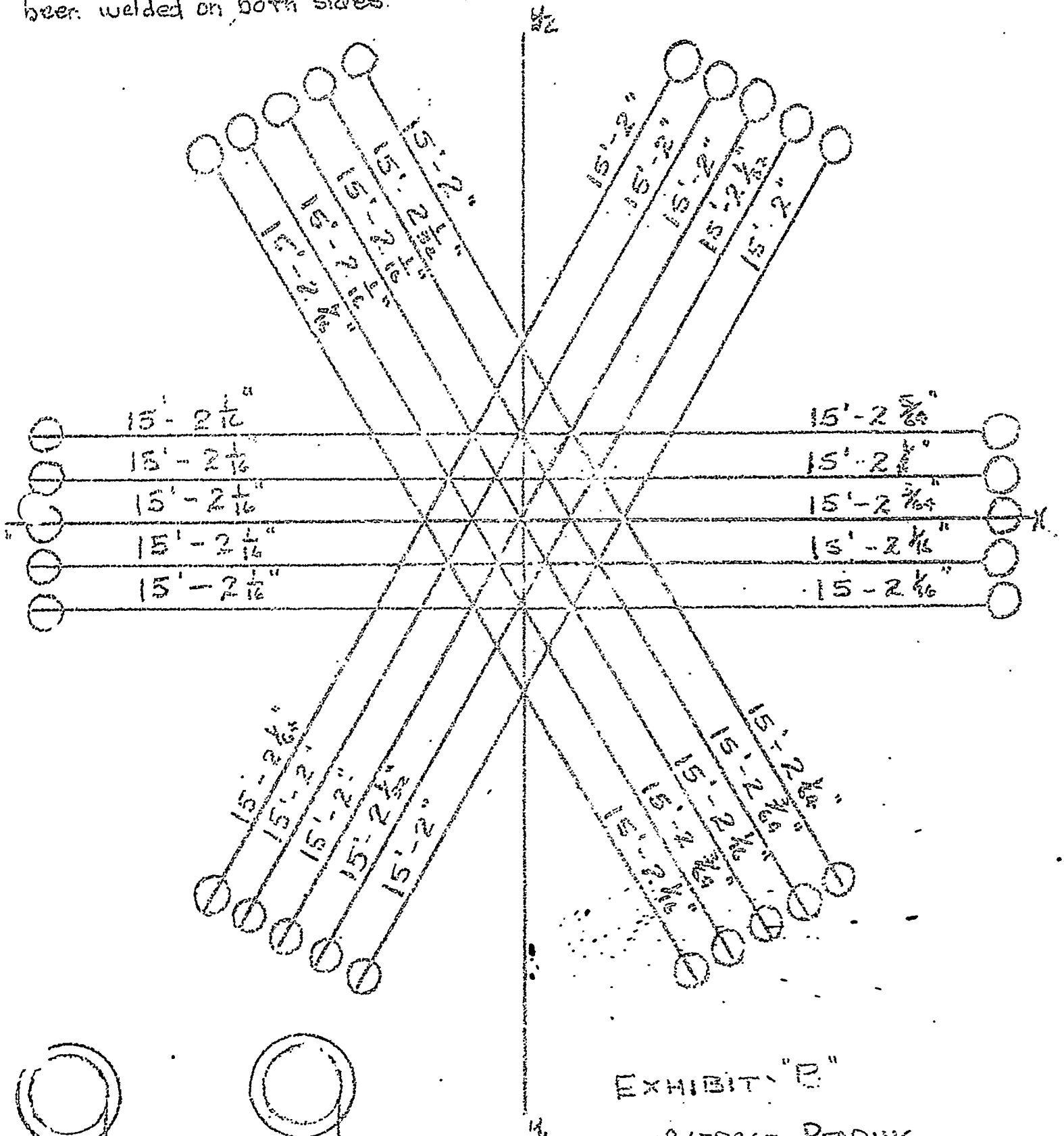


EXHIBIT "B"

AVERAGE READING
15' 2.024"

SKETCH #23

Measurement

Top Side 182.048" (After Shrink Welding)
Bottom Side 182.036" (Same as Before)

.012" Difference

Since this difference (.012" was within Design's tolerance of .0312", no further shrink welding was necessary and the unit was released for further fabrication. See Exhibit #1 for summary of plate diameter measurements.

f. Visual Inspection and Repair of Tube Welding

Inspection and repair of large tube welding was performed in an identical manner as described in Part II-A, Section 5-e.

B. "P" Unit

(1) Verticality Check after Placing Tube Sheets in Circumferential Handling Jig

Same as Section 7A-(1) above, except as follows:

The Wild NIII Precision Level was used to level the circumferential handling jig prior to shifting of the top tube sheet plates until the best verticality condition was obtained.

After shifting the top tube sheet to obtain the best verticality, it was again checked for levelness using this instrument. In both cases the circumferential handling jig was shimmed where required until the unit was level within .020".

Photograph serial #43 illustrates a mock-up of this inspection. All sub-assemblies were leveled in this manner. For detail discussion on use of the Wild NIII precision level, see Part III, Section II-J.

(2) Tube Weld Inspections

a. Rod Tube Assembly and Weld Inspection

Inspection at this stage of fabrication was the same as described in Section 7A-(2)a above, except as follows: Design requested that no solvent containing chlorides be used in any preliminary cleaning operations on "P" and subsequent units; therefore, F.O. 128 (Fine Organics) was used to clean the 165 rod tubes (before assembling into unit) in lieu of CCl_4.

SUMMARY OF PLATE DIAMETER MEASUREMENTS

Plenum Chamber - "R" Unit

Sheet	Date	Temp. of Tape & Plates - °F	Remarks		Sheet Diameter
* PC2-1	12/19/51	55°	Carbon Steel Pin Gage Used	O to O of Trepanned Plate	182.766
** PC2-2	12/31/51	67°	Carbon Steel Pin Gage Used		182.750
PC2-1			S/S Tape Used NBS #9677	C to C after Welding Rod Tubes	182.667
PC2-2					Measurement Not Taken
PC2-1	2/5/52	74°	S/S Tape Used NBS #9677	C to C after Welding all 5½" O.D. Tubes	182.146
PC2-2	2/6/52	65°			182.036
PC2-1	2/15/52	60°	S/S Tape Used NBS #9677	C to C after ½ of tubes Shrink Welded (Top side Only)	182.048
PC2-2					
PC2-1	Total Shrinkage - 0.718"				
PC2-2	Total Shrinkage - 0.714"				
Final Difference between plate diameters - 0.012"					

Note: Measurements not corrected for temperature

*PC2-1 - Plenum Chamber - "R" Unit - Top Plate

**PC2-2 - Plenum Chamber - "R" Unit - Bottom Plate.

EXHIBIT #1

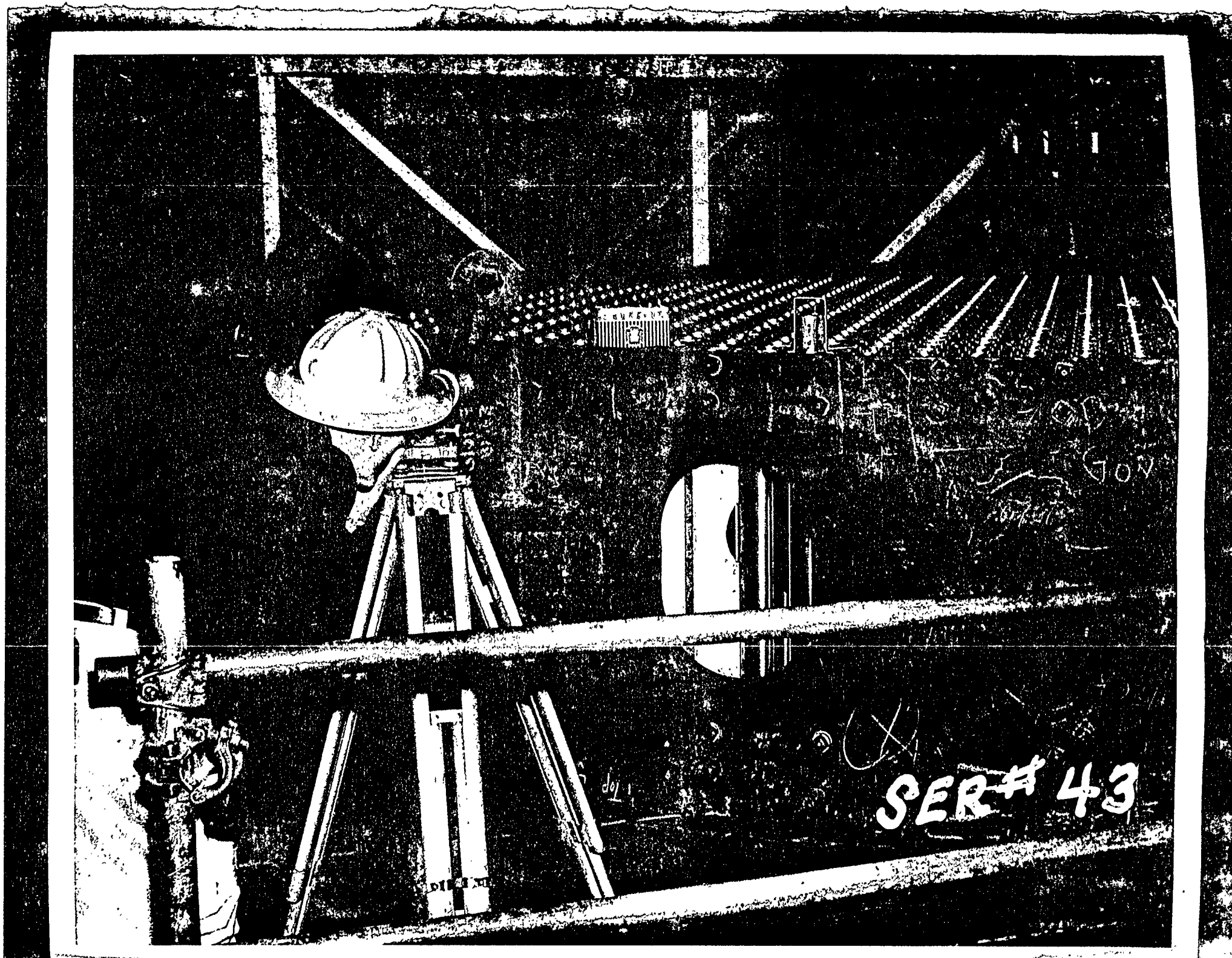
Serial Number 43

New York Shipbuilding Corporation
Camden, New Jersey
November 28, 1952

PROJECT 8980 - SAVANNAH RIVER PLANT

Use of Wild Level

The inspector is shown leveling the top special tube sheet "L" unit with the Wild Level. A battery operated target, shown on the unit, is placed on each of the outer tubes of the two major axes and on the center tube for obtaining readings. Unit is to be leveled within .020".


SER # 43

b. Preliminary Cleaning

Cleaning was performed the same as discussed in Section 7A-(2)b above, except as follows: The top and bottom sides of each plate and all rod tubes were wiped clean using a cloth saturated in F.O. 128 instead of CCl_4. Paragraph "a" above describes why this change was effected.

After this it was decided to jet clean the interior with a solution of 10% sodium metasilicate and de-ionized water heated to approximately 170°F. It was thought that this additional cleaning would further remove oil and traces of foreign material still embedded in the plate surfaces. To do this the unit was moved to a washing pit and placed on pedestals in a horizontal position. Working from the top side, the exterior and interior of the unit was jetted using the above mentioned solution at 300 p.s.i.

Upon visual inspection, it was noticed that traces of iron rust and dirt were present on the tube plates. Thorough investigation revealed that the iron rust came from the circumferential handling jig which was constructed of mild carbon steel. Also, dirt and other foreign material was found on the jig; therefore, this operation was discontinued because it only further contaminated the unit at this stage of fabrication.

The traces of iron rust and dirt were removed by wiping the contaminated areas clean using a cloth saturated in F.O. 128 (Fine Organics).

To prevent iron oxide or rust from "flaking" off the circumferential handling jig and contaminating future plenum chambers, the jig was first thoroughly cleaned and then painted with chromate. This painting was done after removing the "P" plenum chamber from the jig. As experience later proved on "L" and "C" plenum chambers, the painting of the mild steel handling jig reduced greatly the amount of contaminating iron, which heretofore was inherently working its way between tube sheets supported in the jig. In addition to painting the plenum chamber handling jig, the same was also done to the top tube sheet and bottom tube sheet handling jigs to further eliminate the iron contaminating condition mentioned above.

c. Large Tube Assembly and Tack Weld Inspection

Assembly and inspection was performed the same as discussed in Section 7A-(2)c, except as follows:

F.O. 128 was used for cleaning large tubes prior to assembling into the unit. Paragraph "a" above describes why this change was effected.

d. Types of Tubes in Plenum Chamber

There are 358 seamless tubes, 314 cast tubes, and one welded tube in this assembly. The latter is located at position X18-Y54.

e. Measurements Before and After Large Tube Welding to Determine Unit Shrinkage

I. Measurements After Welding Rod Tubes and Before Welding Large Tubes

Measurements were not taken after welding rod tubes. It was decided to use the average diametrical values calculated for the top and bottom tube sheets after trepanning. These results are shown on Sketches #8 and #9. As shown on the sketches, the results are as follows:

PC 3-1 (top plate) - 182.776" overall average diameter
PC 3-2 (bottom plate) - 182.760" overall average diameter

The above "as trepanned" measurements were used for calculating the total amount of shrinkage as discussed in sections to follow.

II. Measurements After All Tubes Had Been Welded

Measurements were taken in the same manner described in Section 7A-(2)e, paragraph 2.

The average measurement for the top side was calculated to be 182.052". The average measurement for the bottom side was calculated to be 181.879". Since Design specified that the top and bottom side measurements had to be within .0312", it can be seen by analyzing the results that the measurements are not within this amount, i.e.,

Top Side 182.052"
Bottom Side 181.879"

.173 Difference

Therefore, since the top side was the larger of the two, it was necessary to shrink the top side to match the bottom. This was done by welding an additional bead around 75% of the tubes on the top side. After this additional welding, measurements were again taken. Results of shrink welding the top side was as follows:

Top Side 181.847" (After Shrink Welding)
Bottom Side 181.879" (Same as Before)

.032" Difference

Since this difference (0.032") was close enough to Design's tolerance of 0.0312", no further shrink welding was necessary and the unit was released for further fabrication. See Exhibit #2 for summary of plate diameter measurements.

f. Visual Inspection and Repair of Tube Welding

A close visual inspection and better control over repairing of large tube and rod tube welding was performed on this unit and also "L" and "C". The need for closer examination and control over repairing of tube welding at this stage of fabrication came about as a result of several things.

First, complaints were received from the field pertaining to tube weld leakage on "R" Unit plenum chamber. An inspector from the M & E Group at New York Ship was sent to the Savannah River Plant site to investigate the complaints, and also to assist in "lofting in" of the "P" main tank. At this time, "R" Unit plenum chamber was "Freon" tested and witnessed by the M & E Inspector. Two leaks were found on the top side; one in a rod tube overlay and the other in a large tube weld. In addition, two leaks on the bottom side were found; one at a rod tube weld overlapping a large tube weld, and the other in a large tube 1" weld overlay.

However, during the time field complaints were being received pertaining to tube weld leakage, preliminary hydrostatic and "Freon" tests on "P" plenum, top tube sheet, and bottom tube sheet (at New York Ship) revealed that tube weld leakage occurred frequently at (1) large tube 1" weld overlay (2) weld roll-over where rod tube weld and large tube weld joined and (3) roll-overs on large tube welds due to lack of fusion.



EXHIBIT #2

In view of these findings, a new tube welding inspection procedure was adopted by the du Pont Inspection Department. In this procedure it was requested that New York Ship grind and chip all large tube 1" weld overlay, chip out all weld roll-over where rod tube and large tube weld joined, and to chip out all roll-overs on large tube welding due to lack of fusion (See Photo Serial #35 & #203). Inspectors would visually inspect all tube welding using flashlights and mark the defective weld with chalk. They would stay with the grinders and chippers while repair work was in progress and reinspect when necessary. If any weld was ground or chipped to such a degree that it was necessary to reweld (using manual Aircomatic Welding Machine), inspectors were to witness and re-inspect after welding and grinding before accepting same.

It was then ascertained that by using a 1" magnifying glass in conjunction with a strong floodlight other defects were found that were not visible to the naked eye, particularly after sandblasting tube welds. However, at a later date the use of magnifying glasses was discontinued because the method was too slow and cumbersome. Also, with the introduction of sandblasting tube welds before final inspection, it was not necessary to use magnifying glasses as defects (if any) were readily visible to the naked eye.

The above discussion on the new tube weld inspection procedure was incorporated with the fabrication procedure after all tube welding was completed on "L" and "C". Also, after sandblasting both top and bottom sides of the unit, all tube welds were again inspected 100% and repairs made following the above procedure.

7. C. "L" Unit

(1) Verticality Check After Placing Tube Sheets in Circumferential Handling Jig

Inspection was performed the same as discussed above in Section 7B-(1).

(2) Tube Weld Inspection

a. Rod Tube Assembly and Weld Inspection

Inspection was performed the same as discussed above in Section 7B-(2)a.

Serial Number 35

New York Shipbuilding Corporation
Camden, New Jersey
December 22, 1952

PROJECT 8980 - SAVANNAH RIVER PLANT

This photograph shows the chipping off of the 1" weld overlap on the bottom side of the "L" Unit Plenum Chamber.



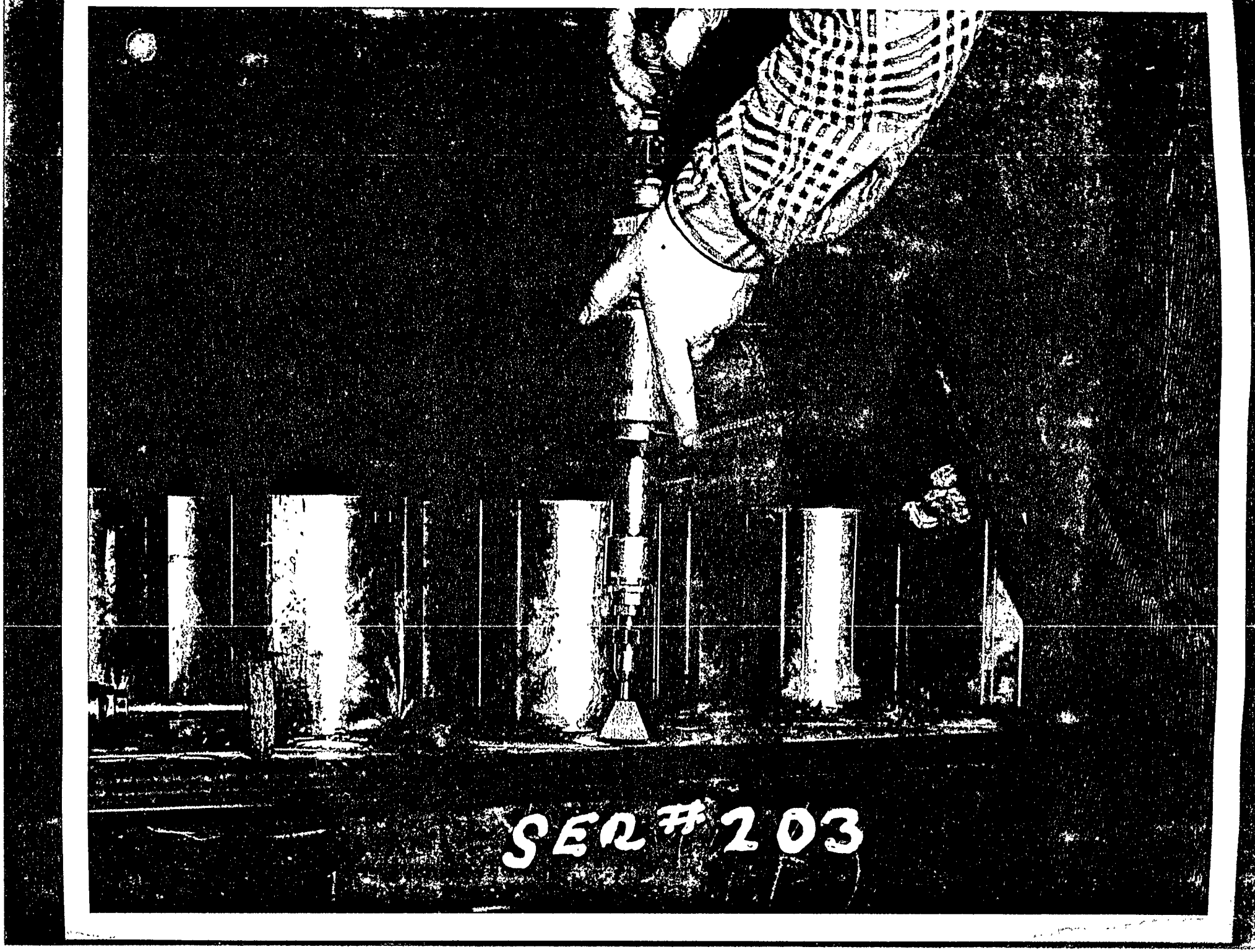
DERA35

Serial Number 203

New York Shipbuilding Corp.
Camden, 4, New Jersey
February 6, 1953

PROJECT 8980 - SAVANNAH RIVER PLANT

Dressing weld overlaps and grinding out shrink-
cracks in the weld crater.


SER#203

b. Preliminary Cleaning

Cleaning was performed the same as discussed in Section 7A-(2)b, except as follows: The top and bottom sides of each plate and all rod tubes were wiped clean using a cloth saturated in F.O. 128 (Fine Organics) instead of CCl_4. Section 7B-(2) describes why this change was effected.

c. Large Tube Assembly and Tack Weld Inspection

Inspection was performed the same as discussed above in Section 7B-(2)c.

d. Types of Tubes in Plenum Chamber

There are 673 seamless tubes in this assembly.

e. Measurements Before and After Large Tube Welding to Determine Unit Shrinkage

I. Measurements After Welding Rod Tubes and Before Welding Large Tubes

After all large tubes had been inserted into the unit, aligned, and tack welded, measurements were taken across three major diameters. Part II-A, Section 5-c, describes the method incorporated to take these measurements. Results of these measurements are shown in Exhibit #3. As shown in the exhibit, results are as follows:

PC 4-1 (Top Plate) 182.666" Avg. Overall Dia.
PC 4-2 (Bottom Plate) 182.654 Avg. Overall Dia.

II. Measurements After All Tubes Had Been Welded

Measurements were taken in the same manner described in Section 7A-(2)e, II. of this manual.

The average measurement for the top side was calculated to be 182.049". The average measurement for the bottom side was calculated to be 181.948". Since Design specified that the top and bottom side measurements had to be within .0312", it can be seen by analyzing the results that the measurements are not within this amount, i.e.,

Top Side	182.049"
Bottom Side	181.948"

.101" Difference

Therefore, since the top side was the larger of the two, it was necessary to shrink the top side to match the bottom. This was done by welding an additional bead around 30% of the tubes on the top side. After this additional welding, measurements were again taken. Results of shrink welding the top side was as follows:

Top Side	181.958" (After Shrink Welding)
Bottom Side	181.980" (Same as Before)

.022" Difference

Since this difference (0.022") was within Design's tolerance of 0.0312", no further shrink welding was necessary, and the unit was released for further fabrication. See Exhibit #3 for summary of plate diameter measurements.

f. Visual Inspection and Repair of Tube Welding

Inspection was performed using the tube welding inspection procedure developed for "P" Unit as discussed in Section 7B-(2)f of this manual.

8. Turning O.D. of Tube Plates and Weld Preparation

A. "R" Unit

After all tube welding was completed, the circumferential handling jig ("pot chuck") was removed from the unit. (See Photo Serial #52). After this, it was moved to a 15' open mill and set up for turning the O.D. of the tube plates and beveling (for weld preparation) to finish size to redeive the plenum nozzle assembly. (See photo serial #182). The top and bottom plates were first machined square and to finished size. Before beveling and preparing a "lip" to serve as a back-up strip for welding; the O.D. of each plate was checked by inspectors using a stainless steel circumferential tape graduated in 1/16". Next, the plate edges were beveled leaving a 1/8" lip protruding at the root to serve as a back-up strip during welding of the plenum nozzle assembly to the outer periphery of the unit. After all machining was completed and before removing the unit from the mill, the distance from the top of each plate to the top of the "lip" was checked using a depth micrometer. This was done to insure that the 1/8" "lip" was maintained throughout the entire circumference on each plate to prevent the likelihood of burn through during welding of nozzle assembly to the unit.

SUMMARY OF SHEET DIAMETER MEASUREMENTS
PLENUM CHAMBER-"L" UNIT

SHEET	AXIS	DATE OF MEASUREMENT	TEMPERATURE OF TAPE AND PLATES - °F	REMARKS	FABRICATION STEP	AV. DIA. ALONG EA. AXIS	OVERALL AV SHEET DIA.
*PC4-1		7/22/52	85°	Carbon steel pin gage used	Trepanned plate prior to assembly		182.768"
*PC4-2		7/23/52	93°	Carbon steel pin gage used			182.768"
PC4-1	X1-X2 X1-Y2 - X2-Y1 X1-Y1 - X2-Y2	9/17/52	75°	S/S tape used 10# tension	After welding rod tubes but prior to welding 5¼" O. D. Tubes	182.658" 182.666" 182.672"	182.666"
PC4-2	X1-X2 X1-Y2 - X2-Y1 X1-Y1 - X2-Y2	9/17/52	70°	S/S Tape used 10# tension		182.672" 182.644" 182.644"	182.654"
PC4-1	X1-X2 X1-Y2 - X2-Y1 X1-Y1 - X2-Y2	9/25/52	68°	S/S Tape used 10# tension	After welding all 5¼" O. D. Tubes	182.034" 182.056" 182.056"	182.049"
PC4-2	X1-X2 X1-Y2 - X2-Y1 X1-Y1 - X2-Y2	9/25/52	68°	S/S Tape used 10# tension		181.980" 181.933" 181.930"	181.948"
PC4-1	X1-X2 X1-Y2 - X2-Y1 X1-Y1 - X2-Y2	10/1/52	70°	S/S Tape used 10# tension	After shrink welding approx. 30% of tubes (Top Side Only)	181.950" 181.961" 181.963"	181.958"
PC4-2	X1-X2 X1-Y2 - X2-Y1 X1-Y1 - X2-Y2	10/1/52	70°	S/S Tape used 10# tension		182.010" 181.977" 181.953"	181.980"

PC4-1 Total Shrinkage - 0.810"
PC4-2 Total Shrinkage - 0.788"
Final Difference between plate diameters - 0.022"

Note: Measurements not corrected for temperature
*PC4-1 Plenum Chamber - "L" Unit - Top Plate
* PC4-2 Plenum Chamber - "L" Unit - Bottom Plate

RESTRICTED

EXHIBIT #3

Serial Number 52

New York Shipbuilding Corporation
Camden, New Jersey
January 20, 1953

PROJECT 8980 - SAVANNAH RIVER PLANT

Handling and turning fixture for Plenum Chamber.

This "Pot Chuck" is used primarily for holding tube plate alignment while fitting and tacking tubes, and for turning the assembly during welding of tubes to tube plates. It is used throughout fabrication, before the nozzle and bulge assembly is welded, for handling and turning the weldment.

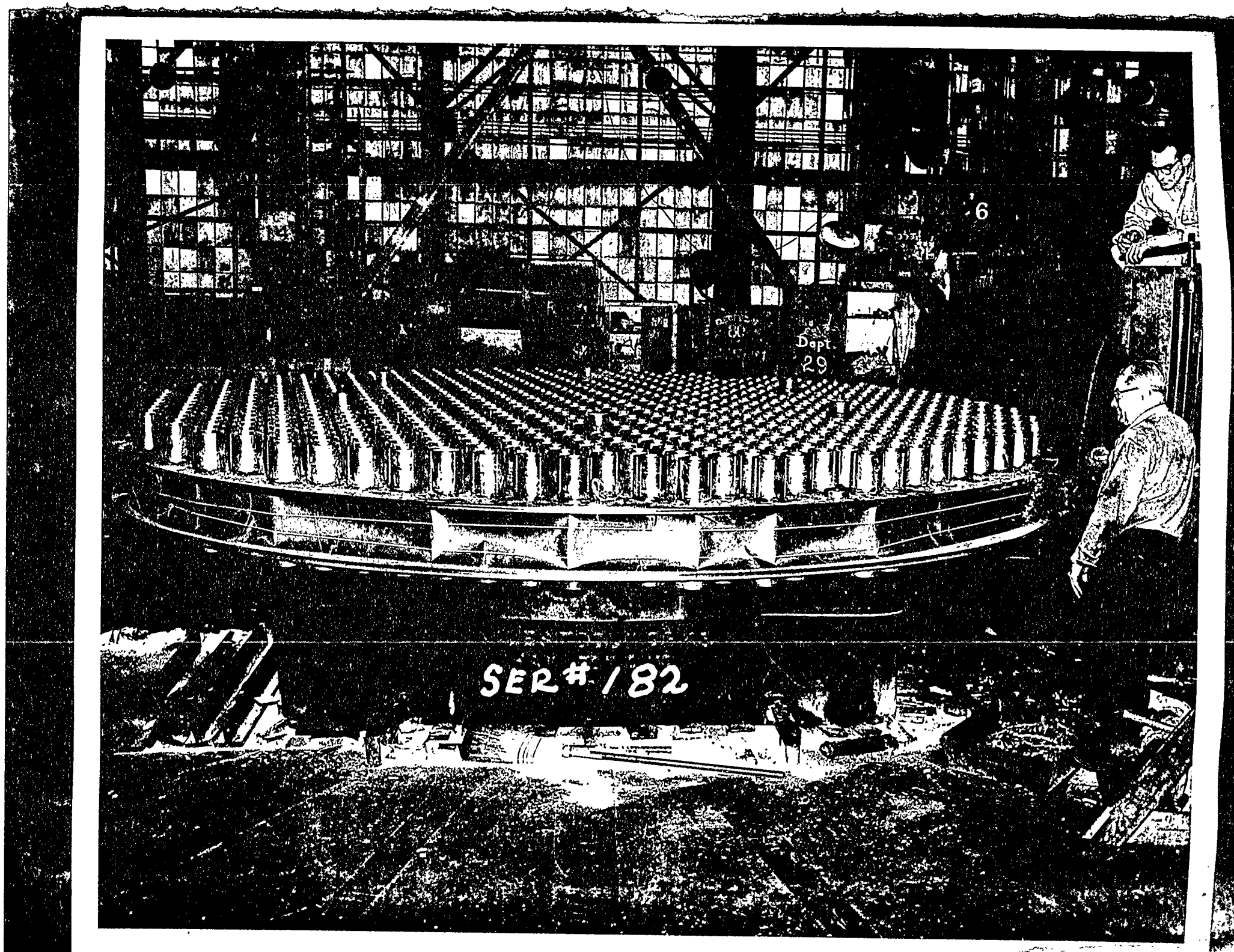
52

Serial Number 182

New York Shipbuilding Corporation
Camden, New Jersey
February 6, 1953

PROJECT 8980 - SAVANNAH RIVER PLANT

This is a view of the open 15' mill with portable mill head at the extreme right. Plenum Chamber ("L" Unit) top and bottom plates are being turned and beveled to finish size to receive half-pipe sections.


Dept.
29
SER# 182

B. "P" Unit

Machining and inspection was performed the same as outlined in Section 8A.

C. "L" Unit

Machining and inspection was performed the same as outlined in Section 8A above, except the following discrepancy was encountered: Due to the welding of tubes, tube shrink welding, and radial shrink welding around the outer periphery on both sides of the unit, waviness resulted in the top and bottom tube sheets. This waviness was of such a degree that machining a minimum 1/8" thick back-up strip on the circumference of the tube sheet edges was impossible. This problem was overcome by building up with weld metal on the inside of the plates so that back-up strip was 1/8" minimum. All welding was done using a hand operated automatic aircomatic welding machine. The weld metal deposited was x-rayed and defects repaired so that defects showing in final x-rays of bulge to tube sheet weld would actually be known to be in this weld and not in back-up deposited metal. In addition, bulge depth was too small by 1/8". To remedy this, see Sketch #24. The inside of the bulge at the top and bottom was undercut 1/16" and the trailing edges of the back-up strip was beveled a minimum of 1/32" to receive the plenum bulge. Sketches #24 and #25 show the location of reinforcement weld on back-up strip for top and bottom tube sheets.

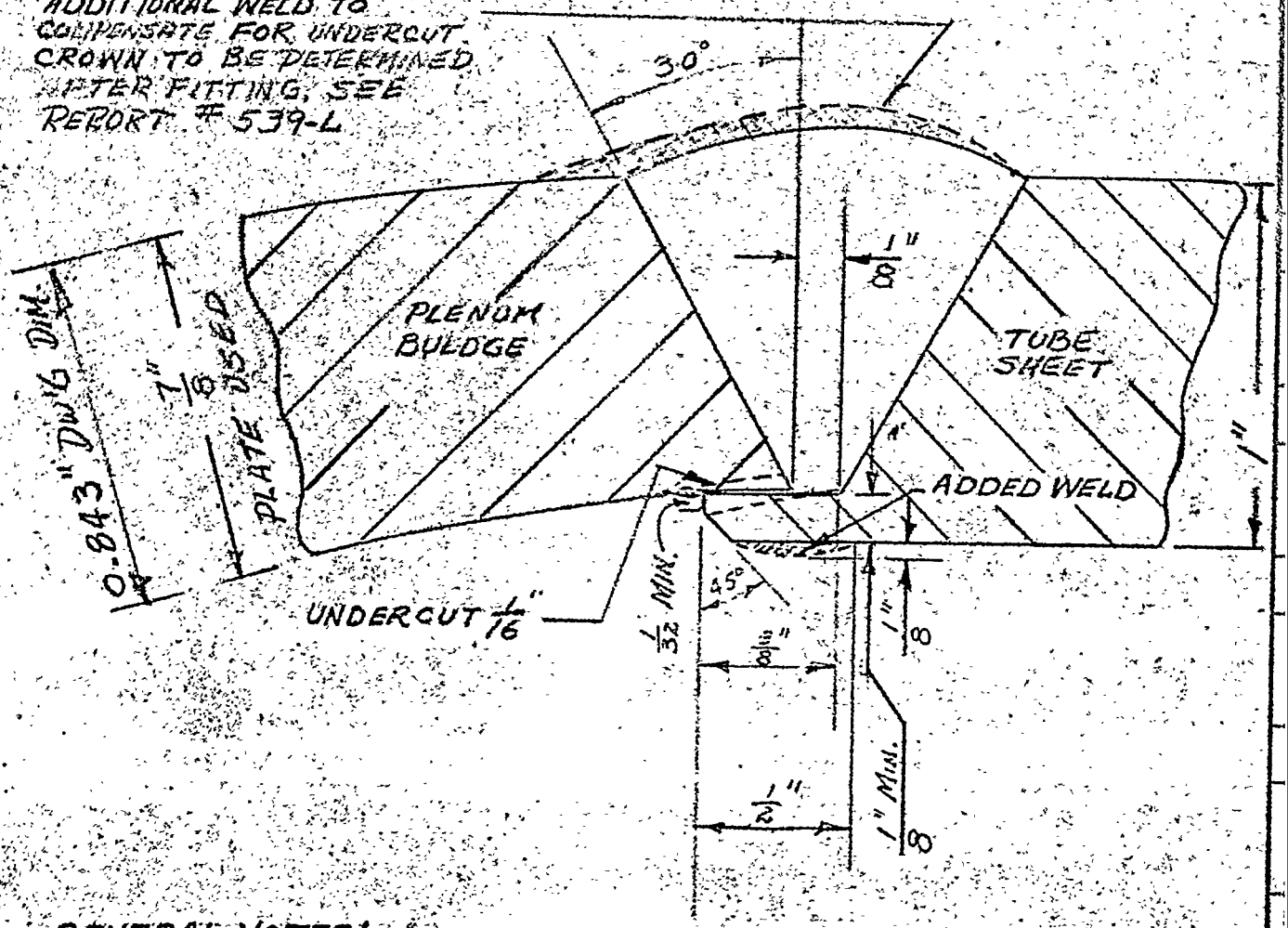
After machining and fitting the plenum bulge and nozzle assembly to the periphery of the unit, depth measurements were taken along the weld preparation joint to determine size of weld crown required. See Exhibit #3-A presented herewith for results of the inspection. Next, the bulge assembly was welded to the top and bottom plates. Enough weld metal was deposited at the locations specified in the above report such that when all grinding, chipping and repairs were completed, the finished weld crown was at the required height.

9. Preliminary Cleaning and Inspection Prior to Assembling and Welding Nozzle Assembly

A. "R" Unit

No preliminary cleaning was performed prior to assembling and welding nozzle assembly to the periphery of this unit. However, the interior was visually inspected for cleanliness before the nozzle assembly was welded and it was found satisfactory.

ADDITIONAL WELD TO COMPENSATE FOR UNDERCUT. CROWN TO BE DETERMINED AFTER FITTING, SEE REPORT # 539-L

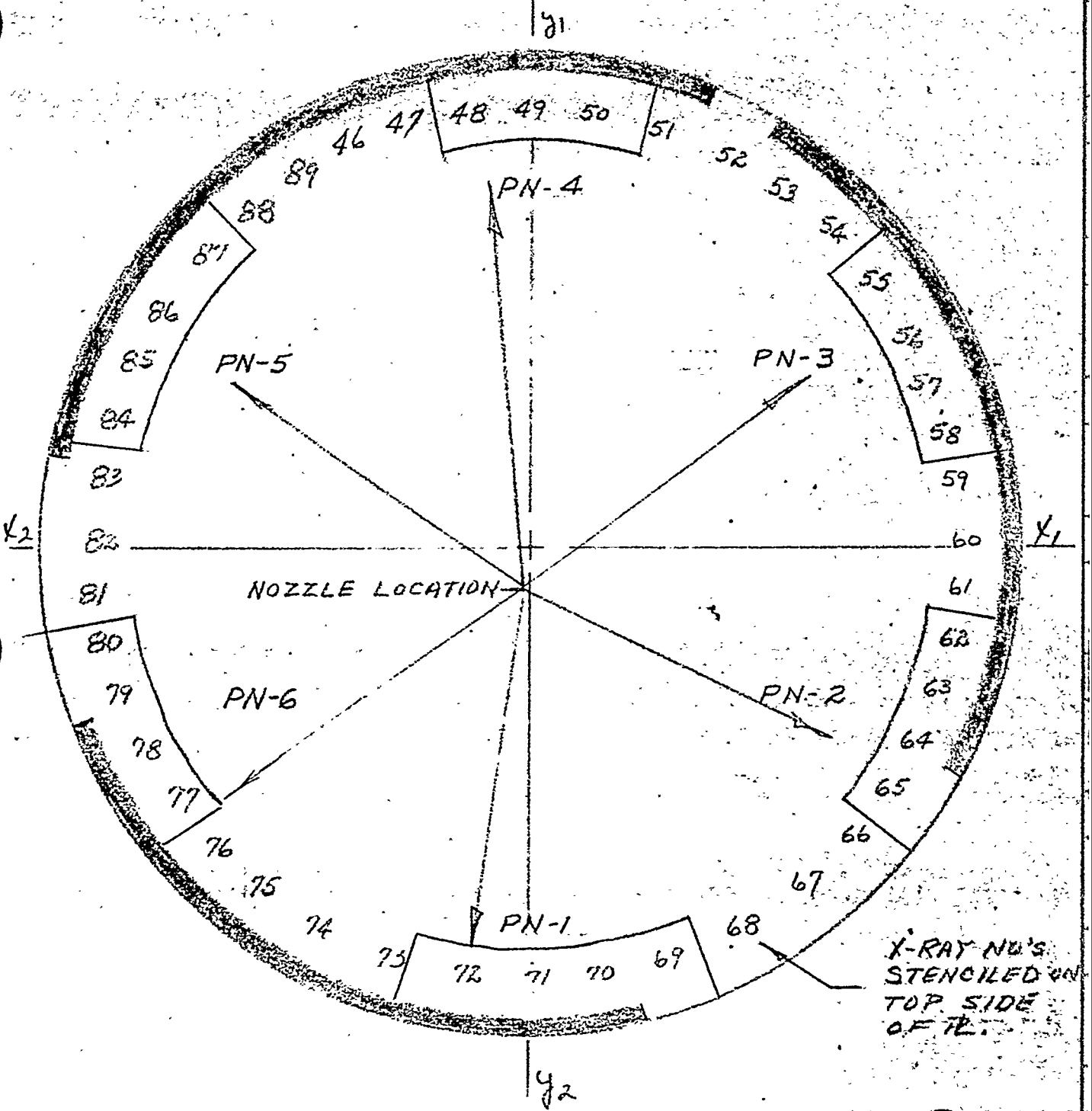


GENERAL NOTES:

1. ADDED WELD UNDER LIP WAS GROUND TO EVEN HEIGHT & CONTOUR SO X-RAYS WOULDN'T BE MISINTERPRETED
2. OVERHEAD WELDING WAS DONE FROM ONE SIDE BUILDING UP LIP. PLENUM WAS UP SIDE DOWN. FOR WELDING B.T.S. BACK-UP STRIP.
3. ADDED WELD ON FINISHED JOINT EQUALED BEVEL ON BULGE.
4. FOR LOCATION OF REINFORCEMENT WELD (ADDED WELD) ON BACK-UP STRIP - BOTTOM TUBE SHEET & TOP TUBE SHEET, SEE SKETCHES #24 & 25.

ENGINEERING SKETCH SHEET E. I. DU PONT DE NEMOURS & CO.	PROJ. No.	SIGNATURE:
PROJ. TITLE	SKETCH #24	DATE
SUBJECT		No. E-42461

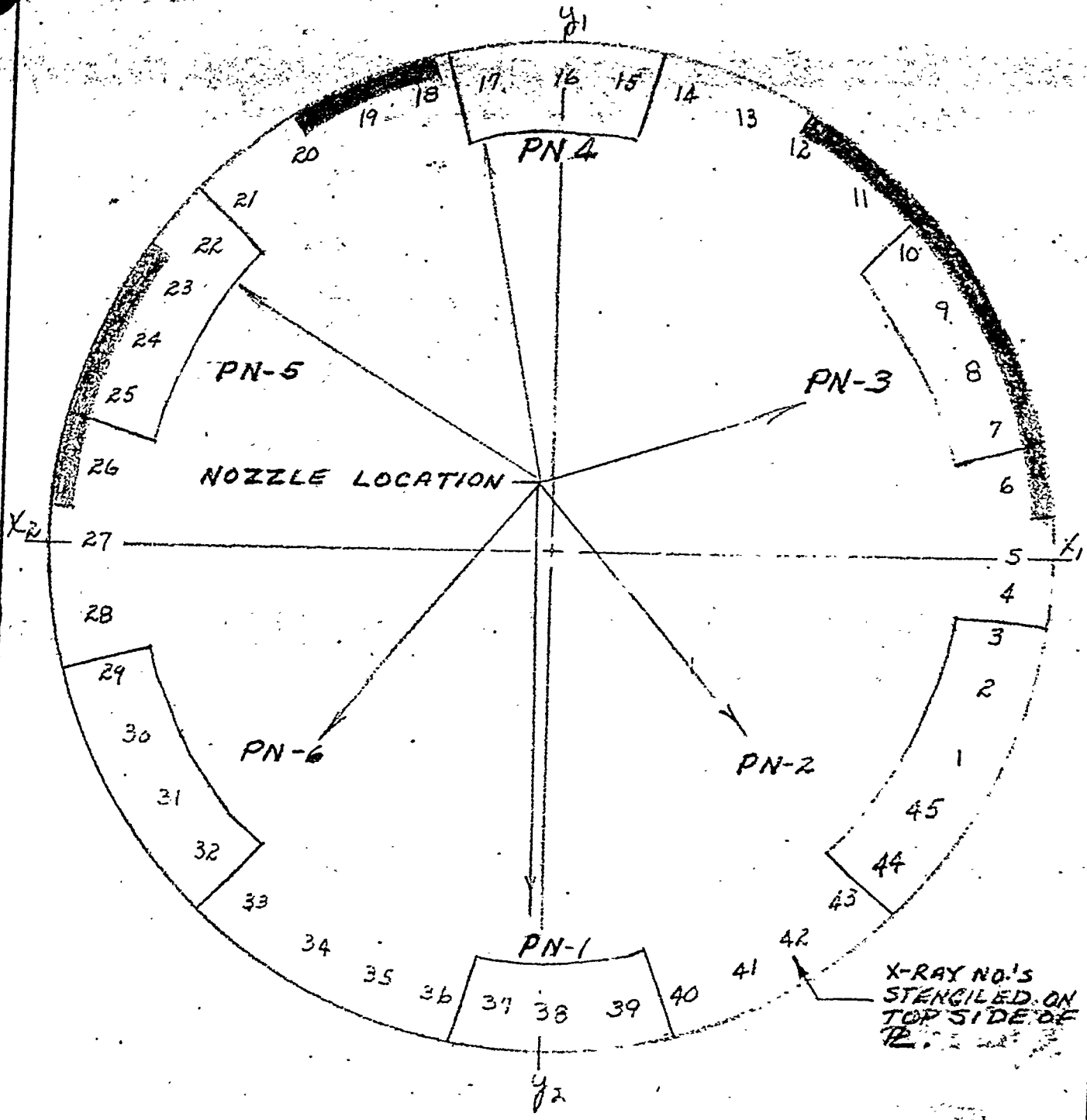
LOCATION OF REINFORCING WELDS ON BACK-UP STRIP-"L" UNIT. PLENUM TUBE SHEET TOP
ALL WELDING WAS DONE DOWNHAND ON LIP



DARK AREAS ARE WELD METAL LOCATIONS ON LIP

ENGINEERING SKETCH SHEET E. I. DU PONT DE NEMOURS & CO.	PROJ. No.	SIGNATURE:
PROJ. TITLE		DATE
SUBJECT: SKETCH #24-A		No. E-42460

LOCATION OF REINFORCING WELDS ON BACK-UP STRIP "L" UNIT PLENUM TUBE SHEET BOTTOM
ALL WELDING WAS DONE OVERHEAD ON "LIP"



DARK AREAS ARE WELD METAL LOCATIONS ON LIP.

ENGINEERING SKETCH SHEET E. I. DU PONT DE NEMOURS & CO.	PROJ. No.	SIGNATURE:
PROJ. TITLE		DATE
SUBJECT: SKETCH #25		No. E-42456

EXHIBIT #3-A

MEASUREMENTS ON CIRCUMFERENTIAL WELD PREPARATION GROOVE ON TOP AND BOTTOM SIDE OF "L" PLENUM CHAMBER

E. I. DU PONT DE NEMOURS & CO., INC.

Report Number 539-L

Construction Division

CC: H. W. Gosney, F.P.M.
R. K. Mason-D.A.Hauser-SRP (3)
R. K. Mason-W.P.Duncan-SRP
H. L. Bunker - J. G. Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
J. B. Johnson - File

RESTRICTED
SECURITY INFORMATION

July 21, 1953
New York Ship - Camden, N. J.

1053

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM H. Neicen DATE March 16, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Plenum Chamber EQ.PC.NC. 155-L

DRAWING NOS. W-132843 Rev. 10 -Detail "W" JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Scope: Measurements on circumferential welds preparation groove on top and bottom side of "L" plenum from top and bottom plates to 10" split pipe to determine size of crown required on weld.

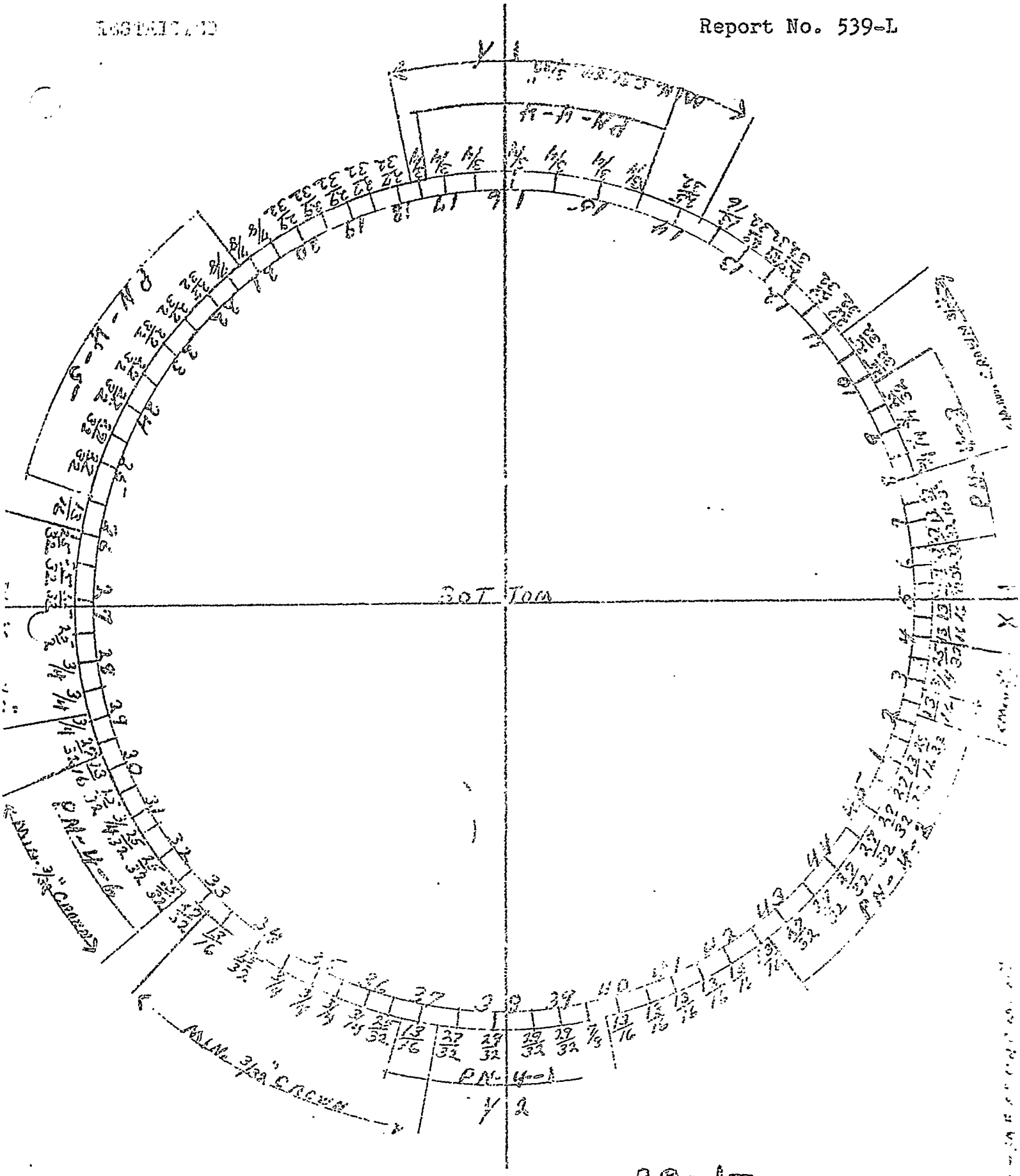
Procedure: Measurements were taken every six inches apart using depth gage and six inch scale on top and bottom side of plenum. Measurements were taken from top of split pipe to the top of backing up strip.

Results: See attached sheets for results of above measurements taken on circumferential weld preparation groove.

Note: The above measurements were required because in machining the plate bevel and backing strip the wavy plane of the tube plate caused a variation in depth of groove and thickness of backing strip.

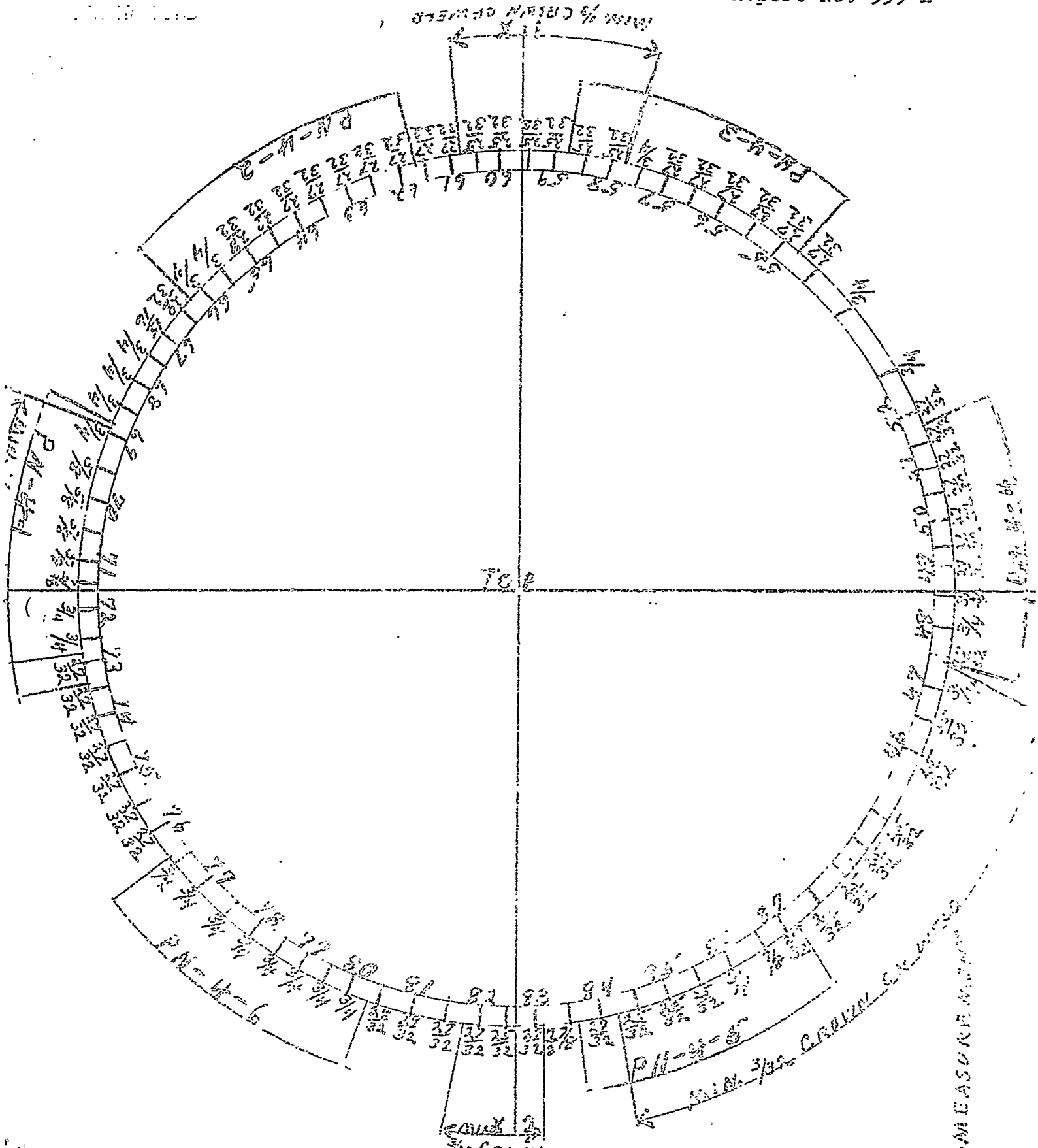
lmw
Attach. 2

RESTRICTED
SECURITY INFORMATION



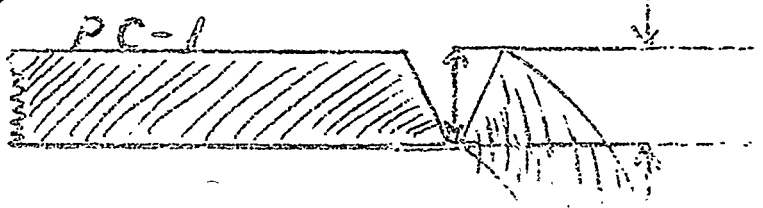
"L" PLENUM CHAMBER

Bottom Side



L PLENUM CHAMBER

Top Side



B. "P" Unit

This unit was placed in the washing pit and the circumferential handling jig removed. After this the interior of the unit was jetted with hot de-ionized water (150° - 170°F.) using Dowells high pressure car wash unit. No detergent was used. After cleaning, the interior of the unit was visually inspected for rust, dirt, and other foreign material. It was found clean and accepted for assembling and welding of the nozzle assembly.

C. "L" Unit

(1) Preliminary Cleaning by Dowell, Inc.

During the initial stages of fabricating "L" Unit, internal cleanliness of the various sub-assemblies became a major problem. This came about as a result of the establishing of strict cleaning specifications by plant site technical personnel. Heretofore, minor complaints had been received from the field pertaining to the cleanliness of "R" and "P" Units, which prompted the du Pont Inspection Department to take immediate steps to better clean all sub-assemblies.

Steps were immediately taken by the du Pont Inspection Department to develop and write preliminary cleaning procedures for the various sub-assemblies. First, a preliminary cleaning procedure was written for internally cleaning the plenum chamber prior to assembling of bulge and nozzle sections. This procedure was as follows: (Final internal cleaning procedure to be covered in later sections)

I. Washing

A. Unit placed in horizontal position (slightly inclined) and interior jetted through tube weir slots using a special jetting plug. Detergent used first and then rinsed with distilled water.

B. Install Sandwich Type Handling Jig

C. Hang Unit in Vertical Position

D. Cleaning Solution to be Used:
0.1% Detergent
Remainder - de-ionized or distilled water
(150° - 190°F.)

E. Jet using S/S nozzle upper 60° for 15 minutes

F. Rinse with manual hose using hot (150° - 190°F.) de-ionized or distilled water upper 60° continuously.

G. Jet remaining 120° each side with cleaning solution for 30 minutes keeping hot rinse water on upper 60° continuously.

H. Rotate unit 180° and repeat steps D, E and F.

II. Rinsing

A. Jet 120° each side with hot distilled water for 30 minutes keeping rinse water on upper 60° continuously.

B. Inspect

The above cleaning procedure was carried out in its entirety by Dowell Corporation and witnessed by a du Pont inspector. After cleaning the interior of the unit was visually inspected and residue resembling rust was found and also weld oxides were present. However, fabrication continued and the bulge and nozzle assembly was welded to the periphery of the unit. In the meantime, a plan for removing the rust and weld oxides was worked out by du Pont Inspection, New York Ship, and Dowell Corporation. Basically, their plan was to soak the unit in a solution of phosphoric acid and then flush the interior with de-ionized water. The procedure for doing this type of cleaning was as follows:

Based on recommendations of Dowell Corporation and New York Ship, du Pont inspection established the following procedure for acid cleaning internally the "L" Unit plenum chamber:

a. Cleaning solution is to be 5% - 10% (left to discretion of Dowell) phosphoric acid in de-ionized or distilled water at 150° - 170°F.

b. Plenum to be hung in vertical position filled with acid and allowed to soak 6 hours without agitation.

c. Acid to be agitated with air and drained simultaneously.

d. Plenum to be filled from top with hot de-ionized water and agitated from bottom with air and then drained.

e. Drain water to be tested by Dowell for acidity and step "d" repeated until acid is removed. (This is left to the discretion of Dowell).

f. On completion of satisfactory rinsing, the plenum is to be moved to a horizontal right side up position and the nuts (this procedure is to start in the center and work toward the outside of the bundle in order that the lower center section of the bottom plate can be drained first) on the tube caps spun off allowing the bottom flanges and bolts to fall in the pit. This is intended to drain through the bottom end of the tubes any water that is left in the bundle that could become iron contaminated from the mild steel flanges and bolts of the tube caps.

The above acid cleaning procedure was carried out in its entirety by Dowell Corporation and witnessed by a du Pont inspector. Upon visual inspection, it was found that the interior of the unit was free of all rust and weld oxides and accepted as being satisfactory.

10. Inspection of Fitting and Welding Nozzle Assembly to Periphery of Unit

A. "R" Unit

(1) Nozzle Inspection

Six nozzles were fabricated and inspected prior to welding them to the periphery of the plenum chamber. Nozzles for "R" and "P" Units were fabricated with hollow-type vanes as shown in photo serial number 50 and drawing 3-3. (This type vane was later replaced with solid vanes and is discussed in sections to follow). All weld joints were visually inspected after grinding and then x-rayed as described on the back of photo serial number 50. Also, see drawing 3-3 for location of weld seams x-rayed. After all repairs were made, the nozzles were released for fabricating into the plenum nozzle assembly.

(2) Plenum Nozzle Assembly

Six nozzles and six "bulge" segments were fabricated into a plenum nozzle assembly. (See Photo Serial #42). All butt welded joints joining nozzles and bulge sections were ground smooth and then x-rayed; repairs made and accepted (See drawing 3-3).

Next, the plenum nozzle assembly was removed from the fabricating jig (photo serial #42) and set up on the 20' Sellers Boring Mill for boring the I.D. to suit plenum O.D. for fit-up. (See photo serial #30).

[redacted]

New York Shipbuilding Corporation
Camden, New Jersey
April 9, 1952

PROJECT 8980 - SAVANNAH RIVER PLANT

OPERATION 16-B - Assembling and welding of Plenum Chamber "P" Unit Nozzles.

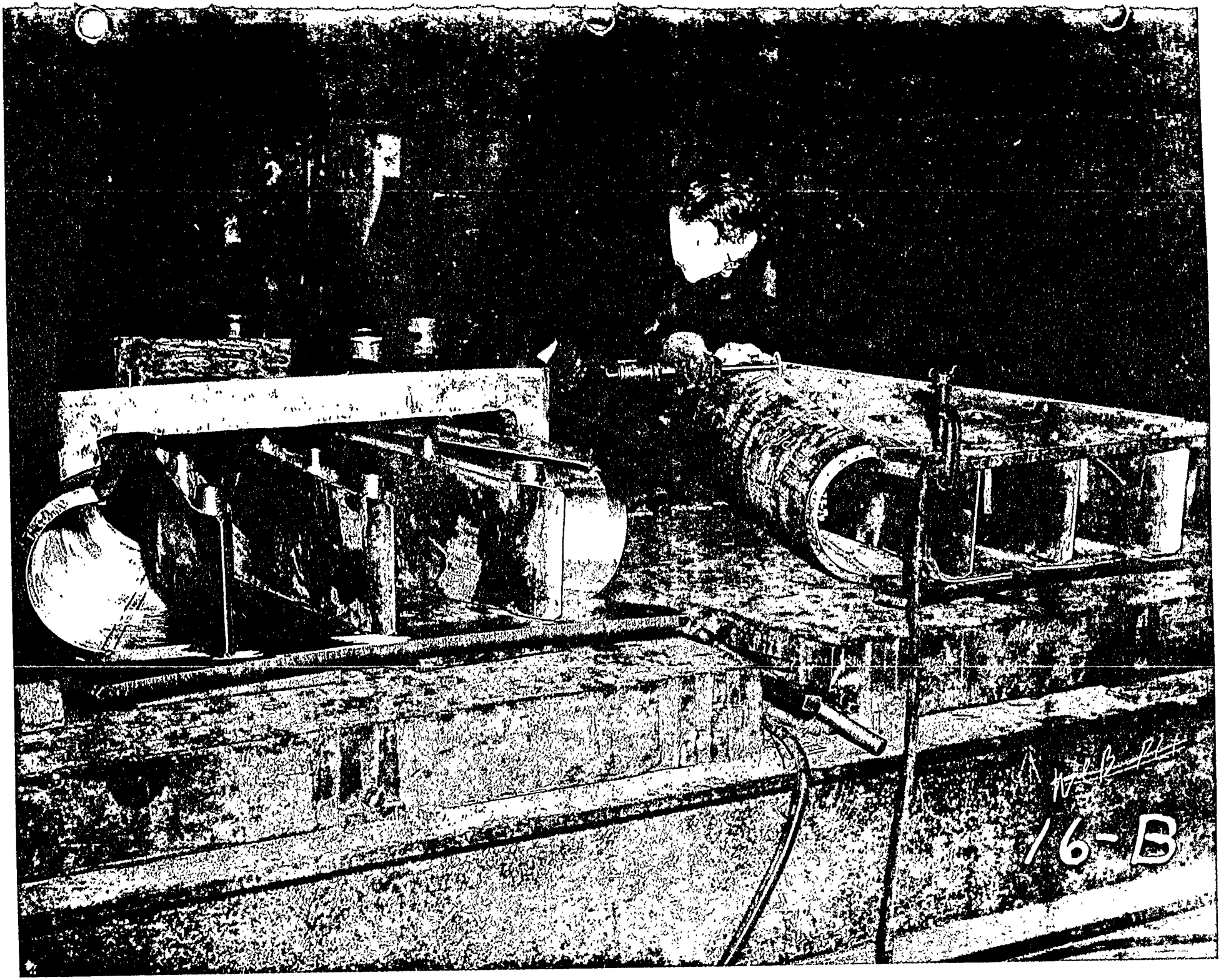
The operator is preparing the welding groove for a second pass between the nozzle buldge and top vane plate.

A detail structure of the nozzle is shown on the left. All butt welds are radiographically examined through out their entire length and interpreted in accordance with the non-destructive test as specified in Par. U-68 (h) 2 to 110 incl) of the A.S.M.E. Code for Unfired Pressure Vessels 1949 Edition. M & E inspectors visually inspect all butt welds and examine all radiographs.

This ma[redacted]tion affecting the national[redacted] meaning of the [redacted] 793[redacted] whic[redacted] is prohibited by law.

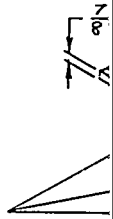
Operation Reference: "Fabrication, Welding and Inspection Procedure" issuedd by New York Shipbuilding Corporation September 11, 1951.

[redacted]


16-B

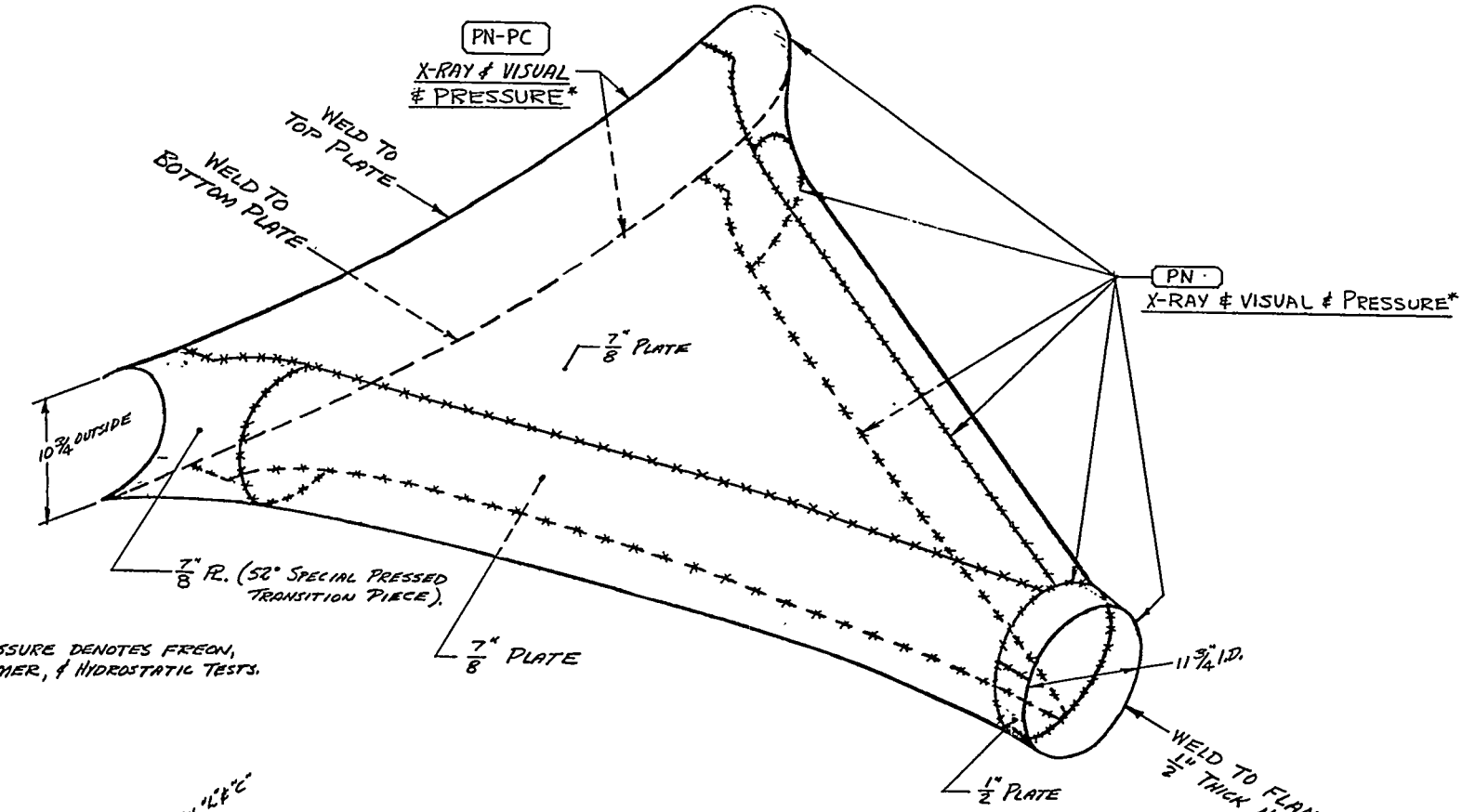
PL

NOTE:
*1. PRE
HAR

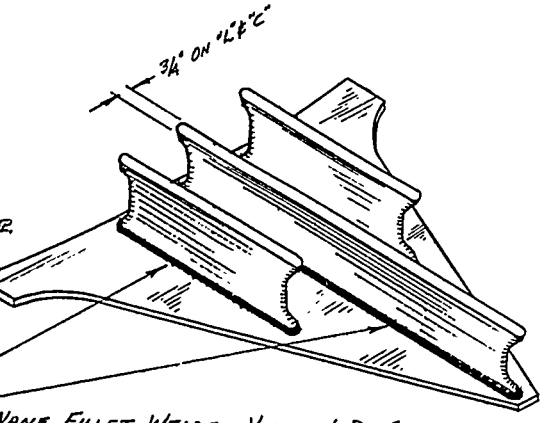


M & E
GOV'T

LENUM CHAMBER NOZZLE ASSEMBLY



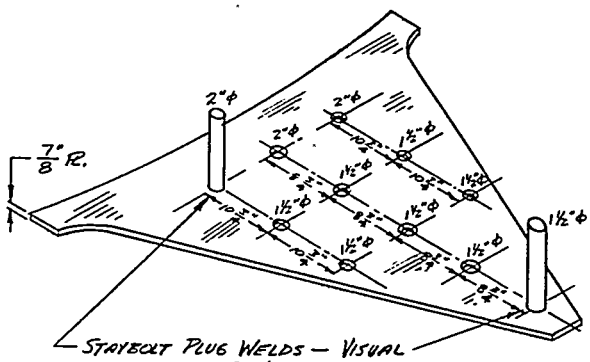
SSURE DENOTES FREON, MER, & HIDROSTATIC TESTS.



VANE FILLET WELDS — VISUAL & DY CHEK TOP & BOTTOM.

NOZZLE VANE LOCATIONS
"L" & "C" UNITS

TES:
1. VANE WIDTHS & CONTOURS OF LEADING & TRAILING EDGES AS SHOWN FOR "L" & "C"
2. VANE WIDTHS FOR "R","P" & "K" VARY FROM 2" TO 1½" & LEADING & TRAILING EDGES ARE STRAIGHT.



STAYBOLT PLUG WELDS — VISUAL TOP & BOTTOM

NOZZLE STAYBOLT LOCATIONS
"R","P" & "K" UNITS

SECTION CONTRACTS

DW'G. 3-3

[redacted]ECTED
BY: S.R. COCHRAN
JAN.-1953

After boring the I.D. of the nozzle assembly and beveling for weld preparation, inspectors checked the I.D. of the assembly using a pin gage and feeler gages. Measurements were made between points "A" and "B" shown on photo serial number 30-1. The O.D. of the boring mill (at point "A") was previously measured; therefore, it was only necessary to measure between points "A" and "B" to determine the I.D. of the plenum nozzle assembly.

(3) Inspections After Welding Plenum Nozzle Assembly to Periphery of Unit

The plenum nozzle assembly was moved from the 20' Sellers Boring Mill and fitted for welding to the periphery of the plenum chamber. After fitting the assembly was welded to the plenum top and bottom tube sheets. Welding was balanced to keep distortion to a minimum. (See Part II-A, Section 6a, photo serial #48).

After all welding and grinding was completed, circumferential welding between plenum and bulge section was visually inspected for cracks, porosity, undercutting, and necessary repairs made. These welds were x-rayed 100%. Repairs were made and welds re-x-rayed and accepted (See drawing 3-2).

B. "P" Unit

(1) Nozzle Inspections

Inspections were performed in an identical manner as described above in Section 10A-(1) and approved.

(2) Plenum Nozzle Assembly

Inspections were performed in an identical manner as described above in Section 10A-(2) and approved.

(3) Inspections Before and After Welding Plenum Nozzle Assembly to Periphery of Unit

Inspections were performed in an identical manner as described above in Section 10A-(3) and approved.

C. "L" Unit

(1) Nozzle Inspections

Inspections were performed in an identical manner as described above in Section 10A-(1) except as follows:

Serial Number 42

New York Shipbuilding Corporation
Camden, New Jersey
January 20, 1953

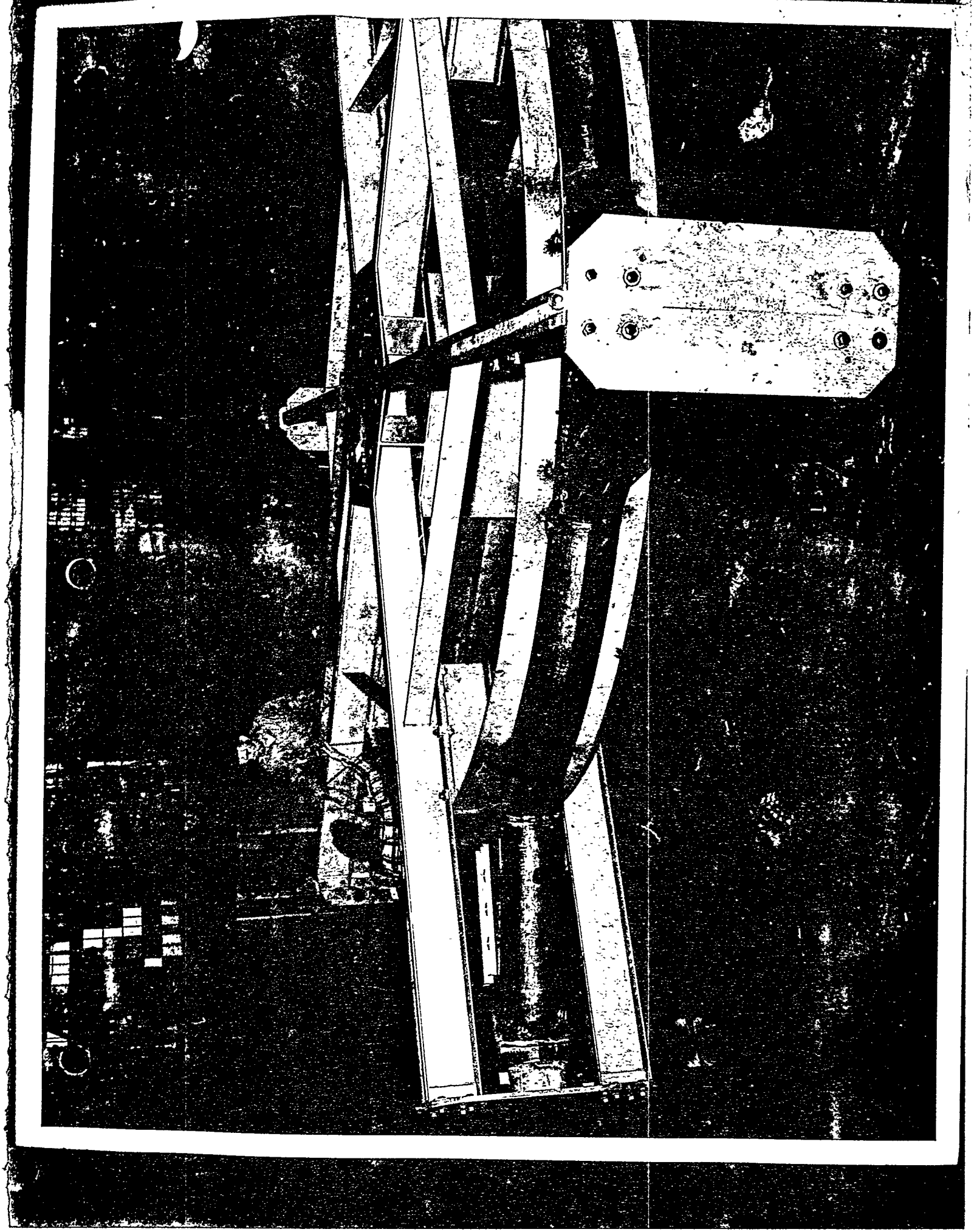
PROJECT 8980 - SAVANNAH RIVER PLANT

Plenum Chamber "Nozzle and Bulge", Fitting, Welding, and Handling Fixture.

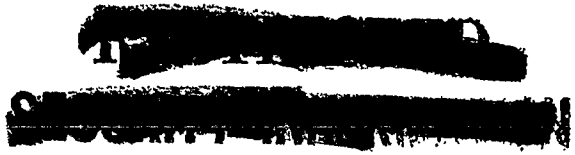
"L" Unit nozzles are located by radius line and center line and are clamped in fixture. A measuring and layout jig is adjusted between the nozzles and the bulge pieces are burned and chipped to proper dimension; then clamped and tacked to radius and center line location. Next, the nozzle to bulge weld is made; the assembly is "turned over" five times during this operation to prevent overhead welding. The fixture is collapsed and the weldment is removed in two sections, then moved to the 20 foot Sellers ~~Boring Mill~~ track turning Machine for finishining.

[redacted]

This material contains information affecting the [redacted] in the [redacted] U.S.C., [redacted] tion [redacted] ized [redacted]



Serial Number 30



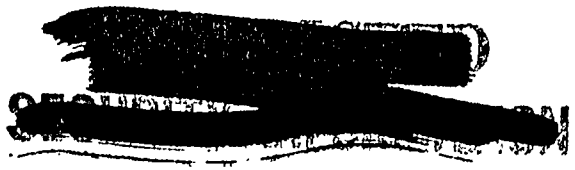
New York Shipbuilding Corporation
Camden, New Jersey
August 27, 1952

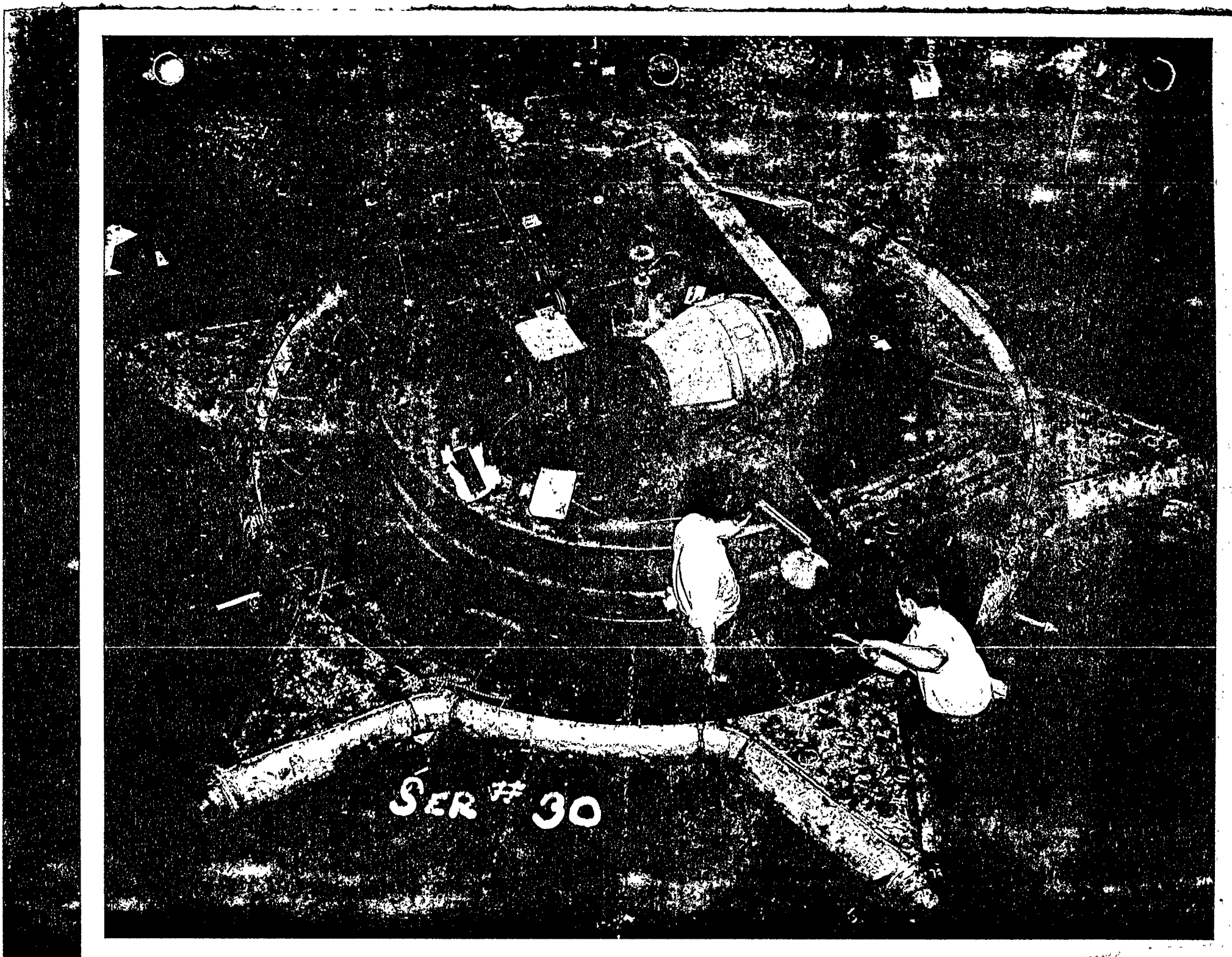
PROJECT 8980 - SAVANNAH RIVER PLANT

This view shows the milling of the excess material on the inside diameter of the nozzle and buldge assembly for the "P" Unit Plenum Chamber. A bevel is milled in the top and bottom portions to the desired inside diameter for welding the assembly to the circumference of the plenum chamber.

Machine: 20' Wm. Sellers Boring Mill.






SER # 30

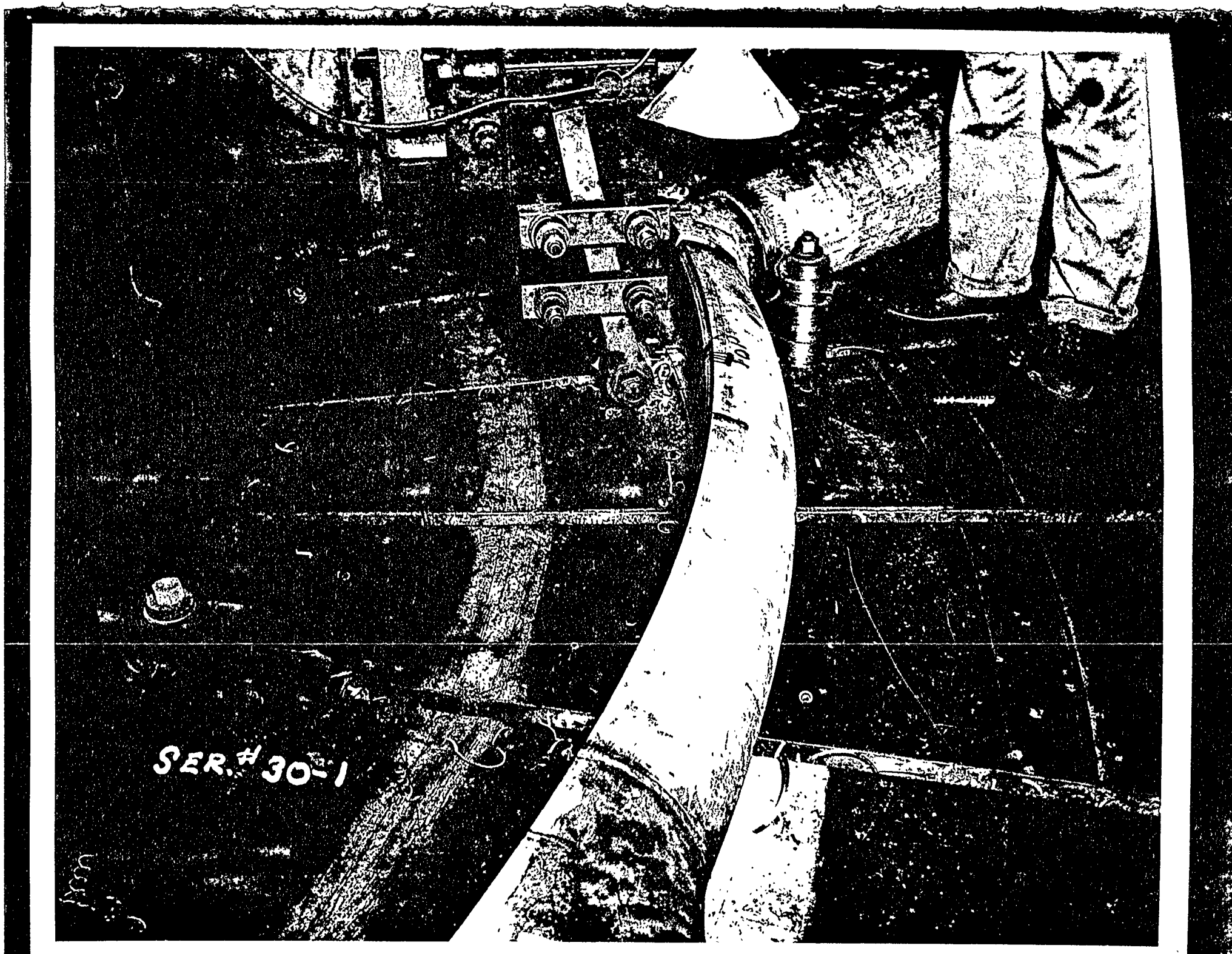
Serial Number 30-1

New York Shipbuilding Corporation
Camden, New Jersey
August 27, 1952

PROJECT 8980 - SAVANNAH RIVER PLANT

This is a close-up of the head of the 20' Sellers Boring Mill. The excess material on the bottom portion of the nozzle and buldge assembly is being milled off to the desired inside diameter.

See Serial Number 30 for overall view of this operation.


SER. # 30-1

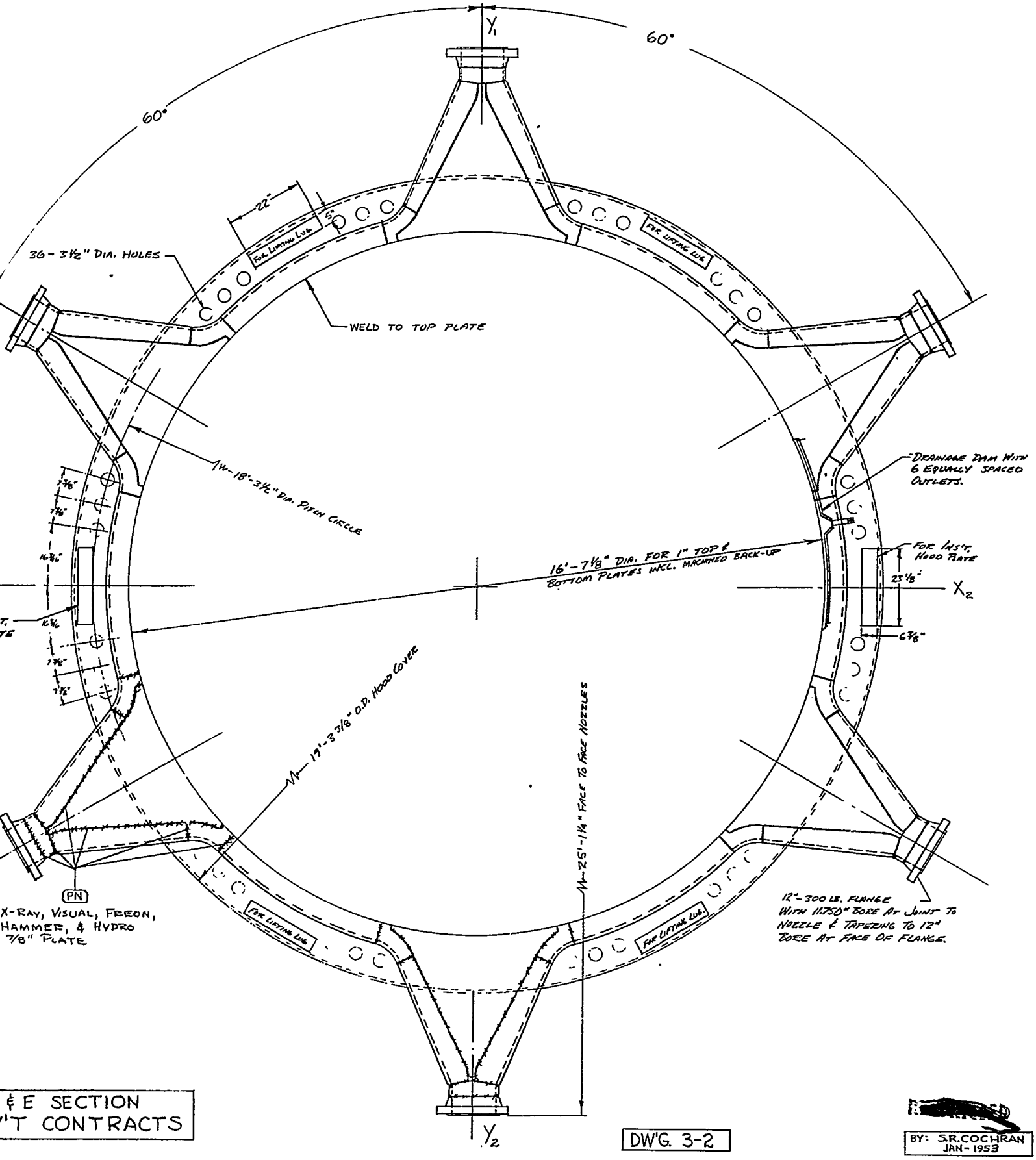
PL

X_1 ——

FOR INS
HOOD PL

N
GO

[redacted]ENUM CHAMBER- BULGE & NOZZLE ASS'Y



& E SECTION
'T CONTRACTS

DW'G. 3-2

[redacted]
BY: S.R.COCHRAN
JAN-1953

Design of nozzle vanes was changed on this unit. Solid type vanes were fabricated into each of the six nozzles before welding to the plenum chamber in lieu of the hollow type used on "R" and "P". Inspection was the same except vane fillet welds were visually inspected after grinding for porosity, undercutting, cracks and other mechanical defects. After this, all vane fillet welds were dy-cheked. Inspection was satisfactory and the job was accepted.

(2) Plenum Nozzle Assembly

Inspections were performed in an identical manner as described above in Section 10A-(2) except as follows:

Some difficulty was experienced in machining, fitting and welding of the nozzle assembly to the plenum chamber. For a detail analysis of the problem and how it was handled, see Section 8-C of this manual.

(3) Inspection Before and After Welding Plenum Nozzle Assembly to Periphery of Unit

Inspections were performed in an identical manner as described in Section 10A-(3) above; however, see Section 8-C of this manual for additional inspections necessary due to special problem encountered.

11. Skirt Plate Inspection

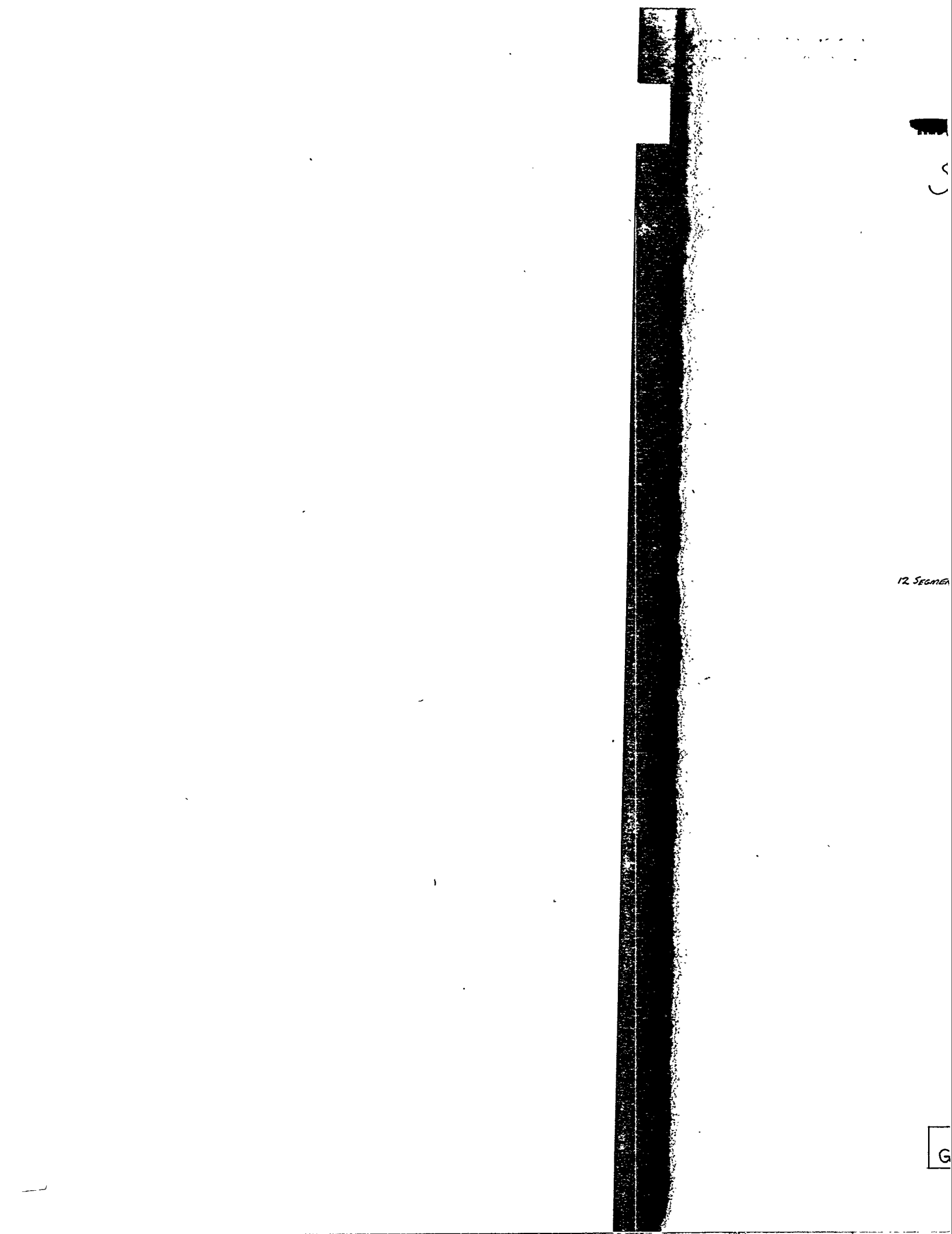
A. "R" Unit

(1) Welding

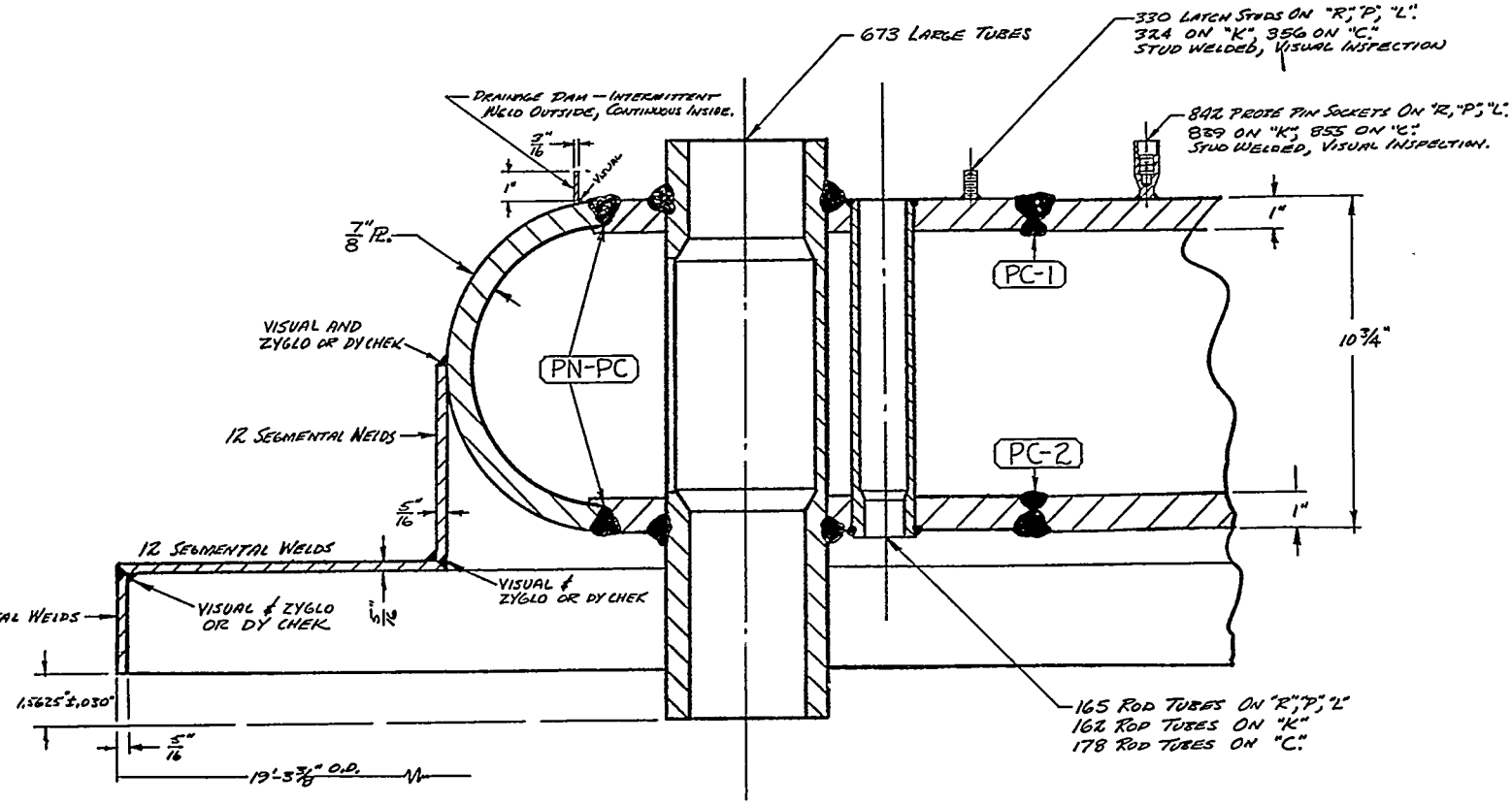
Six individual skirt assemblies were made up and welded to the circumference of the plenum chamber. After grinding and dressing, welding between the skirt assemblies and circumferential pipe was visually inspected for undercutting, cracks, and other mechanical defects. (See Part II-A, Section 12-a, photo serial #51). All inspections were satisfactory and the job was accepted.

(2) Dimensional Checks

Before shipping the plenum chamber to the Navy Yard in Philadelphia for facing tube ends, dimension "A" shown in drawing 3-1 was checked at random around the circumference of the skirt trailing edge to determine if enough metal was present to be machined



ECTION THRU PLENUM CHAMBER



NOTES:

1. ALL WELDS ARE SUBJECT TO VISUAL INSPECTION
2. LARGE & SMALL TUBE WELDS ARE SUBJECT TO:
   a. VISUAL INSPECTION
   b. FREON TEST
   c. HAMMER TEST
   d. HYDROSTATIC TEST
   } PRESSURE TEST
3. PN-PC, PC-1, & PC-2 — X-RAY, VISUAL, AND PRESSURE.
4. TWELVE SEGMENTAL SKIRT WELDS — VISUAL AND ZYGLO OR DYCHEK ON INSIDE.
5. VERTICAL BUTTS — NOZZLES TO BULGE — VISUAL, X-RAY & PRESSURE.
6. TOP & BOTTOM PLATE WELDS ARE NOT ALIGNED AS SHOWN, BUT ARE ORIENTED TO FORM A GRID PATTERN.

M & E SECTION
V'T CONTRACTS

DW'G. 3-1

BY: S.R. COCHRAN
JAN.-1953

to drawing dimensions. This measurement was taken by placing a straight edge on the tube ends on the bottom side of the unit and measuring distance "A" with a 6" scale graduated in 1/64". Measurements were satisfactory, and the unit was released for further fabrication.

B. "P" Unit

(1) Welding

Same as 11A-(1) above except as follows:

After the six individual skirt assemblies were fabricated, they were sand-blasted and then acid washed. Next, they were visually inspected for iron inclusions and other mechanical defects and repairs made. All skirt assemblies were then ferroxyl tested, found satisfactory, and released for welding to the plenum chamber.

In addition to visuallyinspecting all skirt plate welding, all welding was dy-cheked to further detect any pin holes, cracks, porosity, etc., missed during visual inspection. Necessary repairs were made and then accepted. Drawing 3-1 shows where dy-cheking was performed on the segmental welds.

C. "L" Unit

Inspections were performed in an identical manner described above in Section 11B-(1) and accepted.

12. Plenum Nozzle Vane Modification

A. Reason for Vane Replacement

During operation of the NYX unit on a test basis in Building 10, the inboard vane in #6 nozzle ruptured which predicated the change in design of "R" and "P" plenum chamber nozzles from hollow type vanes to solid plate type. Photograph serial number 50 shows the original nozzles with hollow vanes fabricated into NYX, "R" and "P" units. Drawing 3-3 shows the revised vanes using solid plate for the new nozzle vanes.

The following sections cover the changes effected and the inspection methods employed to determine distortion of tube bores and tube pattern resulting from replacement and welding of re-designed nozzle vanes in "R" and "P" plenum chambers.

B. Nozzle Welding Test

Since "R" plenum chamber tubes had already been faced and line bored, it was requested by the Design

Division that New York Ship remove all three hollow-type vanes from nozzle #6 in the "P" plenum chamber. This nozzle was to serve as a test nozzle for the determination of the effect of welding on the position and dimensions of the tubes adjacent to this nozzle. The "P" plenum was chosen for this test repair since the tubes had not yet been faced or bored. All three vanes in this test nozzle were replaced with solid plate vanes with staybolts in holes drilled through the solid vanes. Design Division prepared the necessary drawings showing the requested method of repair. Following the method outlined for vane repair, New York Ship machined and chipped out the three hollow-type vanes in nozzle #6. Next, the three new type vanes (solid plate) were fabricated into the test nozzle.

The procedure for repair of "P" plenum nozzle #6 with solid vanes was as follows:

(1) Replace vanes and staybolts in accordance with du Pont Design and welding preparation.

(2) Before starting welding, make sure proper check measurements have been taken on adjacent tubes.

(3) Before starting to weld, qualify welds using samples of both plug weld and staybolt weld with same preparation and materials that are to be used.

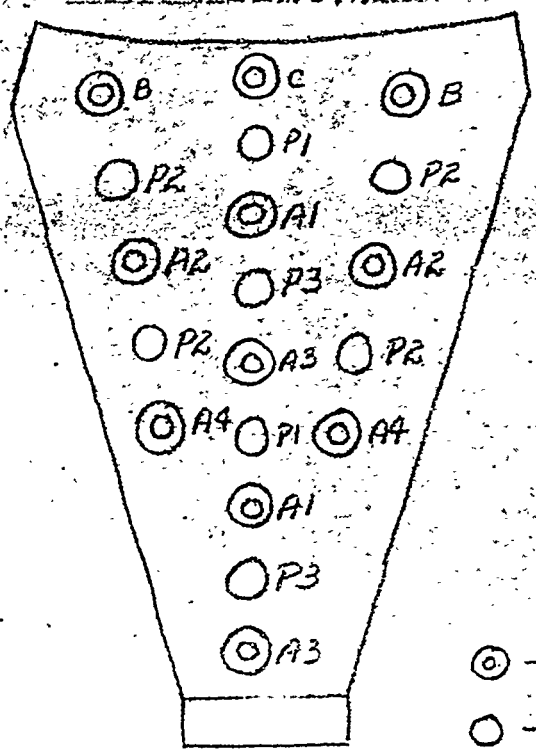
(4) Weld staybolts and plug welds and take check measurements as outlined in Sketch #26, taking care to skip weld in sequence as shown. Air cool each bead of weld and adjacent plate area immediately following deposition of each bead.

The following is an outline of inspections that were performed on the test nozzle to determine the amount of distortion caused by welding new type vanes and staybolts:

(1) A group of tubes, adjacent to nozzle #6, was selected for checking distortion. See Sketch #27.

(2) Before any welding, tubes shown in pattern on Sketch #27 were checked both on the top and bottom side for location and bore sizes. Locations of tubes were measured using the ligament gage shown in photo serial #159, Part II-A, Section 18. Ligaments were taken in the pattern in three directions. Tube bores were measured using a standard dial indicator bore gage and ring gage.

NOZZLE #6
"P" PLENUM



Sequence of Welding

1st Side		2nd Side
A1 to 4	1/3 full	A½ to 2/3 full
P	1/2 full	P full
A1 to 4	Complete	A1 to 4 Complete
P	Complete	

Check Measurements

B	1/2 Full	B Full
B	Complete	

Check Measurements

C	1/2 Full	C Full
C	Complete	

Check Measurements

ENGINEERING SKETCH SHEET
E. I. DU PONT DE NEMOURS & CO.

PROJ. No.

SIGNATURE

PROJ. TITLE

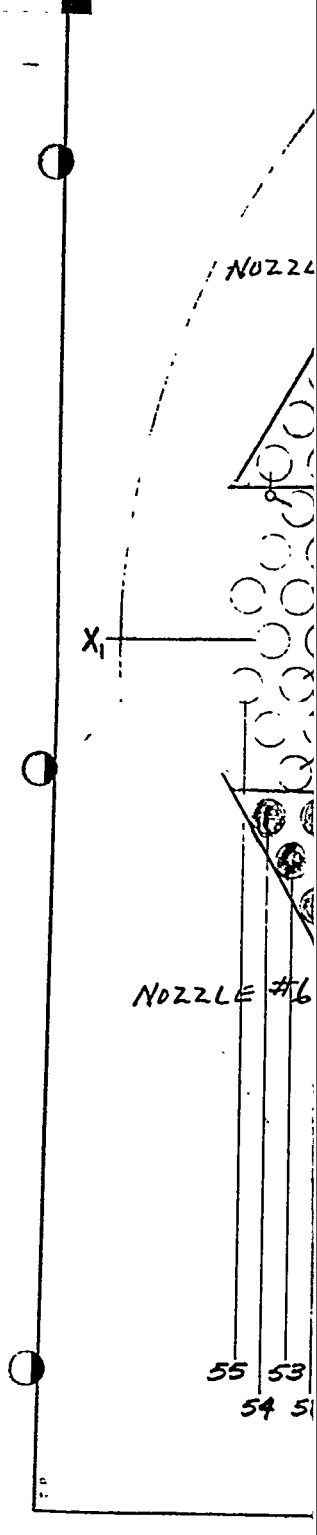
SKETCH #26

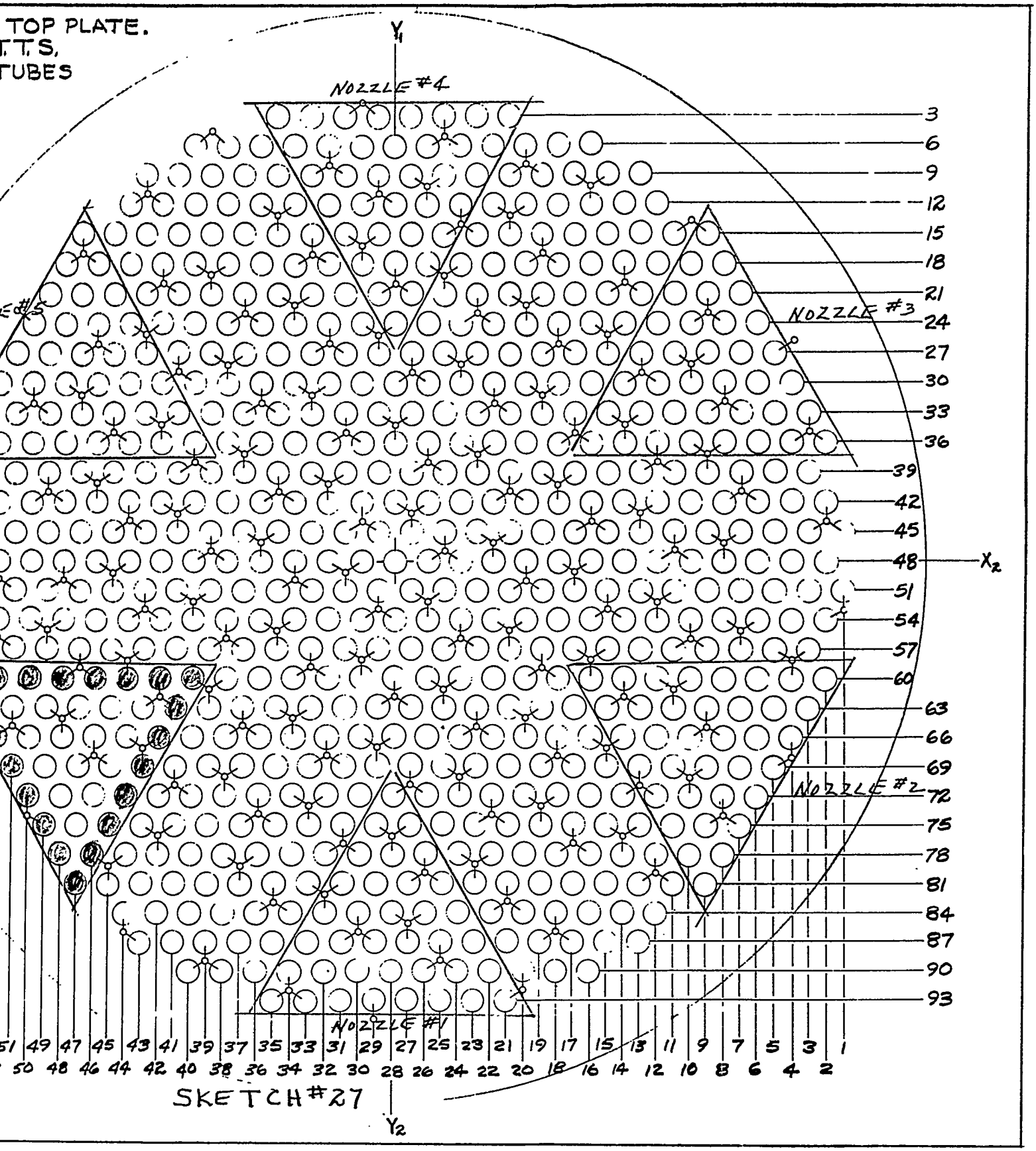
DATE

SUBJECT

No. E-42459

TOP SIDE OF
FOR P.C. &
OMIT ROD
FOR B.T.S.




TOP PLATE.
T.T.S,
TUBES
NOZZLE #4
NOZZLE #3
NOZZLE #2
NOZZLE #1
3
6
9
12
15
18
21
24
27
30
33
36
39
42
45
48
51
54
57
60
63
66
69
72
75
78
81
84
87
90
93
X_2
Y_1
Y_2
51 49 47 45 43 41 39 37 35 33 31 29 27 25 23 21 19 17 15 13 11 9 7 5 3 1
50 48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 8 6 4 2
SKETCH #27

(3) A group of tubes (colored red in Sketch #27) were checked for relative heights from an established bench mark using the Wild NIII precision level and target.

The above measurements were taken after each sequence of welding as outlined in Sketch #26. For results, see Exhibit #3-B.

After all welding was completed (on nozzle #6) and all measurements taken, the data was forwarded to the Design Division for evaluation. Evaluation of the test welding data (Exhibit #3-B) indicated that the effect of additional welding on nozzle #6 did not appreciably affect the tube pattern, bore diameter or tube profile. Permission was then granted by Design for New York Ship to repair the remaining five nozzles on "P" plenum and the six nozzles on "R" plenum.

C. Revised Welding and Inspection Sequences for Vane Modification on "R" and "P" Plenum Chambers

(1) "P" Plenum Chamber

After replacing and welding three solid type vanes in nozzle #6 ("P" Plenum), New York Ship revised the original method of repair for the five remaining nozzles in "P" plenum, and presented it to the du Pont Design Division for their approval. Design reviewed the new proposal and accepted it. The revised welding procedure for replacement of vanes in the five remaining nozzles on "P" plenum chamber was as follows:

a. Fit 3 vanes in 5 nozzles

b. Weld staybolts as follows:

I. 1st side (Top side of unit)

A. Staybolts 1 to 5 - 1 pass in all 5 nozzles

B. Staybolts 6 to 11 - 1 pass in all 5 nozzles

C. Staybolts 1 to 5 - 2nd pass in all 5 nozzles

D. Staybolts 6 to 11 - 2nd pass in all 5 nozzles (See Sketch #28).

EXHIBIT #3-B

RESULTS OF MEASUREMENTS TAKEN ON TEST NOZZLE #6

BEFORE, DURING AND AFTER VANE WELDING REPAIR

[redacted] INC.

[redacted]nstruction Division

September 22, 1952
New York Ship - Camden, N. J.

This material contains information affecting the national defense of the United States within the meaning of the espionage laws, Title 18, U.S.C., Secs. 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM H.E. Dills-R.E. Chaney & A.J. Piatek DATE September 22, 1952

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Plenum Chamber EQ.PC.NO. 155-P

DRAWING NOS. W-131155 JOB RATING

VENDOR New York Shipbuilding Corporation LOCATION Camden, N. J.

Scope: To determine the amount of distortion caused by welding new type vanes and staybolts into the nozzles of this assembly.

Procedure: A group of tubes, adjacent to the Plenum Chamber nozzle that was to have new vanes installed, was selected for checking distortion (see drawing). Before welding, these tubes were checked, both on the top and bottom sides, for location and bore sizes. Also a group of these tubes were checked for relative heights from an established bench mark using the "Wild Level". For identification of these tubes, see attached sheets. These same measurements were taken after welding "A" staybolts, then again after welding "B" staybolts and finally after welding "C" staybolts.

Results: See attached sheets. This inspection was completed on 9-21-52.

Remarks: The accuracy of the measurements is explained as follows:
Ligaments - These measurements, it is felt, are very reliable because the gauge used could recover the measurements between the same two points with ease.

[redacted]

I.D. - These measurements are fairly reliable but it is literally impossible to recover a measurement between two points in a tube because of the condition of the unbored tube I.D.

Wild Level Readings - These measurements are not reliable because of the nature of the tube tops after welding into the tube sheet. The target could not be made to assume the same position on the same tube twice in succession. It is possible to get a variation of .100" in some cases.

lmw
Attach. 5

WILD LEVEL READINGS BEFORE & AFTER WELDING STAYBOLTS IN NOZZLE

"P" Plenum Chamber - Bottom Side - Rod Setting On Bottom of Tube
All Readings in inches.

TUBE NO. X	Y	BEFORE WELDING	AFTER WELDING "A" BOLTS	AFTER WELDING "B" BOLTS	AFTER WELDING "C" BOLTS
54	60	-.108	-.128	-.296	-.161
53	63	-.072	-.090	-.276	-.108
52	66	-.112	-.120	-.225	-.133
51	69	-.134	-.132	-.248	-.138
50	72	-.146	-.131	-.256	-.131
49	75	-.162	-.163	-.251	-.136
48	78	-.260	-.252	-.250	-.208
47	81	-.223	-.216	-.279	-.153
49	69	-.181	-.165	-.143	-.176
46	66	-.040	-.040	-.122	-.037
43	63	-.024	-.022	-.033	-.027
40	60	+.060	-.066	-.089	+.062
37	57	.000	.000	.000	.000
34	54	+.084	+.080	+.034	+.081
31	51	+.040	+.048	-.100	+.048
28	6	-----	-.200	-.039	-.165
54	48	-----	-.208	-.286	-.181
2	48	-----	-.211	-.267	-.173
28	90	-----	-.200	-.238	-.163
28	48	-.024	-.025	-.226	-.022

Top Side - Rod Setting on Top of Tubes

54	60	-.032	-.035	-.040
53	63	-.064	-.068	-.070
52	66	-.053	-.076	-.104
51	69	-.041	-.064	-.044
50	72	-.043	-.068	-.044
49	75	-.020	-.046	-.020
48	78	+.046	+.024	+.037
47	81	-.004	-.024	-.002
49	69	+.005	+.010	+.005
46	66	-.155	-.175	-.158
43	63	-.163	-.180	-.168
40	60	-.241	-.257	-.245
37	57	-.187	-.203	-.192
34	54	-.277	-.286	-.282
31	51	-.241	-.251	-.249
28	48	-.167	-.174	-.176
28	90	-.003	-.002	-.001
54	48	-.008	-.000	-.008
2	48	-.011	-.008	-.009
28	6	000	000	000

RESTRICTED

BORE MEASUREMENTS BEFORE & AFTER
WELDING STAYBOLTS IN NOZZLE
BOTTOM SIDE; BOTTOM LAND

"P" Plenum Chamber - Basic 4.000 - September 21, 1952

TUBE NO. X	TUBE NO. Y	BEFORE WELDING	AFTER WELDING "A" BOLTS	AFTER WELDING "B" BOLTS	AFTER WELDING "C" BOLTS
		X + 5	X + 4	X + 2	X + 2
47	81	Y + 5	Y + 4	Y + 2	Y + 3
		+ 8	+ 7	+ 5	+ 6
48	78	+ 6	+ 6	+ 5	+ 5
		+ 1	0	+ 2	+ 1
49	75	+ 5	+ 4	+ 2	+ 3
		- 8	- 6	- 6	- 6
50	72	- 6	- 7	- 8	- 8
		+ 5	+ 5	+ 5	+ 4
51	69	+ 3	+ 6	+ 4	+ 4
		- 6	- 6	- 6	- 6
52	66	- 6	- 6	- 5	- 6
		- 1	- 2	- 5	- 3
53	63	- 1	- 1	- 2	- 2
		+ 9	+ 7	+ 9	+ 9
54	60	+12	+16	+12	+12
		+16	+14	+14	+14
52	60	+18	+15	+12	+13
		+ 3	+ 1	- 1	- 2
51	63	+ 2	- 1	- 2	- 2
		0	0	0	+ 1
50	66	+ 3	+ 2	0	0
		+10	+ 9	+ 6	+ 7
49	69	+ 8	+ 6	+ 6	+ 6
		+ 3	0	- 2	- 1
48	72	+ 2	- 2	0	- 2
		+ 3	- 3	- 4	- 1
47	75	+ 3	- 1	- 2	- 3
		+ 3	+ 2		+ 2
46	78	+ 2	+ 1		0
		- 4	- 6	- 6	- 6
45	75	- 4	- 7	- 7	- 8
		0	+ 1	+ 1	+ 1
46	72	+ 1	+ 1	0	0
		+ 3	+ 3	+ 3	+ 2
47	69	+ 5	+ 5	+ 5	+ 6
		+ 2	+ 2	+ 1	0
48	66	0	0	0	0
		+5	+ 4	+ 3	+ 3
49	63	+ 7	+ 6	+ 7	+ 7
		+ 7	+ 7	+ 7	+ 6
50	60	+ 5	+ 6	+ 6	+ 7
		- 3	- 2	- 3	- 3
48	60	- 3	- 2	- 5	- 5
		+ 1	0	0	0
47	63	+ 2	+ 2	0	- 4

RESTRICTED

RESTRICTED

BORE MEASUREMENTS BEFORE & AFTER WELDING STAYBOLTS IN NOZZLE BOTTOM SIDE; BOTTOM LAND

"p" Plenum Chamber - Basic 4.000 - September 21, 1952

TUBE NO. X	TUBE NO. Y	BEFORE WELDING	AFTER WELDING "A" BOLTS	AFTER WELDING "B" BOLTS	AFTER WELDING "C" BOLTS
		X +3	X +3	X +2	X +2
46	66	Y + 3	Y +3	Y +2	Y 0
		0	0	-1	-1
45	69	+ 2	+2	+1	+1
		+ 8	+9	+9	+7
44	72	+ 8	+11	+9	+10
		+ 8	+8	+7	+7
43	69	+ 1	+2	+1	+1
		+ 6	+7	+5	+5
44	66	+ 7	+8	+6	+6
		+ 4	+4	+1	+3
45	63	+ 4	+6	+6	+6
		+ 1	+1	-1	-1
46	60	- 2	-2	-2	-2
		-10	-9	-8	-8
44	60	- 8	-9	-8	-8
		0	-1	-3	-2
43	63	+ 1	0	-1	-1
		+ 2	0	0	-2
42	66	0	+2	+2	0
		+15	+15	+15	+15
41	63	+18	+15	+13	+14
		- 2	-5	-6	-5
42	60	- 3	-5	-6	-5
		- 3	-4	-7	-6
40	60	- 4	-6	-5	-6

RESTRICTED

BORE MEASUREMENTS BEFORE & AFTER WELDING STAYBOLTS IN NOZZLE TOP SIDE; TOP LAND

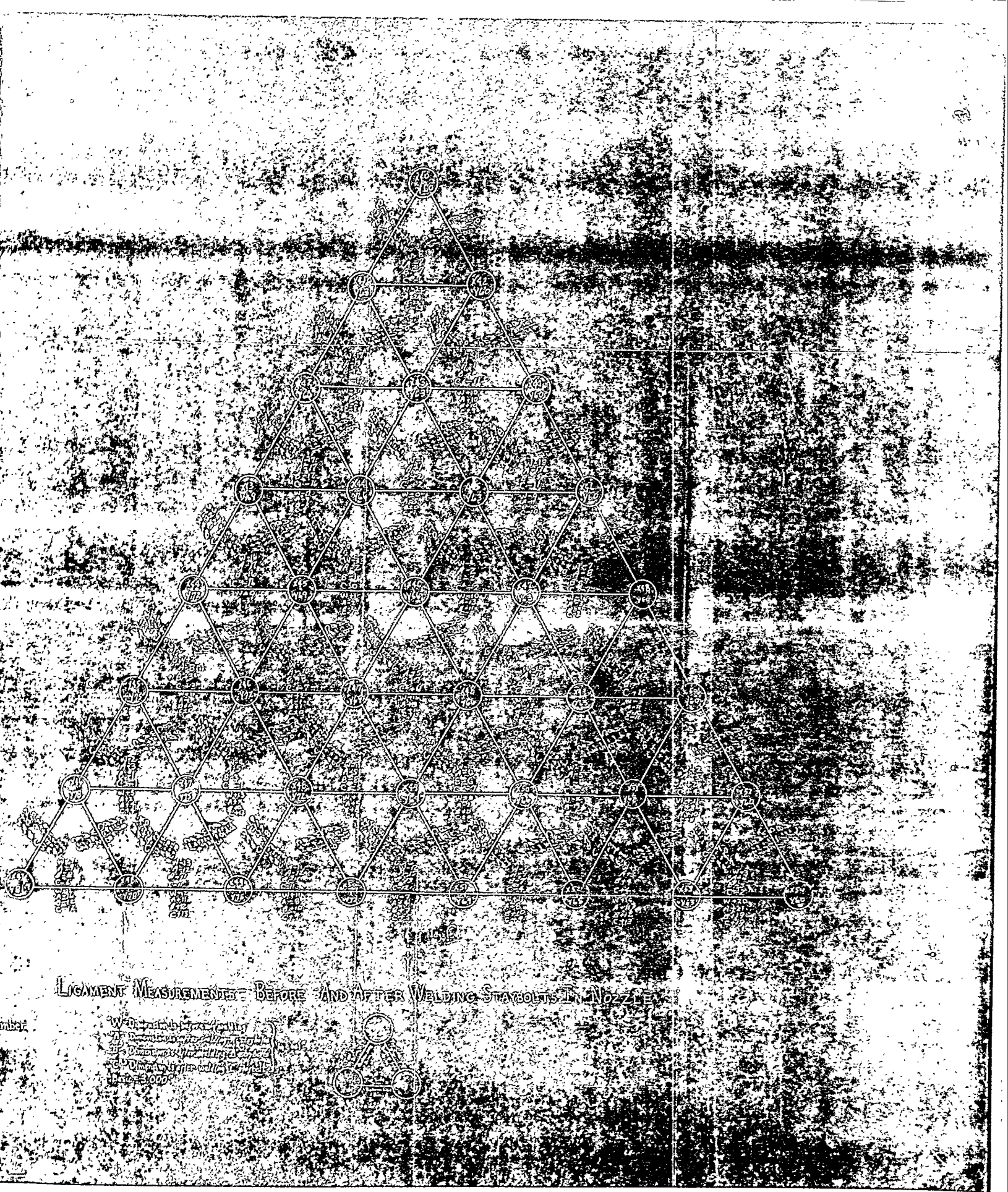
"P" Plenum Chamber - Basic 4.000 - September 21, 1952

TUBE NO. X	TUBE NO. Y	BEFORE WELDING	AFTER WELDING "A" BOLTS	AFTER WELDING "B" BOLTS	AFTER WELDING "C" BOLTS
		X - 1	X + 9	X +10	X + 9
47	81	Y	Y - 6	Y - 6	Y - 6
			+ 5	+ 5	+ 6
48	78		+ 7	+ 6	+ 5
			- 8	- 7	- 7
49	75		+ 6	+ 4	+ 4
			-14	-16	0
50	72		- 8	- 1	+14
			-13	-10	+ 6
51	69		-24	-13	- 2
			+11	+11	+ 9
52	66		+ 5	+ 4	+ 4
			-19	-17	-15
53	63		-10	-11	-11
			+24	+24	+25
54	60		- 8	- 8	- 7
			+ 5	+ 5	+ 3
52	60		+13	+10	+10
			- 3	- 5	- 7
51	63		- 2	- 3	- 4
			+ 2	0	0
50	66		- 8	- 8	- 8
			+ 4	+ 4	+ 5
49	69		+12	+13	+10
			+ 7	+ 3	+ 8
48	72		+ 5	+ 3	+ 7
			+ 3	+ 2	0
47	75		+ 3	+ 4	+ 1
			- 5	- 5	- 4
46	78		- 7	- 7	- 1
			-20	-15	-20
45	75		+ 2	- 0	+ 2
			- 3	- 3	- 8
46	72		- 1	- 1	- 2
			+ 9	+ 9	+ 9
47	69		- 1	- 1	- 5
			- 9	- 6	- 9
48	66		+12	+10	+11
			+ 6	+ 7	+10
49	63		- 8	- 8	- 9
			+ 1	0	- 3
50	60		+ 5	+ 6	+ 5
			+ 2	+10	+10
48	60		- 4	- 5	- 5
			0	0	- 1
47	63		+ 2	+ 2	+ 2

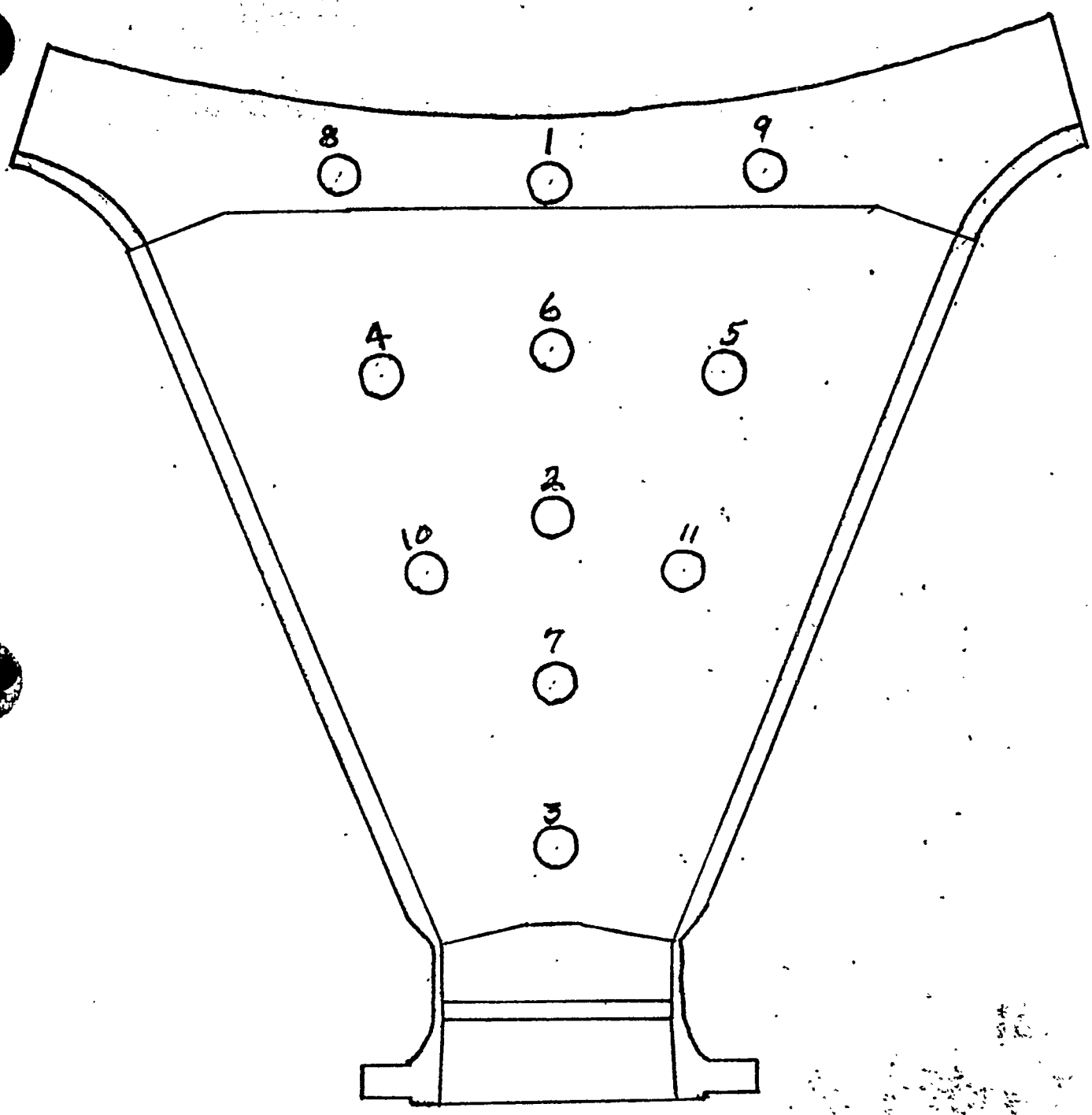
BORE MEASUREMENTS BEFORE & AFTER WELDING STAYBOLTS IN NOZZLE TOP SIDE; TOP LAND

"P" Plenum Chamber - Basic 4.000 - September 21, 1952

TUBE NO. X	TUBE NO. Y	BEFORE WELDING	AFTER WELDING "A" BOLTS	AFTER WELDING "B" BOLTS	AFTER WELDING "C" BOLTS
		X	X + 2	X - 0	X + 1
46	66	Y	Y + 5	Y + 4	Y + 1
			0	0	- 2
45	69		+ 6	+ 4	+ 3
			+ 6	+ 5	+ 3
44	72		+10	+11	+10
			-11	-11	- 8
43	69		+13	+12	+13
			- 6	- 5	- 7
44	66		+ 5	+ 5	+ 3
			+ 6	+ 4	+ 4
45	63		+ 7	+ 6	+ 5
			+ 5	0	+ 7
46	60		+ 5	+ 4	+ 4
			+11	+10	+10
44	60		+ 6	+ 6	+ 8
			+14	+12	+13
43	63		+ 5	+ 5	+ 4
			+ 2	0	0
42	66		+ 7	+ 7	+ 6
			- 6	+ 1	+ 3
41	63		+ 8	+ 8	+ 6
			-11	- 1	0
42	60		+ 8	+ 6	+ 6
			- 1	- 1	- 6
40	60		+10	+ 8	+11



LIGAMENT MEASUREMENTS - BEFORE AND AFTER WELDING STAYBOLTS IN NOZZLE



SHEET #3

PROCEDURE FOR WELDING STAY BOLTS FOP PLEN. NOZZLE VANES

SKETCH #28

II. 2nd side (Bottom side of unit)

A. Staybolts 1 to 5 - 2 passes in all 5 nozzles

B. Staybolts 6 to 11 - 2 passes in all 5 nozzles

C. Complete welding - 2nd side 1 pass at a time in all 5 nozzles, first in staybolts 1 to 5 then in staybolts 6 to 11.

III. 1st side

A. Complete weld 1st side 1 pass at a time in all 5 nozzles, first in staybolts 1 to 5, then in staybolts 6 to 11.

c. Weld up grooves cut in nozzles for fitting vanes

d. No cooling other than normal cooling from moving from vane to vane is required

Along with the newly developed vane welding procedure outlined above, du Pont Inspection Department outlined a new inspection procedure for determining the amount of distortion caused by welding new type vanes and staybolts into the nozzles of this assembly. This procedure was as follows:

a. Profile of triangular tube pattern at each nozzle using a 6' straight edge and feeler gages. (See photo serial #47)

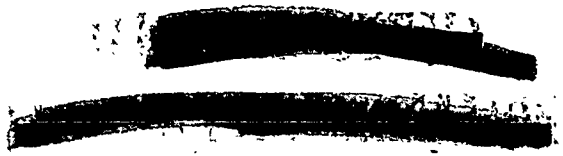
b. Complete ligament pattern in triangular tube pattern on top side of unit at each of the five nozzles using the ligament gage shown in photo serial #159, Part II-A, Section 18.

c. Ligament pattern on bottom side of unit on three rows of tubes that form the triangular tube pattern.

d. Bore measurements in top and bottom lands (three bore measurements 120° apart on top land and two on bottom land in X & Y direction) using a standard dial indicator bore gage and ring gage.

The measurements as outlined above were taken before and after replacing and welding solid type vanes in the remaining five nozzles on "P" plenum chamber. Final measurements were compared with initial measurements and the latter indicated that no appreciable shrinkage or distortion resulted.

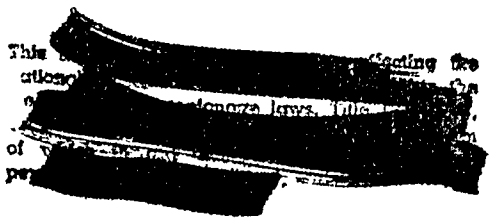
Serial Number 47

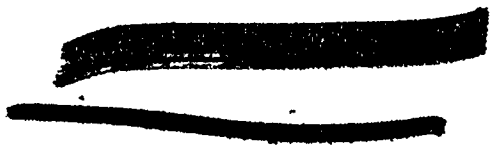


New York Shipbuilding Corporation
Camden, New Jersey
September 1952

PROJECT 8980 - SAVANNAH RIVER PLANT

This view shows the checking of the tube plane for flatness with a straight edge and feeler gage after welding plenum chamber "R" nozzle vane stay-pins.





SERIAL 47

The "P" plenum was accepted and fabrication continued.

(2) "R" Plenum Chamber

Solid type vanes and staybolts were installed in six nozzles on this assembly after all rod tubes had been line bored and large tubes honed to the required inside diameter. These vanes were of the same construction and design as those replaced in the "P" plenum.

The welding inspection and procedure for replacing vanes in the "R" plenum was the same as outlined for "P" plenum discussed above in Section 12C-(1), except as follows:

a. The "R" plenum was placed over the "R" top tube sheet and the eight tubes confronting each of the six nozzles were functional gaged before and after replacing vanes. This was necessary since all tubes were bored and honed to finish size. The functional gage (4.365" O.D.) successfully entered all tubes checked before and after replacement of old type vanes.

b. Three additional centering devices were added to the unit per Design's request making a total of 6 indexing devices on the plenum and top tube sheet. The purpose of these indexing devices was to index the plenum over the top tube sheet to the original position after line boring. Likewise, six centering devices were required for "P", "L", "K", and "C" units.

Again, measurements, as outlined above in paragraph C-1, were taken before and after replacing and welding solid type vanes in all six nozzles. Final measurements were compared with initial measurements and the latter indicated that no appreciable shrinkage or distortion resulted.

c. To determine if the nozzle welds were leakproof after all welding, the unit was subjected to a hydrostatic test. All tubes in the unit were sealed, nozzle flanges blanked and deionized water was pumped into the unit. Pressure of the water was raised to 375 psi and held for one hour. A visual inspection was made of all welds on all six nozzles and no leakage was found. The unit was accepted and fabrication continued.

13. Machining of Plenum Chamber Tube Ends

A. "R" Unit

(1) Verticality and Establishing Datum for Machining Tube Ends

Prior to taking verticality measurements on the plenum chamber spider web tubes (See Part II-A, Section 4, for location of spider web tubes), the unit was placed on cast iron pedestals and leveled. An 18' straight edge and 10" precision level was used to level the unit. Verticality readings were then taken with a specially designed verticality gage in the spider web tube pattern. Readings were recorded in .001" per foot. Verticality readings were analyzed and then the unit was shimmed where required to approach the best average verticality possible. After this condition was satisfied, level readings were taken on reference tubes X48-Y28, X48-Y54, X90-Y28, and X6-Y28. These level differential readings were stamped on reference tube ends (top ends) to be used as machine set up points for leveling the unit on the vertical boring mill for facing tube ends. Differential readings were taken using the Wild NIII precision level and target.

(2) Tube End Machining and Inspection

a. General

The NYX plenum chamber tube ends (top and bottom sides) were faced at New York Ship without the nozzles welded to the periphery of the unit. In this case it was necessary to leave the nozzles off since the 20' mill table at New York Ship was not large enough to handle the plenum with nozzles welded in place. When the nozzles were welded in place, the over-all diameter was approximately 24'. It was required that nozzles on subsequent units ("R", "P", "L", & "C") be welded in place before facing tube ends. This was necessary since any excessive welding on the unit after machining tube ends distorted the tube pattern beyond allowable tolerances. This condition was ascertained on the NYX plenum chamber after welding the six nozzles to the unit. Consequently, machining of tube ends on subsequent units had to be done by some outside vendor.

A survey was made and the only mill which was available and within feasible transportation distance from New York Ship was at the Philadelphia Navy Yard. Necessary arrangements were made with the Navy Yard to: (this applies to "R", "P", "L", & "C" plenum chambers)

I. "Provide transportation facilities (barge and tug) to receive plenum chamber assembly at the wet slip, North Yard, New York Shipbuilding Corporation, Camden, New Jersey, and transport same to Philadelphia Navy Yard; all facilities provided by the Philadelphia Navy Yard.

II. Face the top and bottom of plenum chamber tubes; face edge of gas seal ring in same plane and face any miscellaneous bench marks attached to the unit to the same plane. This work is to be accomplished with labor and immediate supervision as provided by the Philadelphia Navy Yard and under the technical supervision and inspection of the du Pont Material and Equipment Section. The du Pont Inspection Group to provide the Philadelphia Navy Yard with data to establish the facing plane; check the work before machining, during machining, and finished operation.

III. Philadelphia Navy Yard to provide transportation to return the unit to the wet slip, North Yard, New York Shipbuilding Corp., Camden, N. J."

b. Inspection

After the unit was received in the Navy Yard machine shop, it was removed from the handling jig and placed on the 25' Betts Mill table with the top side up. During the initial set up of the unit on the mill table, bench marks previously established were duplicated in a similar manner as outlined in Part II-A, paragraph 10-b. Prior to shipping the unit to the Navy Yard, New York Ship welded four disc-type buttons, approximately 1½" in diameter, on the top side of the top plate at the four extremities of the "X" and "Y" axes.

As the first machining operation, a light cut was taken on these four index buttons to establish a reference plane. At various intervals (time) thereafter, the faces of these buttons (machined within .001") were used for all setting up and machining operation. Next, the tube ends were faced to a common plane. However,

this initial facing on the top side was not to finish size. To insure a satisfactory bearing plane for machining the bottom side, tube ends on the top side were deburred after machining and then visually inspected. Before turning the unit, a profile of the top side was taken by placing a 18' straight edge on the X1-X2 axis. Distances between the bottom of the straight edge and tube face ends were measured with a feeler gage to determine the profile of the machined tube ends. The same procedure was followed for checking the Y1-Y2 axis. Maximum deviation of the machined tube ends from the straight edge was within two to three thousandths of an inch. While taking the profile vertical measurements were also taken between the faces of the reference buttons and the bottom face of the straight edge. This was done to insure that the plane of the machined tube ends was parallel to the plane of the four index button faces.

Next, the unit was turned with the top side resting on the mill table. Before any further machining took place, feeler gages were used to determine the distances between the faced tube ends and the face of the mill table. If none of these measurements were greater than a few thousandths of an inch, the unit was shimmed up and an initial rough machining cut was taken on the bottom side. Semi-finish and finished cuts were taken until the tube ends were machined to finished size. To determine if the plane of the tube ends was machined to the correct height from the top of the tube slots, measurements were taken between these two points using vernier calipers. A representative member of tubes were chosen for taking a pattern of the measurements.

For the purpose of obtaining a profile of the finished faced tube ends in the bottom side, an 18' straight edge was placed across the X1-X2 axis and repeated on the Y1-Y2 axis. By measuring the distance between the straight edge and tube ends with a feeler gage, a true profile of the bottom side was obtained. All tube ends were found to be within .003" from the face of the straight edge in both the X and Y directions.

After the profile had been found satisfactory, the skirt was then machined to finish size. The vertical distance between the face of the skirt and the finished machined tube ends on the bottom side was 1.5625" ± .030". The trailing edge of

the skirt was checked dimensionally by placing a straight edge on the finish plane of the plenum tubes (bottom side), and then measuring the distance between the face of the straight edge and the trailing edge of the skirt. These measurements were taken using an inside micrometer. All measurements were taken at 60° intervals, including the extremities of the X and Y axes.

Tube ends on the bottom side were then deburred and inspected for finish. Every tube had to meet required finish specifications of 125 RMS.

After the bottom side was found acceptable, the unit was turned allowing the bottom side to rest on the mill table. Again, feeler gages were used to determine the distances between the finished faced tube ends and the face of the mill table. If none of these measurements were greater than a few .001", the unit was shimmed up in preparation for final machining operations on the top side. Semi-finish and finish cuts were taken until all tubes met the specification of 19 1/8" ± .015" in length. This dimension was checked using vernier calipers. After this, a final profile was taken on the X and Y axes as previously discussed in this section.

The unit was accepted and placed in its handling jig and returned to New York Ship.

B. "P" Unit

(1) Basis for Establishing New Machining Operation

The "R" unit plenum chamber top plate was found to be dished about 1/4 of an inch. As a result when the tops of the tubes were faced off to a reference tube in the center, (low area) the tubes on the outside of the pattern were faced off to a distance of approximately 1-3/4" from the plate instead of 2" as specified on the drawing. For purpose of uniform machining of all units ("P", "L", & "C"), the following new procedure was established:

a. The tubes must be faced off top and bottom in planes parallel to the datum plane as defined by the bench mark readings. (See drawings W131407, W131156 and W131155)

b. The top faces of the tubes should be faced off to a dimension of 1.750 ± .015" from the plate at a point which is marked at the end of the X2 axis. (High point of top plate)

c. The tubes are to be finished to an over-all length as specified on the drawing.

d. The bottom edge of the skirt is to be finished to size with reference to the bottom face of the tubes. The distance between finish face of skirt and finish face of tubes should be the difference between the drawing dimensions of each to the plenum chamber center line.

(2) Preparation of "P" Plenum Chamber Before Shipping to the Philadelphia Navy Yard

After the hood-nozzle assembly had been welded to the plenum chamber assembly, it was placed on cast iron pedestals with the top side of the unit up.

Next, an 18' straight edge was set on the top side of the plenum chamber tubes and a level was used to level the unit. To make for the best average levelness of the unit, varying thicknesses of shim stock were inserted between the faces of the tubes on the bottom side and the top side of the pedestals. The unit was supported on four pedestals located along the outer periphery of the unit and in the center by a pedestal and jack arrangement. The jack was sitting on top of the pedestal with the top face of the jack seated on a steel plate. In turn, the steel plate was seated on tube faces in the center of the unit on the bottom side.

The welding of the large tubes and the welding of the hood sub-assembly to the plenum tube assembly caused considerable distortion in the top and bottom 1" plates. In effect, this distortion of the plates caused the tube face heights to vary by as much as 1/4".

Using the wild level (See Part III, Section II, paragraph J-2 for the written procedure covering the operation of the instrument) the top plate when the top side was up was placed in its best average plane. To find the best average plate levelness, the wild level target was seated on the top surface of the top plate conforming with locations established by the pattern shown on Exhibit #3C. Repetitive sets of readings were taken and shim stock was either added or removed from between the bottom faces of the large tubes and the top surfaces of the cast iron pedestals to achieve the best average plate levelness.

The levelness of the tube faces on the top side of the unit was checked for the minimum and maximum amount of variation. The lowest tube face was

EXHIBIT #3C

DETERMIN, INITIA, SET-UP POINTS FOR MACHINING TUBE ENDS

E. I. DU PONT DE NEMOURS & CO., INC.

Construction Division

[redacted]

Report Number 301-P

CC: H. W. Gosney, F.P.M.
R. K. Mason, F.P.M.-SRP (3)
H. L. Bunker - J.G. Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
R. H. Potts (2)
J. B. Johnson - File

November 6, 1952
New York Ship - Camden, N.J.

R.P.

FIELD INSPECTOR'S REPORT

TO [illegible] - [illegible] & E FILE

FROM [illegible] - H. E. Dahlke - I. R. Louder DATE November 5, 1952

PROJECT NO. 6980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Plenum Top Side EQ.PC.NO. "P"-UNIT

DRAWING NOS. W-131155 JOB RATING

VENDOR New York Shipbuilding Corporation LOCATION CAMDEN, N. J.

Scope: To determine elevation of various points on the top side of the top plate (not tubes) after unit has been leveled using the top of the tubes as a level plane. (Inspection performed 11/5/52)

Procedure:

The unit was leveled using the target on the top of the four end axis tubes and bringing it into level with the Wild level. Readings were then taken with the target resting on the top surface of the top plate at various locations (spider-web pattern).

Results: See attached sheets.

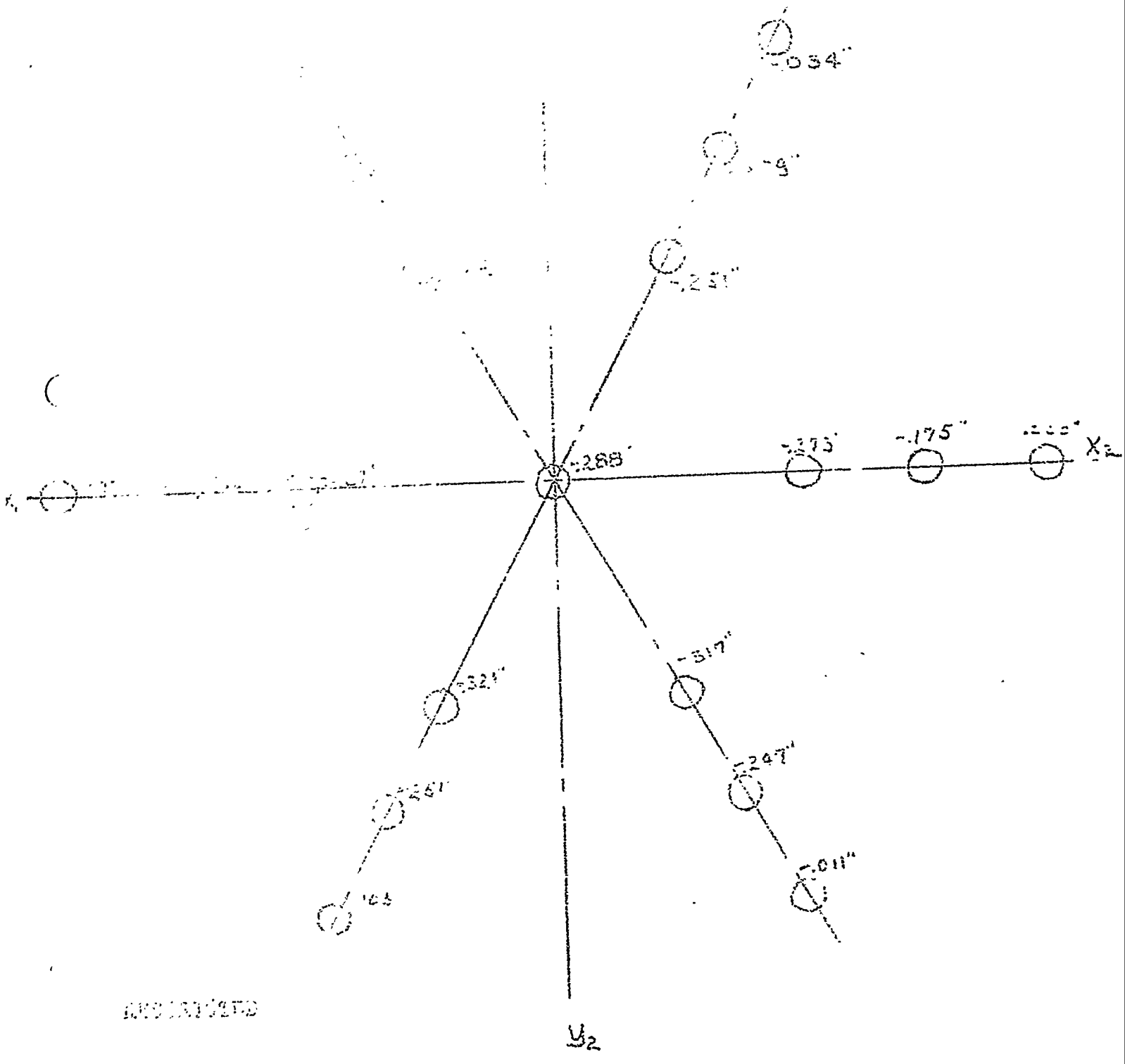
Disposition: This is the final setting for tube facing operation, superseding all previous setting data.

lmw
Attach. 2

[illegible] (TIB)
[illegible]

RESTRICTED

LEVEL READINGS ON TOP PLATE.
TARGET SETTING WITH A POINT ON
TOP PLATE NOT ON TOPS OF TUBES.
ALL READINGS IN THOUSANTHS OF AN
INCH.



RESTRICTED

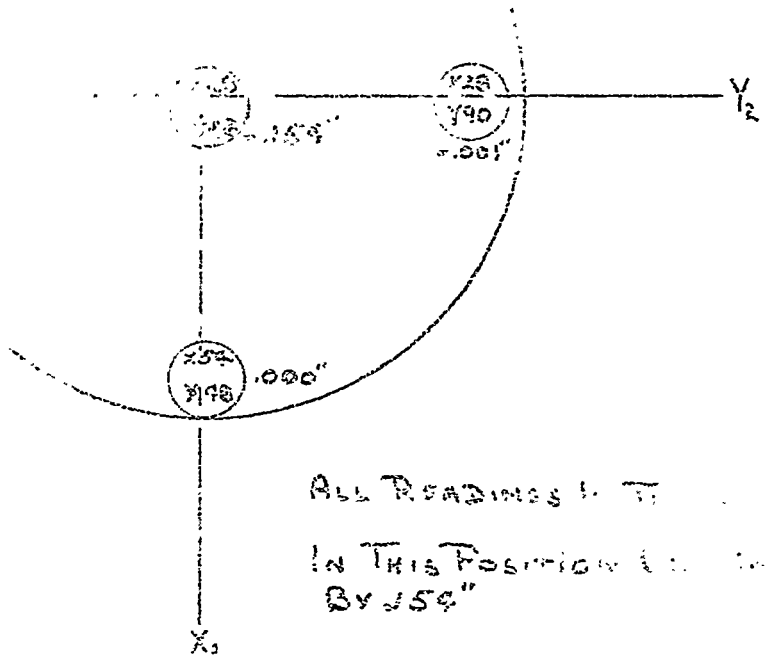
RESTRICTED

"P" Unit Plenum

Before Tubes Were Faced Off

In Top Of The Four (4) Tubes On

On Top Of Reference Tubes



All Readings In This Plane Are

In This Position The Tubes Are

By .154"

established as being the tube with the coordinate X28-Y48 and an elevation of -.154". The highest tube face had the coordinate X28-Y6 and an elevation of +.002" in relation to the lowest tube elevation.

To prepare the unit for shipment to the Philadelphia Navy Yard, the weir slots (three in each large tube) in all tubes were blanked off by placing a wood strip in each weir. Two metal clips attached to each wooden strip nullified the possibility of the wooden strips entering the interior of the plenum chamber. The plenum chamber was placed in its lifting gear or cradle and shipped to the Philadelphia Navy Yard via Navy tug and barge.

(3) Machining of the Plenum Chamber Tube Faces at the Philadelphia Navy Yard

After the plenum chamber was received at the Philadelphia Navy Yard, it was located near the Betts boring mill and prepared for the facing operation.

First of all, the Betts mill, Serial #E-4920, designed and built by the Betts-Newton-Colburn-Modern-Hilles and Jones Division of the Consolidated Machine Tool Corporation, Rochester, New York, was adjusted for the facing operation. The entire length of the rail from which the tool heads are suspended was checked for levelness using a precision machinist's level. It was finally leveled to within a .004" maximum variation. It was then set at the proper height for carrying through the entire facing operation.

Prior to checking the mill table, all grit, dirt, oil, grease, chips, etc., was removed from the mill table. Next, the mill was started up and the mill table allowed to revolve at approximately one R.P.M. speed for a thirty minute period. This allowed the oil to properly build up in the mill's bearing race and permitted the table to be properly cushioned on a film of oil. After it was determined that the mill table had been properly balanced and that it actually simulated the operating conditions required for the pending facing operation, the table was checked for levelness using a precision machinist's level. As a matter of fact, the table was checked for levelness over a wide range of locations. For all practical purposes, it was concluded that the top bearing surfaces of the mill rail were considered to be parallel to the face of the circular mill table to within seven thousandths of an inch. The rail was locked in place at each extremity using a large hand wrench designed for this specific job. Both

ram type heads were set absolutely vertical to the upper face of the rail and locked in this position using a special wrench designed for this job.

The mill table had an outside diameter of 24'-1". This table had a rated capacity of 100 tons. At regular intervals of one foot along the radii of the table, circles had been scribed. These circles were used in setting up the plenum chamber on the table. In addition, the table was designed with recesses running in a radial direction (25" apart on outer periphery) and so spaced that "T" type fixtures could slide in the recesses and be properly clamped to the exterior of the plenum chamber.

Next, the plenum chamber, with the top side up, was carefully seated on the mill table. Its location was altered until selected points on the outer periphery of the unit were equally distant from the nearest scribed circle.

A mathematical analysis of the elevations required for simulating the previous set up of the plenum chamber at New York Ship indicated that considerable shimming would be necessary prior to any machining (See Exhibit #3C). First of all, one spot was selected and marked on the bottom side of the Betts mill rail. This spot was located in a vertical plane common to a spot on the top surface of any one of the four large tubes located at the extremities of the X and Y axes. An inside micrometer was used to measure the vertical distances between the two spots. Measurements were repeated and shim stock was added or removed from between the bottom tube faces and the tube surface until the elevations furnished for the setup were duplicated. To simplify the setup, shim stock was restricted to those tubes located on the extremities of each axis. Sufficient shim stock was used to completely free all tubes located on the outer periphery with the exception of those tubes supported on shim stock. A jack was used to raise and lower the unit when shim stock was being added or removed from beneath the unit.

Next, the difference in elevation of the high and low point on the top plate was determined by measuring the vertical distance from the bottom of the rail to the two points using an inside micrometer. Shim stock was removed and added until the difference of -.154" was established for the high and low tube faces. The top faces of the four orientation discs were established correctly relative to their difference in elevation. These readings conformed to those readings furnished for duplicating the setup at New York Ship.

To maintain this setup, additional shim stock was placed between the tube faces and the mill table surface. Shim stock was added in the center and on the outside of the unit. The plenum chamber was clamped securely to the table and all elevations were rechecked.

To have a permanent reference for this setup, the outer third of the top surface of each orientation disc was machined or faced off. In this manner the same elevation was realized for the four orientation discs. Ultimately, two planes would have to be machined parallel to each other and parallel to the plane established by the machined surfaces of the four orientation discs.

Two "Red Sabre" roughing tools were placed in the right tool holder (facing the Betts Mill) and tightened with an Allen wrench. The lead tool was set up to take an average initial cut of 1/16" while the other tool was set to take an additional 1/16". Both tools were ground to have a good lip that gradually tapered to a point.

Before taking an initial out, all large tube weirs were inspected for the condition of the chip stoppers. Where necessary, the chip stoppers were replaced or tightened up.

To start taking the initial cut, the mill table was first revolved for approximately twenty minutes before the right head was run partially in on the traverse. The heavy "C" clamp was placed over the head and tightened with the aid of a monkey wrench. This prevented the possibility of the tools slipping in the head during the cutting operation. A "C" clamp was also attached to the other head.

The rough cut was started with a table speed of one minute and ten seconds per revolution. Tool feed was set at .071" per revolution of the table. The right head was allowed to take its cut until it had traversed for about one-third of the distance from the outer edge of the unit to the center of the unit. At this point, the left hand head was started using the same rate of feed and R.P.M. of the mill table.

After the second head had traversed to the center of the unit at an increased table speed of approximately two R.P.M., the mill was stopped. The four orientation discs, high and low points on the top plate were checked for relative elevation in respect to the original setup of the plenum chamber. They were found to be in agreement with the setup readings.

Next, tube faces located on the X & Y axis and the axis for each nozzle were deburred. Profile measurements were taken using a precision straight edge and feeler gages. With the straight edge resting on the tube faces, measurements were obtained to the nearest thousandths of an inch by inserting the feeler gage in the gap between the tube face and the bottom face of the straight edge.

Concurrent with the taking of the profile, the distance was measured from the high point of the plate to the plane established by the machined tube faces adjacent to the high point. The reading was procured by placing the straight edge on the tube faces and measuring from the bottom face of the straight edge to the high point using an inside micrometer. This reading was 1.825". Since specifications called for a final reading of 1.750" $\pm$ .015" for the distance from the high point of the plate to the tube faces, the decision was reached that the top side could be faced with the required finish on each tube face and all slots would be removed from the top face of the large tubes.

Permission was granted to finish deburring the top side of the plenum. In the meantime, tube lengths were taken using a standard vernier caliper. These tube lengths would be required to set up the plenum chamber for facing the bottom side. The plenum chamber was inspected for feather type burrs, etc., before it was removed from the mill table.

The plenum chamber was removed from the mill table and lowered in its cradle. All handling gear was tightened and the entire handling gear assembly was turned leaving the bottom side up.

The handling gear was removed and with the aid of the proper slings and overhead crane, the plenum chamber was lifted and moved and set on wood blocks in front of the Betts mill.

Next, the plenum chamber was lifted by overhead crane and allowed to rest on the mill table. It was again positioned in relation to the scribed lines on the mill table. Measurements were taken for the distance from the rail to the face of the tubes previously measured for over-all length. With the aid of shim stock, the plenum chamber was set up to the dimensions defined via tube lengths and the profile taken when the top side of the unit was up. Since the basis for this setup would be lost after the first cut on the bottom side had been taken, elevations (distance from top of 1"

plate to the bottom of the Betts mill rail) were taken at the end of each axis and in the center of the unit. An inside micrometer was employed for taking these measurements. Measurement locations on the 1" plate were marked with layout fluid.

The unit was bolted down and a dimensional recheck was made to insure the proper setup before the initial roughing cut was taken. As previously stated, "Red Sabre" roughing tools were chosen for both heads. The tools were set up to take 1/16" cut for each tool. In other words, the right head was set up for a roughing cut of 1/8" and the left hand (facing the front of the mill) head was set up for a roughing cut of 1/8".

The rough cut on the bottom side was taken in a manner similar to that used for the top side. Periodic checks were made to be positive that the set up had been retained. After the rough machine cut had been completed, those tubes lying on the X and Y axis were deburred. A straight edge was set on the X and Y axis, and it was ascertained that the roughing cut was satisfactory. Over-all tube lengths at various locations in the unit were also obtained using a vernier caliper. The profile and the tube lengths indicated that the two machined surfaces had been defined within several thousandths of an inch. Permission was granted to go ahead with the finishing or broad-nosing cuts.

To set up the right hand head for broad-nosing, the ram remained in a vertical position. The two roughing tools were removed and visually examined for any unusual wear that could have happened during the rough machine cut. Next, two "Circle C" tools (approximately 1" wide and designed for cuts of .003" to .005") were placed in the tool holder. The lead tool was tightened and the ram lowered so the cutting tool edge rested on a machinist's precision "box type" steel gage block. The gage block was seated on the surface of the mill table.

Feeler gages were employed to set up the second broad-nosing tool after the cutting edge of the first tool had been set parallel to the face of the gage block. As an additional check on the cutting tools, a dial indicator graduated in .001" was attached to a surface gage and run across the cutting edges of both tools. The readings were consistent. The mill table was revolved for a twenty minute period preparatory to taking the first cut.

Next, the mill table was stopped and the right hand head was moved into cutting position. The dial indicator (graduated in .001") attached to the Betts mill tool ram was adjusted to a reading of zero when the lead tool had been set on an average tube face of the unit. Through lowering the ram or head to have a dial indicator reading of .003", the lead tool and other tool were ready for the initial broad-nosing cut. The broad-nosing or finishing operation was repeated using both heads to within approximately .012" of the finished plane on the bottom side. Then, only the right hand broad-nosing tools were employed to give the best average finished machined plane. Prior to the final finishing cut, the setup of the unit was again checked. From time to time, over-all tube lengths were measured using a vernier caliper. Over-all tube lengths were in the range of 19.219" to 19.225" when the machining of the tube faces on the bottom side had been completed.

To take the profile of the bottom side, a Brown and Sharpe precision straight edge was positioned on the "X" and "Y" axis after the tube faces in the area being measured had been deburred. The profile and tube lengths indicated that the finish facing was satisfactory. Deburring of all tube faces followed the procurement of the above "Profile" and "Tube Length" dimensions.

All tube faces were deburred using two mechanical deburring tools. Four men were required for operating the tools. The first one was a flute-type circular, solid steel, conical deburring tool. It was attached to a tool holder for turning the deburring head. The conical fluted surface of the deburring tool was allowed to rest on the inner tube surface before revolving to remove the stainless steel burrs.

To deburr the outer edge of the tube, another deburring tool was required. This deburring tool was not as heavy and cumbersome as the other deburring tool, but it was also difficult to operate. It consisted of a round disc conforming to the tube bore and had an O.D. slightly less than the I.D. of the large tubes. One regular cutting tool was mounted at about a 45° angle to the disc assembly. The tool was designed to have the maximum rake effect. Likewise, this disc-tool assembly was attached to a tool holder and a pneumatic motor. The deburring of the outer edge of the tube was somewhat faster than the deburring of the interior surface.

The vertical hood plate was machined after all tubes had been deburred. A cutting tool was placed in the Betts mill tool holder and the cutting edge of the tool was allowed to rest on the vertical plate of the hood assembly. The drawing specifications called for the edge of the hood plate to be machined parallel to the bottom faces of the large tubes to a dimension of 1.563 ± .015", below the tube ends. The machining of the vertical hood plate was stopped when the dimension was in the range of 1.553 to 1.562". This dimension was accurately measured with a straight edge seated on the tube faces and with the aid of an inside micrometer graduated in .001".

The facing operation on the bottom side was considered satisfactory. Consequently, the knees, drivers, and other angle fixtures were removed from the unit and Betts table. The plenum chamber was lifted by a crane with four slings attached to four nozzles and placed in its cradle prior to turning. The Betts mill table was thoroughly cleaned of all debris, chips, and foreign material.

The unit was turned and placed on the table for final setup and final facing of the top side. An analysis of the profile measurements along with the tube lengths and their pattern indicated that the original setup for the top side of the unit was applicable to the final setup prior to machining the top side. Thus, the unit was set up by measuring the distance from the bottom of the rail to the faced portion of the orientation discs.

The plenum chamber was shimmed up and bolted down as before. Since only 0.100" had to be machined from the top side of the unit, no additional rough machining was required. The "Circle C" broad-nosing tools were set up in both heads as before. Final specifications for this facing operation called for the top ends of all 5¼" O.D. tubes to be machined to a datum plane to a length of 1.750" ± .015" from the highest point on the top plate. Final tube lengths for all 5¼" O.D. tubes had to be 19.125" ± .015".

The top side of the unit was broad-nosed until all tube lengths were in the 19.124 to 19.129" range. The vertical distance from the high point on the plate to the final machined tube facing surface was 1.745".

Before the unit was completely deburred, the orientation discs were checked for elevation. The measurements indicated that the original setup had been retained to within a few thousandths of an inch. Profile measurements were also taken with the Brown and Sharpe precision straight edge. It was positioned on the "Y" axis, then on the "X" axis. Feeler or thickness gages were employed to measure the distances from the tube faces to the bottom face of the straight edge. Inside micrometers graduated in .001" were employed for measuring the vertical distances from the bottom face of the straight edge to the faces of the following:

a. Machined setup faces of the four orientation discs located at the extremities of the "X" and "Y" axis when the top side was up. The vertical distance from the spot on the low point of the top plate to the datum plane established by the machined tube faces was less than 2.000". This dimension along with all other dimensions was considered satisfactory.

   Consequently, it was postulated that the latch studs and probe pin sockets could be set to the correct height on the top side of the top plate of the plenum chamber. Drawing specifications stated that the rod tubes should not be finished to a plane lying below the adjacent plenum plate.

   The actual drawing dimension was 1.800" ± 0.062" from the datum plane established by the machined faces of the large tubes to the machined faces of the rod tubes. The vertical distances from the datum plane established by the machined large tube faces to the high and low point of the plate allowed for the proper machining of all rod tube faces and the installation of all parts, etc., relative to the plenum chamber.

   The plenum chamber was completely deburred and placed in its handling gear or cradle. It was moved by a "low-boy" type of truck to the pier and placed on a U.S. Navy barge. A Navy tug delivered the barge and plenum chamber to New York Ship for additional fabrication work pertaining to the "C" unit plenum chamber.

C. "L" Unit

(1) Establishment of Datum Plane for Machining Tube Ends

The "P" Unit plenum chamber top plate was found to be dished about 1/4 of an inch. As a result, when the tops of the tubes were faced off to reference measurements at New York Ship (low area), the tubes on the outside of the pattern were faced off to a distance of approximately 1-3/4" from the plate instead of 2" as specified on the drawing. For purpose of uniform machining of all subsequent units (L and C), the following procedure, based on "P" unit facing operation, was established:

a. The datum plane for machining tube faces is given on page 2 of Exhibit 3D.

b. The top ends of all 5¼" O.D. tubes are to be machined parallel to this datum plane to a length of 1.750" ± .015" from the highest point on the top plate. See drawings W-132841 and W-132842.

c. The bottom ends of all 5¼" O.D. tubes are to be finished in a plane parallel to the top ends and to a length of 19.125" ± .015" as specified on the drawing W-132843.

d. The bottom edge of the plenum chamber hood is to be machined parallel to the bottom faces of the large tubes to a dimension of 1.563" ± .015" below the tube ends when the plenum is in an upside down position.

(2) Preparation of the "L" Plenum Chamber Before Shipping to the Philadelphia Navy Yard

After the hood-nozzle assembly had been welded to the plenum chamber assembly, it was placed on cast iron pedestals with the top side of the unit up.

Next, an 18' straight edge was set on the top side of the plenum chamber tubes and a level was used to level the unit. To make for the best average levelness of the unit, varying thicknesses of shim stock were inserted between the faces of the tubes on the bottom side and the top side of the pedestals. The unit was supported on four pedestals located along the outer periphery of the unit and in the center by a pedestal and jack arrangement. The jack was sitting on top of the

EXHIBIT 3D

ESTABLISHING DATUM PLANE AND BENCH MARKS ON THE TOP SIDE OF THE "L" PLENUM CHAMBER

E. I. DU PONT DE NEMOURS & CO., INC.

Report Number 410 - L

Construction Division

[redacted]

CC: H. W. Gosney, F.P.M.
R. K. Mason - D. A. Hauser
Savannah River Plant (3)
R. K. Mason - W. P. Duncan-SRP
H. L. Bunker - J. G. Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H Barto - NYS (2)
J. B. Johnson - File

March 16, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM A.J. Piatek - F. J. Jarczynski DATE March 14, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Plenum Chamber EQ.PC.NO. 155-L

DRAWING NOS. W-132842 R2 JOB RATING

VENDOR New York Shipbuilding Corporation LOCATION Camden, N. J.

Scope: To establish datum plane and bench marks on unit after both best drainage conditions of top sheet and best level conditions of top sheet for facing of rod tubes top side were taken into consideration.

Procedure: By means of a Wild Level and target, the top plate was first placed in as level plane as possible. With the plate level, the verticalities of tubes in the spider web pattern were taken to determine if the best possible verticalities were available. The unit had to be raised at different points to get best verticalities.

For results see attached sheets.

[redacted]

lmw
Attach 3

Bench Mark Readings taken with Wild Level
Target setting on top of marked tubes.





2



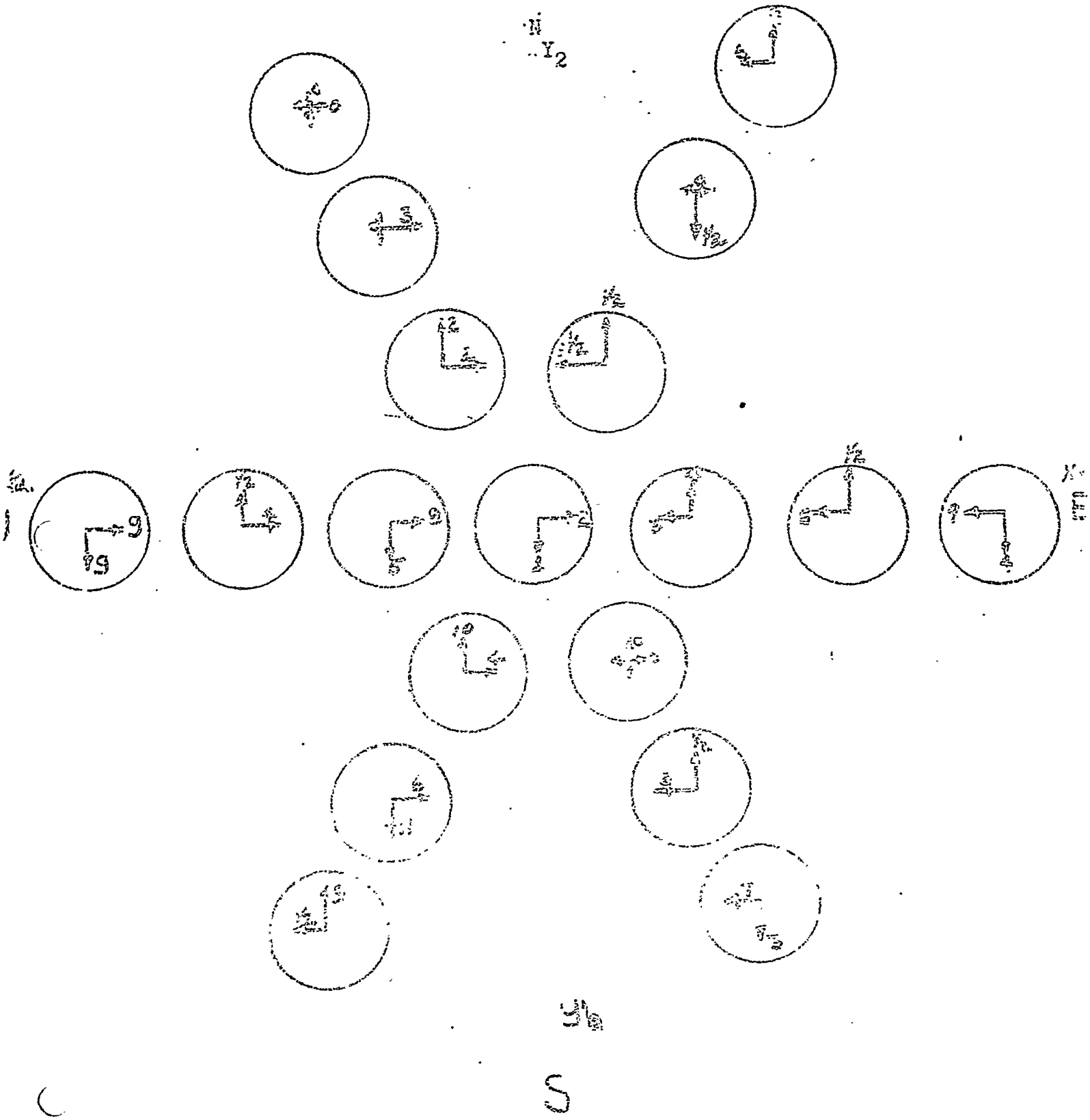


X1

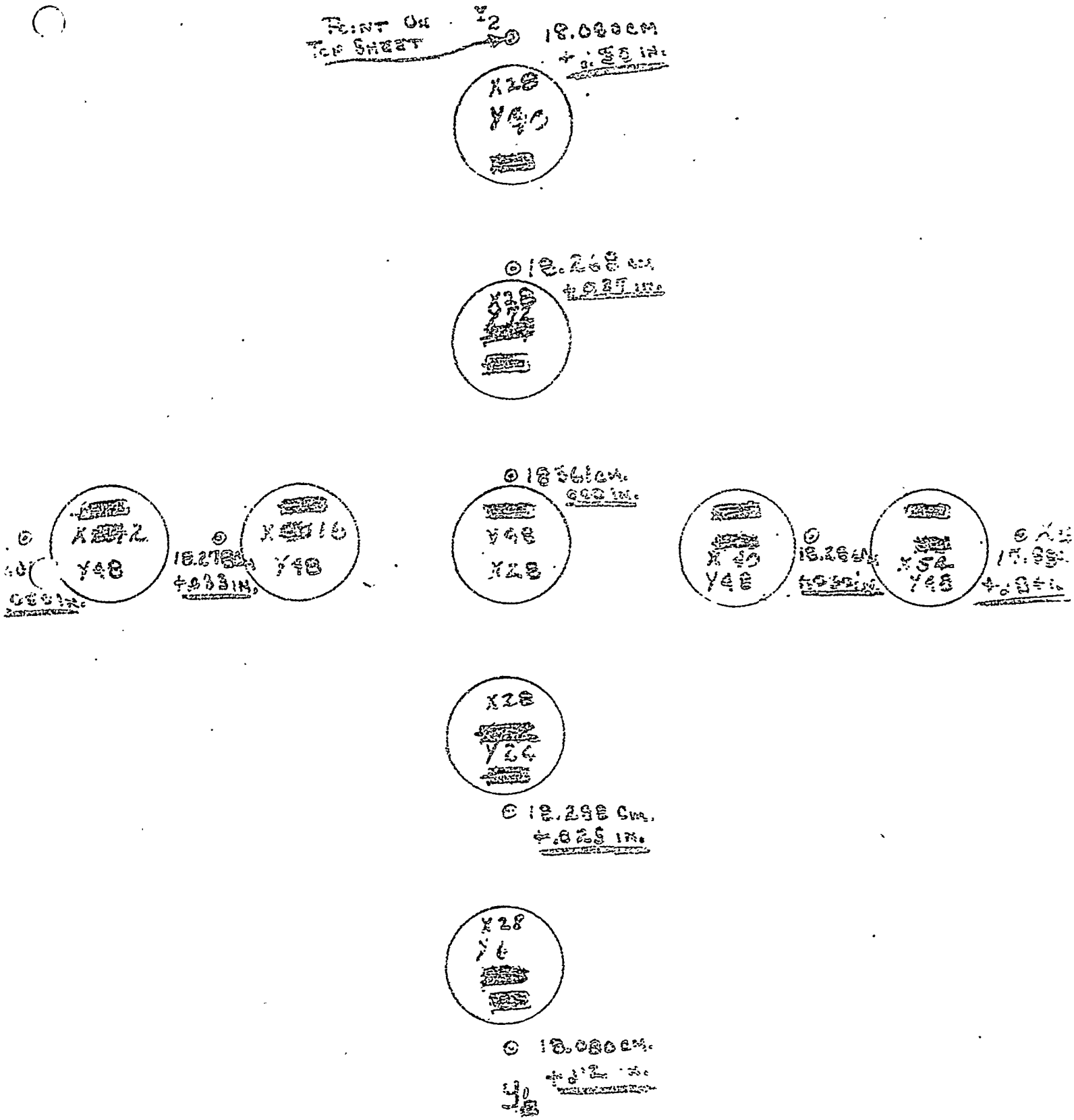


Y1

Best possible verticality of large tubes in spider web pattern.



Levelness of top tube sheet when best possible verticality was obtained



pedestal with the top face of the jack seated on a steel plate. In turn, the steel plate was seated on tube faces in the center of the unit on the bottom side.

The welding of the large tubes and the welding of the hood subassembly to the plenum tube assembly caused considerable distortion in the top and bottom 1" plates. In effect, this distortion of the plates caused the tube face heights to vary by as much as 1/4".

Using the wild level (See Part III, Section II, paragraph J-2 for the written procedure covering the operation of the instrument) the top plate when the top side was up was placed in its best average plane.

To find the best average plate levelness, the wild level target was seated on the top surface of the top plate conforming with locations established by the pattern shown on Exhibit 3D. Repetitive sets of readings were taken and shim stock was either added or removed from between the bottom faces of the large tubes and the top surfaces of the cast iron pedestals to achieve the best average plate levelness.

In spite of the fact that plate levelness was considered to be of prime importance and the assumption was made that the established distance between the top and bottom 1" plates had not changed to any appreciable degree during the fabrication and welding of the plenum chamber, it was realized that verticality of the tubes was also important.

Experience previously gained during the line boring of "P" indicated that with the top and bottom plates in the best average level condition, many large tubes had poor verticality.

Therefore, verticalities of the large tubes conforming to the spider web pattern had to be taken using a verticality gage. The first set of readings indicated that several tubes had very poor verticality. Conventional methods could not be applied to these tubes for line boring at a later date. Then, it was decided that optimum verticality of the tubes and best average relative levelness of the plates would have to be found before both ends of the tubes were machined to two planes parallel to each other. Repetitive sets of readings were taken to find the optimum

set of verticality readings required to set up the plenum chamber in the Philadelphia Navy Yard machine shop for machining the top and bottom faces of the unit. (See Exhibit 3D)

After optimum tube verticality had been established, it was observed that the top plate was in a dished condition. Consequently, with the aid of the wild level and target, the high and low points on the top plate were established and readings recorded. The low spot of the plate was adjacent to tube X28-Y48 near the center of the unit. It had an elevation denoted at .000". The high point on the plate was adjacent to the large tube having the coordinate X28-Y90. It had an elevation of ∱ 0.130" in relation to the low point of the plate and was located on the outer periphery of the top plate.

Also, the levelness of the tube faces on the top side of the unit was checked for the minimum and maximum amount of variation. The lowest tube face was established as being the tube with the coordinate X28-Y48 and an elevation of .000". The highest tube face had the coordinate X28-Y90 and an elevation of ∱ 0.123" in relation to the lowest tube elevation.

To prepare the unit for shipment to the Philadelphia Navy Yard, the weir slots (three in each large tube) in all tubes were blanked off by placing a wood strip in each weir. Two metal clips attached to each wooden strip nullified the possibility of the wooden strips entering the interior of the plenum chamber. The plenum chamber was placed in its lifting gear or cradle and shipped to the Philadelphia Navy Yard, via Navy tug and barge.

(3) Machining of the Plenum Chamber Tube Faces at the Philadelphia Navy Yard

After the plenum chamber was received at the Philadelphia Navy Yard, it was located near the Betts boring mill and prepared for the facing operation.

First of all, the Betts mill, Serial #E-4920, designed and built by the Betts-Newton-Colburn-Modern-Hilles and Jones Division of the Consolidated Machine Tool Corporation, Rochester, New York, was adjusted for the facing operation. The entire length of the rail from which the tool heads are

suspended was checked for levelness using a precision machinist's level. It was finally leveled to within a .004" maximum variation. It was then set at the proper height for carrying through the entire facing operation.

Prior to checking the mill table, all grit, dirt, oil, grease, chips, etc. was removed from the mill table. Next, the mill was started up and the mill table allowed to revolve at approximately one R.P.M. speed for a thirty minute period. This allowed the oil to properly build up in the mill's bearing race and permitted the table to be properly cushioned on a film of oil. After it was determined that the mill table had been properly balanced and that it actually simulated the operating conditions required for the pending facing operation, the table was checked for levelness using a precision machinist's level. As a matter of fact, the table was checked for levelness over a wide range of locations. For all practical purposes, it was concluded that the top bearing surfaces of the mill rail were considered to be parallel to the face of the circular mill table to within seven thousandths of an inch.

The rail was locked in place at each extremity using a large hand wrench designed for this specific job. Both ram type heads were set absolutely vertical to the upper face of the rail and locked in this position using a special wrench designed for this job.

The mill table had an outside diameter of 24'-1". This table has a rated capacity of 100 tons. At regular intervals of one foot along the radii of the table, circles had been scribed. These circles were used in setting up the plenum chamber on the table. In addition, the table was designed with recesses running in a radial direction (25" apart on outer periphery) and so spaced that "T" type fixtures could slide in the recesses and be properly clamped to the exterior of the plenum chamber.

Next, the plenum chamber, with the top side up, was carefully seated on the mill table. Its location was altered until selected points on the outer periphery of the unit were equally distant from the nearest scribed circle.

A mathematical analysis of the elevations required for simulating the previous setup of the plenum chamber at New York Ship indicated that

considerable shimming would be necessary prior to any machining. (See Exhibit #3D) First of all, one spot was selected and marked on the bottom side of the Betts mill rail. This spot was located in a vertical plane common to a spot on the top surface of any one of the four large tubes located at the extremities of the "X" and "Y" axes..

An inside micrometer was used to measure the vertical distance between the two spots. Measurements were repeated and shim stock was added or removed from between the bottom tube faces and the table surface until the elevations furnished for the setup were duplicated. To simplify the setup, shim stock was restricted to those tubes located on the extremities of each axis. Sufficient shim stock was used to completely free all tubes located on the outer periphery with the exception of those tubes supported on shim stock. A jack was used to raise and lower the unit when shim stock was being added or removed from beneath the unit.

The difference in elevation of the high and low point on the top plate was found by measuring the vertical distances from the bottom of the rail to the two points using an inside micrometer. Shim stock was removed and added until the difference of /0.123" was established for the high and low points of the plate. As an added check on the setup of the plenum relative elevations of the tube faces were checked using an inside micrometer and measuring from the bottom of the rail to the faces of the tubes. These readings conformed to those readings furnished for duplicating the setup at New York Ship.

To maintain this setup, additional shim stock was placed between the tube faces and the mill table surface. Shim stock was added in the center and on the outside of the unit. The plenum chamber was clamped securely to the table and all elevations were rechecked.

To have a permanent reference for this setup, reference points were established and recorded on the top plate at the extremities of the "X" and "Y" axes. Ultimately, two planes would have to be machined parallel to each other and parallel to the plane established by the above reference points on the top plate.

Two "Red Sabre" roughing tools were placed in the right tool holder (facing the Betts mill) and tightened with an Allen wrench. The lead tool was set up to take an average initial cut of 1/16" while the other tool was set to take an additional 1/16". Both tools were ground to have a good lip that gradually tapered to a point.

The "Red Sabre" roughing tools were placed in the left tool holder (facing the Betts mill) and tightened with an Allen wrench. The lead tool was set up to take an average cut of 1/16" while the other tool was set to take an additional 1/16". Both tools were ground to have a uniform concave type lip that gradually tapered to a point.

Before taking an initial cut, all large tube weirs were inspected for the condition of the chip stoppers. Where necessary, the chip stoppers were replaced or tightened up.

To start taking the initial cut, the mill table was first revolved for approximately twenty minutes before the right head was run partially in on the traverse. The heavy "C" clamp was placed over the head and tightened with the aid of a monkey wrench. This prevented the possibility of the tools slipping in the head during the cutting operation. A "C" clamp was also attached to the other head.

The rough cut was started with a table speed of one minute and ten seconds per revolution. Tool feed was set at .071" per revolution of the table. The right head was allowed to take its cut until it had traversed for about one-third of the distance from the outer edge of the unit to the center of the unit. At this point, the left hand head was started using the same rate of feed and R.P.M. of the mill table.

After the second head had traversed to the center of the unit at an increased table speed of approximately two R.P.M., the mill was stopped. The reference points on the top plate were checked for relative elevation in respect to the original setup of the plenum chamber. They were found to be in agreement with the setup readings.

Next, tube faces located on the "X" and "Y" axes and the axis for each nozzle were deburred. Profile measurements were taken using a precision straight edge and feeler gages. With the straight edge resting on the tube faces, measurements were obtained to the nearest thousandths of an inch by inserting the feeler gage in the gap between the tube face and the bottom face of the straight edge.

Concurrent with the taking of the profile, the distance was measured from the high point of the plate to the plane established by the machined tube faces adjacent to the high point. The reading was procured by placing the straight edge on the tube faces and measuring from the bottom face of the straight edge to the high point using an inside micrometer. This reading was 1.875". Since specifications called for a final reading of 1.750" ± .015" for the distance from the high point of the plate to the tube faces, the decision was reached that the top side could be faced with the required finish on each tube face and all slots would be removed from the top face of the large tubes.

Permission was granted to finish deburring the top side of the plenum. In the meantime, tube lengths were taken using a standard vernier caliper. These tube lengths would be required to set up the plenum chamber for facing the bottom side. The plenum chamber was inspected for feather type burrs, etc. before it was removed from the mill table.

The plenum chamber was removed from the mill table and lowered in its cradle. All handling gear was tightene and the entire handling gear assembly was turned leaving the bottom side up.

The handling gear was removed and with the aid of the proper slings and overhead crane, the plenum chamber was lifted and moved and set on wood blocks in front of the Betts mill.

Next, the plenum chamber was lifted by overhead crane and allowed to rest on the mill table. It was again positioned in relation to the scribed lines on the mill table. Measurements were taken for the distance from the rail to the face of the tubes previously measure for over-all length. With the aid of shim stock, the plenum chamber was set up to the dimensions defined via tube lengths and the profile taken when the top side of t unit was up. Since the basis for this setup would be lost after the first cut on the bottom side had been taken, elevations (distance from top of 1" plate to the bottom of the Betts mill rail) were taken at the end of each axis and in the center of the unit. An inside micrometer was employed for taking these measurements. Measurement locations on the 1" plate were marked with layout fluid.

The unit was bolted down and a dimensional recheck was made to insure the proper setup before the initial roughing cut was taken. As previously stated, "Red Sabre roughing tools were chosen for both heads. The tools were set up to take 1/16" cut for each tool. In other words, the right head was set up for a roughing cut of 1/8" and the left hand (facing the front of the mill) head was set up for a roughing cut of 1/8".

The rough cut on the bottom side was taken in a manner similar to that used for the top side. Periodic checks were made to be positive that the setup had been retained. After the rough machine cut had been completed, those tubes lying on the "X" and "Y" axes were deburred. A straight edge was set on the "X" and "Y" axes, and it was ascertained that the roughing cut was satisfactory. Over-all tube lengths at various locations in the unit were also obtained using a vernier calipers. The profile and the tube lengths indicated that the two machined surfaces had been defined within several thousandths of an inch. Permission was granted to go ahead with the finishing or broad-nosing cuts.

To set up the right hand head for broad-nosing, the ram remained in a vertical position. The two roughing tools were removed and visually examined for any unusual wear that could have happened during the rough machine cut. Next, two "Circle C" tools (approximately 1" wide and designed for cuts of .003" to .005") were placed in the tool holder.

The lead tool was tightened and the ram lowered so the cutting tool edge rested on a machinist's precision "box type" steel gage block. The gage block was seated on the surface of the mill table. Feeler gages were employed to set up the second broad-nosing tool after the cutting edge of the first tool had been set parallel to the face of the gage block. As an additional check on the cutting tools, a dial indicator graduated in .001" was attached to a surface gage and run across the cutting edges of both tools. The readings were consistent. The mill table was revolved for a twenty-minute period preparatory to taking the first cut.

Next, the mill table was stopped and the right hand head was moved into cutting position. The dial indicator (graduated in .001") attached to the Betts mill tool ram was adjusted to a reading of zero when the lead tool had been set on an average tube face of the unit. Through lowering the ram or head to have a dial indicator reading of .003", the lead tool and other tool were ready for the initial broad-nosing cut. The broad-nosing or finishing operation was repeated using both heads to within approximately .012" of the finished plane on the bottom side. Then, only the right hand broad-nosing tools were employed to give the best average finished machined plane. Prior to the final finishing cut, the setup of the unit was again checked. From time to time, over-all tube lengths were measured using a vernier calipers. The over-all

tube length was 19.355" for tube number X54-Y48 when the machining of the tube faces on the bottom side had been completed.

To take the profile of the bottom side, a Brown and Sharpe precision straight edge was positioned on the "X" and "Y" axes after the tube faces in the area being measured had been deburred. The profile and tube lengths indicated that the finish facing was satisfactory. Deburring of all tube faces followed the procurement of the above "Profile" and "Tube Length" dimensions.

All tube faces were deburred using two mechanical deburring tools. Four men were required for operating the tools. The first one was a flute-type circular, solid steel, conical deburring tool. It was attached to a tool holder. A pneumatic motor was attached to the tool holder for turning the deburring head. The conical fluted surface of the deburring tool was allowed to rest on the inner tube surface before revolving to remove the stainless steel burrs.

To deburr the outer edge of the tube, another deburring tool was required. This deburring tool was not as heavy and cumbersome as the other deburring tool, but it was also difficult to operate. It consisted of a round disc conforming to the tube bore and had an O.D. slightly less than the I.D. of the large tubes. One regular cutting tool was mounted at about a 45° angle to the disc assembly. The tool was designed to have the maximum rake effect. Likewise, this disc-tool assembly was attached to a tool holder and a pneumatic motor. The deburring of the outer edge of the tube was somewhat faster than the deburring of the interior surface.

The vertical hood plate was machined after all tubes had been deburred. A cutting tool was placed in the Betts mill tool holder and the cutting edge of the tool was allowed to rest on the vertical plate of the hood assembly. The drawing specifications called for the edge of the hood plate to be machined parallel to the bottom faces of the large tubes to a dimension of 1.563 $\pm$ .015", below the tube ends. The machining of the vertical hood plate was stopped when the dimension was in the range of 1.560 to 1.565". This dimension was accurately measured with a straight edge seated on the tube faces and with the aid of an inside micrometer graduated in .001".

The facing operation on the bottom side was considered satisfactory. Consequently, the knees, drivers, and other angle fixtures were removed from the unit and Betts table. The plenum chamber was lifted by a crane with four slings attached to four nozzles and

placed in its cradle prior to turning. The Betts mill table was thoroughly cleaned of all debris, chips, and foreign material.

The unit was turned and placed on the table for final setup and final facing of the top side. An analysis of the profile measurements along with the tube lengths and their pattern indicated that the original setup for the top side of the unit was applicable to the final setup prior to machining the top side. Thus, the unit was set up by measuring the distance from the bottom of the rail to the reference points on the top plate located at the extremities of the "X" and "Y" axes.

The plenum chamber was shimmed up and bolted down as before. Since only 0.230" had to be machined from the top side of the unit, no additional rough machining was required. The "Circle C" broad-nosing tools were set up in both heads as before. Final specifications for this facing operation called for the top ends of all 5¼" O.D. tubes to be machined to a datum plane to a length of 1.750" ± .015" from the highest point on the top plate. Final tube lengths for all 5¼" O.D. tubes had to be 19.125" ± .015".

The top side of the unit was broad-nosed until all tube lengths were in the 19.121" to 19.124" range. The vertical distance from the high point on the plate to the final machined tube facing surface was 1.734".

Profile measurements were also taken with the Brown and Sharpe precision straight edge. It was positioned on the "Y" axis, then on the "X" axis. Feeler or thickness gages were employed to measure the distances from the tube faces to the bottom face of the straight edge. Inside micrometers graduated in .001" were employed for measuring the vertical distances from the bottom face of the straight edge to the faces of the following:

a. Top plate faces established as reference points located at the extremities of the "X" and "Y" axes when the top side was up.

The vertical distance from the spot on the low point of the top plate to the datum plane established by the machined tube faces was less than 2.000". This dimension along with all other dimensions was considered satisfactory.

Consequently, it was postulated that the latch studs and probe pin sockets could be set to the correct height on the top side of the top plate of the plenum chamber. Drawing specifications stated that the rod

tubes should not be finished to a plane lying below the adjacent plenum plate.

The actual drawing dimension was 1.800" ± 0.062" from the datum plane established by the machined faces of the large tubes to the machined faces of the rod tubes. The vertical distances from the datum plane established by the machined large tube faces to the high and low point of the plate allowed for the proper machining of all rod tube faces and the installation of all parts, etc. relative to the plenum chamber.

The plenum chamber was completely deburred and placed in its handling gear or cradle. It was moved by a "low-boy" type of truck to the pier and placed on a U.S. Navy barge. A Navy tug delivered the barge and plenum chamber to New York Ship for additional fabrication work pertaining to the "C" unit plenum chamber.

14. Inspections Performed on "R", "P", and "L" Plenum Chambers After Receiving from Navy Yard and Prior to Line Boring

A. "R" Unit

(1) Nozzle Flange Inspections

Flanges were welded to the six nozzles according to a set procedure by New York Ship. After this the circumferential welds between the flanges and nozzles were x-rayed and necessary repairs made. Du Pont inspectors visually inspected all flange welding prior to x-ray and again after repairs were made. (See photo serial #49).

Final over-all flange measurements were taken and results are shown in sketch #29. These dimensions were taken by measuring with a 50' stainless steel tape between straight edges held flush against opposite flange faces. Radial distances to each of the six flange faces were taken by measuring from the center of tube X28-Y48 to the inside face of a straight edge held flush against the flange face. The center point of tube X28-Y48 was located by plugging the I.D. with a stainless steel spider disc and working in with hermaphrodite calipers, thus locating the center point of the tube I.D. on the disc.

(2) Facing of Plenum Skirt

Inspection of the facing operation at the Navy Yard on the plenum skirt disclosed three relatively small areas of the skirt section did not "clean-up".

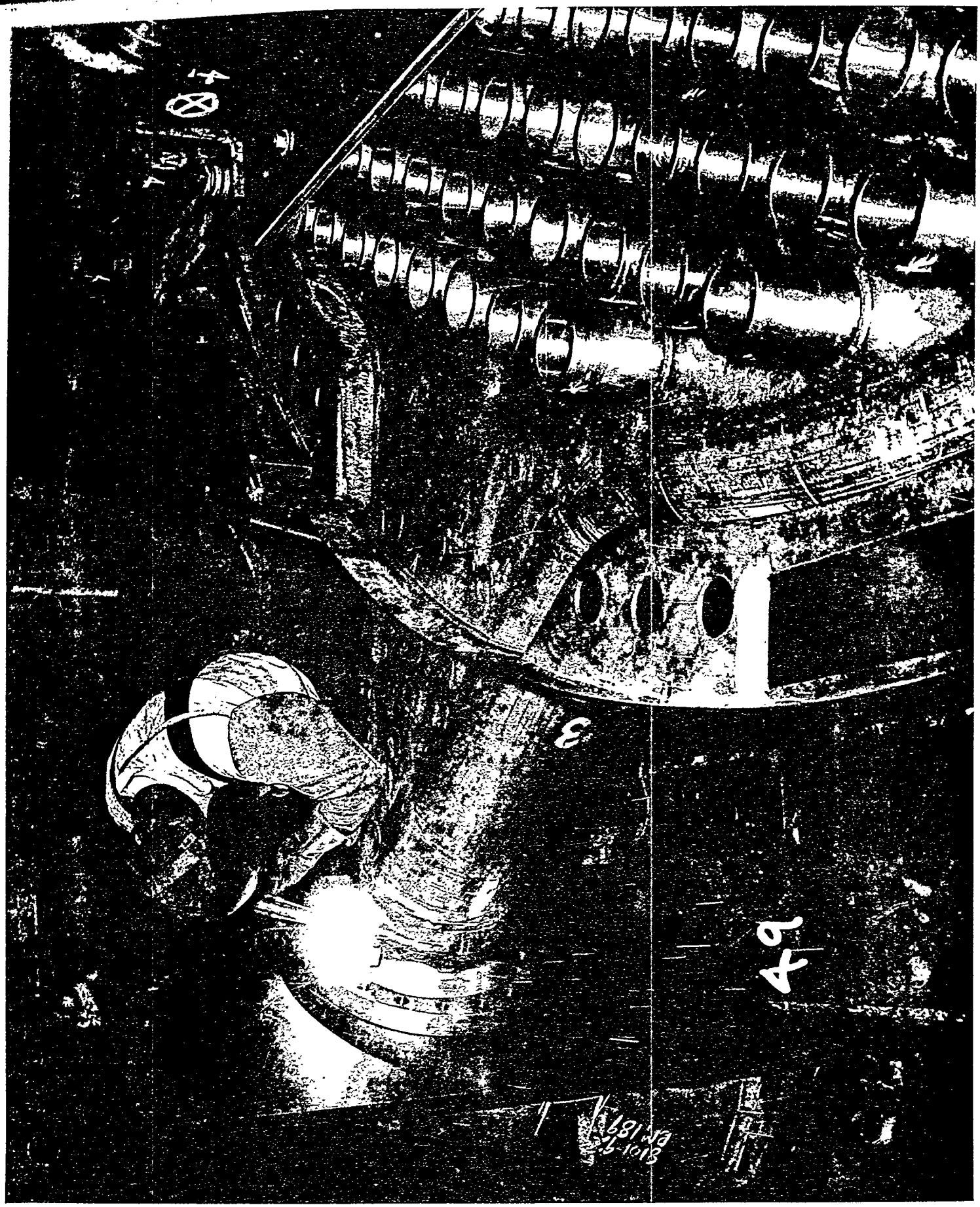
Serial Number 49

New York Shipbuilding Corporation
Camden, New Jersey
March 31, 1952

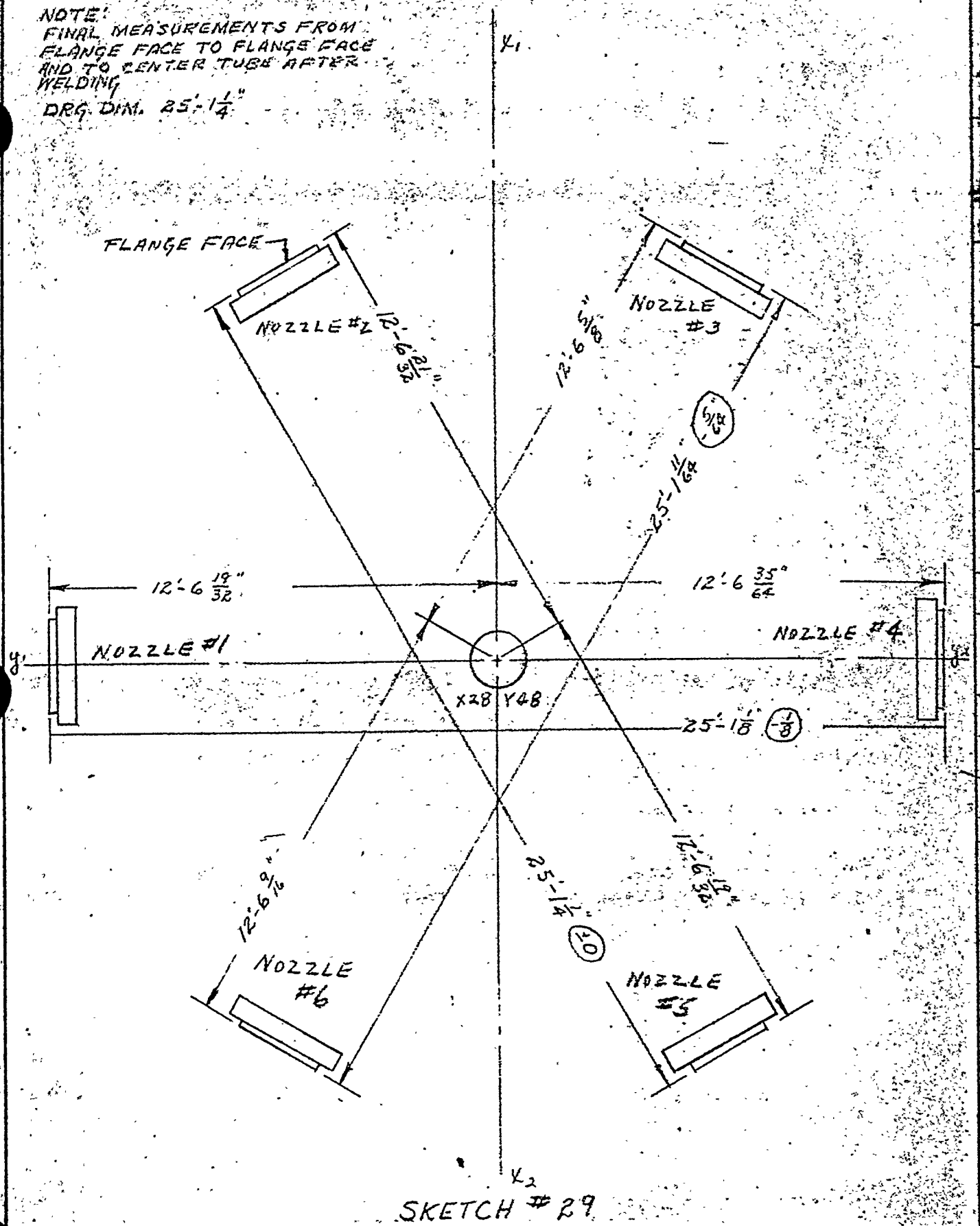
PROJECT 8980 - SAVANNAH RIVER PLANT

OPERATION 16-A - Plenum Chamber "R" Unit: Welding Flanges to Nozzles. The welder is welding a flange to the nozzle section with an aircomatic welding machine. The knee brace in front of the nozzle is used to position the flange for tack welding and to hold flange in place during final welding operation.

All butt welds are X-rayed throughout their entire length and interpreted in accordance with the non-destructive test as specified in Par. U-68 (h) (2) to (10) incl. of the A.S.M.E. Code for Unfired Pressure Vessels 1949 edition. M & E inspectors visually inspect all butt welds and examine all radiographs.



NOTE:
FINAL MEASUREMENTS FROM
FLANGE FACE TO FLANGE FACE
AND TO CENTER TUBE AFTER
WELDING
DRG. DIM. 25'-1 1/4"



SKETCH # 29

ENGINEERING SKETCH SHEET E. I. DU PONT DE NEMOURS & CO.	PROJ. No. 8980	SIGNATURE:
PROJ. TITLE R' PLENUM CHAMBER		DATE 4-4-52
SUBJECT:		No. E-42315

These unfinished sections were confined to one to two inches in length and about 1/16" deep.

Design was notified of the above discrepancy and they replied that it would be satisfactory to repair the skirt by building up with weld metal of proper specification and hand finish the surface to a true plane to assure a gas seal with the gasket in the top tube sheet enclosure. This procedure was followed by New York Ship, and after repairing the skirt, the du Pont Inspection Department visually inspected the job and found it satisfactory.

(3) Indexing Devices

a. Dimensional Inspections

Three centering tongues and grooves (indexing devices) were dimensionally checked using a six inch scale graduated in sixty-fourths of an inch and found within tolerances. Centering tongues were then welded to the bottom side of the plenum chamber 120° apart and welding visually examined and found satisfactory.

Later, three additional indexing devices were added. This is covered in Section 12C (2) of this manual.

b. Alignment of Indexing Devices

Inspection was performed the same as outlined in Part II-A, Section 14-b.

(4) Deburring Tube Ends

After receiving the plenum chamber from the Navy Yard, shipping fixtures were dismantled and the unit was placed on a platen for deburring tube ends on top and bottom sides of the unit. Burrs were removed by hand filing. After all tube ends were dressed on both sides, tube ends were visually inspected for rough edges and found satisfactory.

(5) Establishing Centerlines

Layout and establishing of centerlines was the same as discussed in Part II-A, Section 13-a.

(6) Preliminary Hydrostatic Test

Before further fabrication continued, it was decided by the Inspection Group and New York Ship to perform a preliminary hydrostatic test on the plenum chamber. This was done to determine the soundness of welding around 5¼" O.D. tubes, rod tubes, bulges and nozzles. The unit was filled with

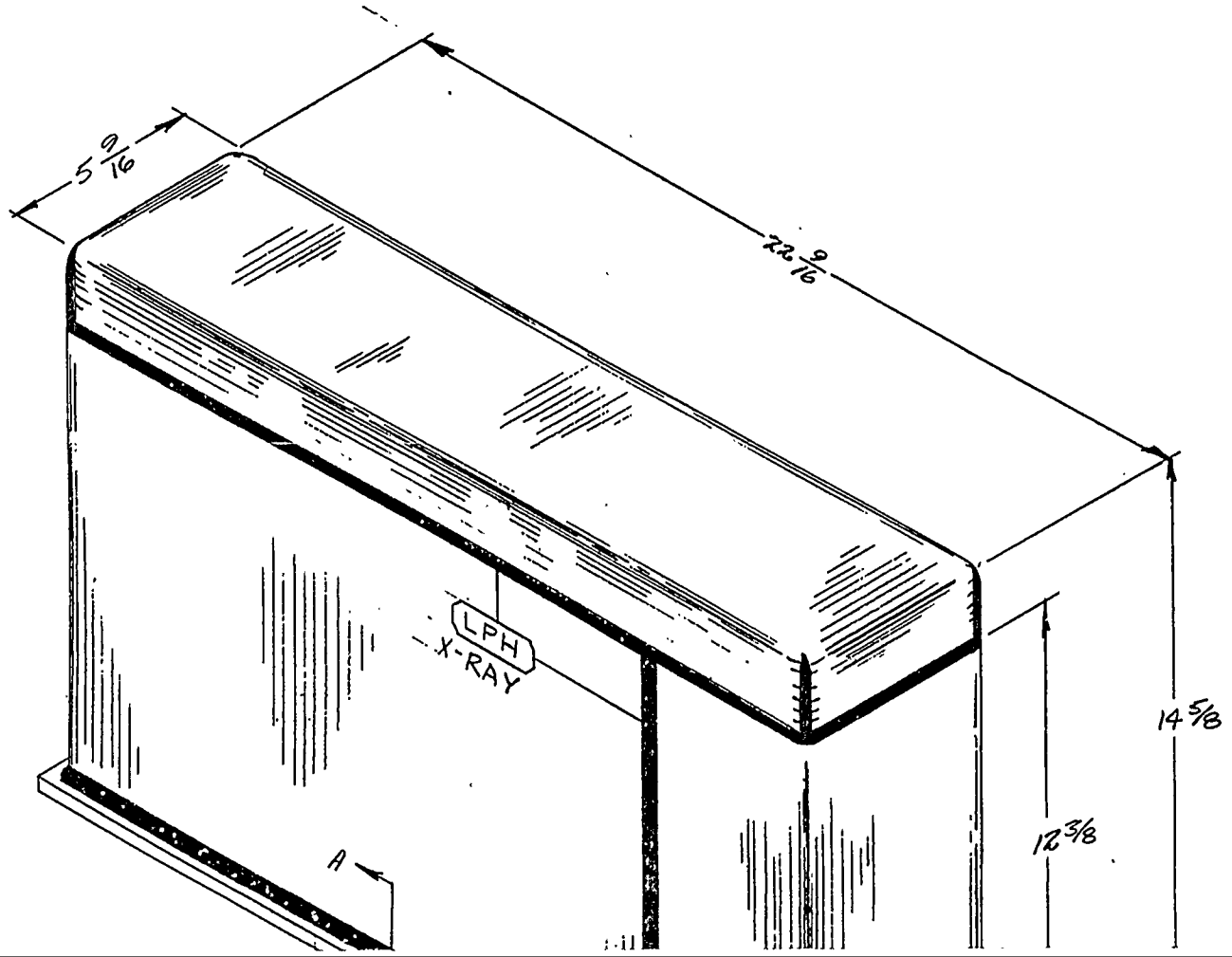
city water and then brought up to 375 #/sq. in. with a hand pump. Preliminary inspection revealed that leakage occurred around rod tube X43 Y25 on the bottom side and around large tubes X26 Y90, X12 Y36 and X50 Y54 on the top side. These tube welds were repaired and the unit was again hydrostatically tested at 375 #/sq. in.; however, the equipment used to seal off tube ends was leaking. In addition to this, the unit was placed approximately two feet off the floor such that inspectors were cramped during this preliminary visual inspection for tube leakage. Also, grease and oil, grit, and other foreign debris were present around all tube welds both on the top and bottom sides. In view of these prevailing conditions, it was decided jointly by the du Pont Inspection Department and New York Ship to discontinue the test and to proceed with line boring operation.

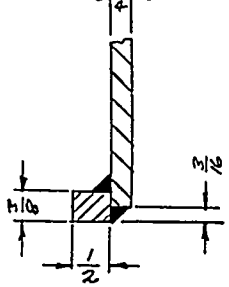
(7) Plenum Chamber Hoods for Top Tube Sheet Lifting Lugs

After fabricating four hoods for the "R" Unit, all welding was ground smooth and visually inspected for mechanical defects prior to x-ray. Minor repairs were made and then the welding on each of the four hoods was x-rayed, radiographs examined, repairs made, and re-x-rayed (See drawing 3-4). The four hoods were then given a 100% dimensional inspection using a six foot steel tape graduated in 1/16". All measurements were within drawing tolerances and accepted.

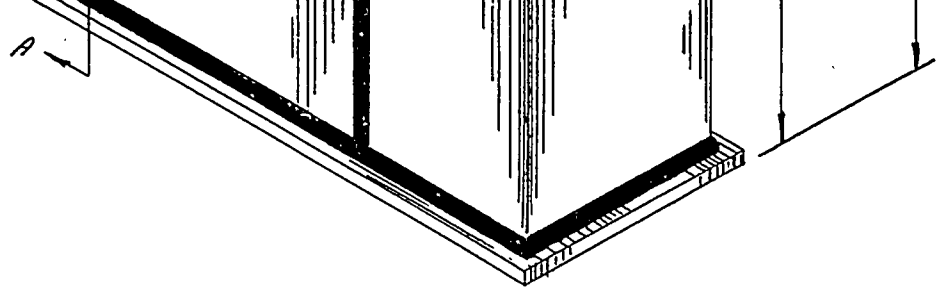
Next, the hoods were prepared for hydrostatic testing. Each was filled with city water and then the pressure was raised to 10 psi using a hand water pump and held for fifteen minutes. Upon visual examination of welding for possible leakage, it was ascertained by inspectors that the hood "bulged" on the sides due to the internal test pressure. Design was notified of this condition. "R" unit hood drawings were revised by adding four stiffeners (1" x 1/4" thick) equally spaced on the outside to provide additional rigidity. (See du Pont drawing D110275). The hoods for this unit were fabricated from 16 gage (.0625" thick) type 304 stainless steel material. This method of repair did not prove satisfactory and the original hoods (four) were scrapped. In the meantime, hoods for "P", "L", "K" and "C" were redesigned and fabricated from 1/4" thick type 304 stainless steel material to provide the additional strength necessary to retain its shape when subjected to an internal test pressure of 10 psi. (The new design of hoods is shown on du Pont drawing D110283). Since repair of the original four hoods for "R" was not satisfactory, "P" unit was substituted for "R" and an additional set was fabricated for "P". The four new type hoods for "R" were

PLENUM CHAMBER HOOD





SECTION A-A



NOTES:
1. ALL WELDS SUBJECT TO VISUAL, HAMMER, & HYDROSTATIC TESTS AT 10 PSI.
2. MATL - UNLESS SHOWN IS 1/4" THICK
3. ALL INSIDE CORNERS HAVE 1/2" R.
4. "D" UNIT HOODS WERE OVERSIZE.

M & E SECTION
GOV'T CONTRACTS

DWG. 3-4

[redacted]

BY: S.R. COCHRAN
MAR-53

given the same inspection outlined above for the original ones. (No hammer test or freon test was performed on these hoods or on those for subsequent units. This was not considered necessary by the du Pont Inspection Department.) With the plenum and top tube sheet assemblies in an operating position, the four hoods were then fit over the lifting lugs on the top tube sheet and lifting lug holes in the plenum skirt. Fit-up was satisfactory and the four hoods were accepted. All were interchangeable.

Next, the hoods were sandblasted. After this they were acid washed and then rinsed with city water. The four hoods were then ferroxyl tested, visually inspected and found satisfactory.

(8) Plenum Chamber Instrument Hood Plates

Inspection was performed identical to that described in Section 14C (11) of this manual.

B. "P" Unit

(1) Nozzle Flange Inspections

Over-all flange measurements and inspections were performed in the same manner discussed above in Section 14A (1), except as follows:

Measurements from the center tube (radially) to each of the six nozzle flange faces were not taken. These measurements were not considered necessary by the du Pont Inspection Department.

Results were as follows: (Refer to Sketch #29 for numbering of nozzles)

Nozzle #1 to Nozzle #4 - 25' - 1"
Nozzle #2 to Nozzle #5 - 25' - 31/32"
Nozzle #3 to Nozzle #6 - 25' - 31/32"

Drawing dimension was 25' - 1-1/4". The above measurements were considered satisfactory and accepted. (Per Design.)

(2) Deburring Tube Ends

Inspection was performed the same as outlined in Section 14A-(4) of this manual.

(3) Indexing Devices

a. Dimensional and Weld Inspections

Before welding to the bottom side of the

plenum chamber, six centering tongues and grooves (indexing devices) were dimensionally checked using a six-inch scale graduated in 1/64" and found within tolerances. Centering tongues were then welded to the bottom side of the plenum chamber 60° apart and welding visually examined and found satisfactory. Also, the location of the centering tongues were checked visually to determine if they were in their correct location with respect to the X & Y axes. A dimensional inspection was not necessary since location of indexing devices by New York Ship's layout man was witnessed by a du Pont inspector and approved.

b. Alignment of Indexing Devices

Inspection was performed in a similar manner to that on the NYX unit, Part II-A, Section 14-b, except on this unit ("P"), six centering devices were involved due to a change in design. See Section 15B-(1) and (2) which covers in detail the alignment and welding of these six indexing devices. The reason for the change from three to six indexing devices is covered in Section 12 of this manual.

(4) Re-inspection of Tube Welds

Prior to preliminary hammer and hydrostatic testing, tube welds (rod tubes and large tubes) on both the top and bottom side were re-inspected for pin holes, roll-overs and other mechanical defects. This inspection was carried out in the same manner discussed in Section 7B-(2)f of this manual. Five tube welds were found with roll-overs and deep pin holes. These defects were chipped out, re-welded, ground smooth, inspected and accepted. No other major defects were found at this time and the tube welding was accepted subject to further inspection at a later date.

(5) Preliminary Hammer and Hydrostatic Test Prior to Line Boring

The plenum was placed on pedestals with the top side up in a horizontal position, and the unit was prepared for preliminary hammer and hydrostatic testing. First, all flanges were closed off using mild steel flange blanks and 1/8" thick Garlock #900 gaskets. Next, the tube ends were sealed off using mild steel tube cap flanges and 1/16" thick Garlock #900 gaskets shown in photo serial #240. Pressure gages (two gages 0-500 psi range) were installed on one of the nozzle flange blanks. The assembly was then filled with de-ionized water pumped from a storage tank in the immediate area. The unit was vented through a 1/4" tapped hole in the top end of each tube cap flange while pumping water into the unit. The unit was also vented through 1/2" pipe plugs in each of the nozzle flange blanks and two instrument tapped holes located in the top plate near the center of the unit.

Serial Number 240

New York Shipbuilding Corporation
Camden, New Jersey

PROJECT 8980 - SAVANNAH RIVER PLANT

Plenum Chamber Tube Plugs and Freon Testing

1. Mild steel tube flanges and tie bolts are used for preliminary hydrostatic test and sandblasting.

2. Wooden "O" ring plugs for shipping and to prevent dirt from entering the tubes after final cleaning.

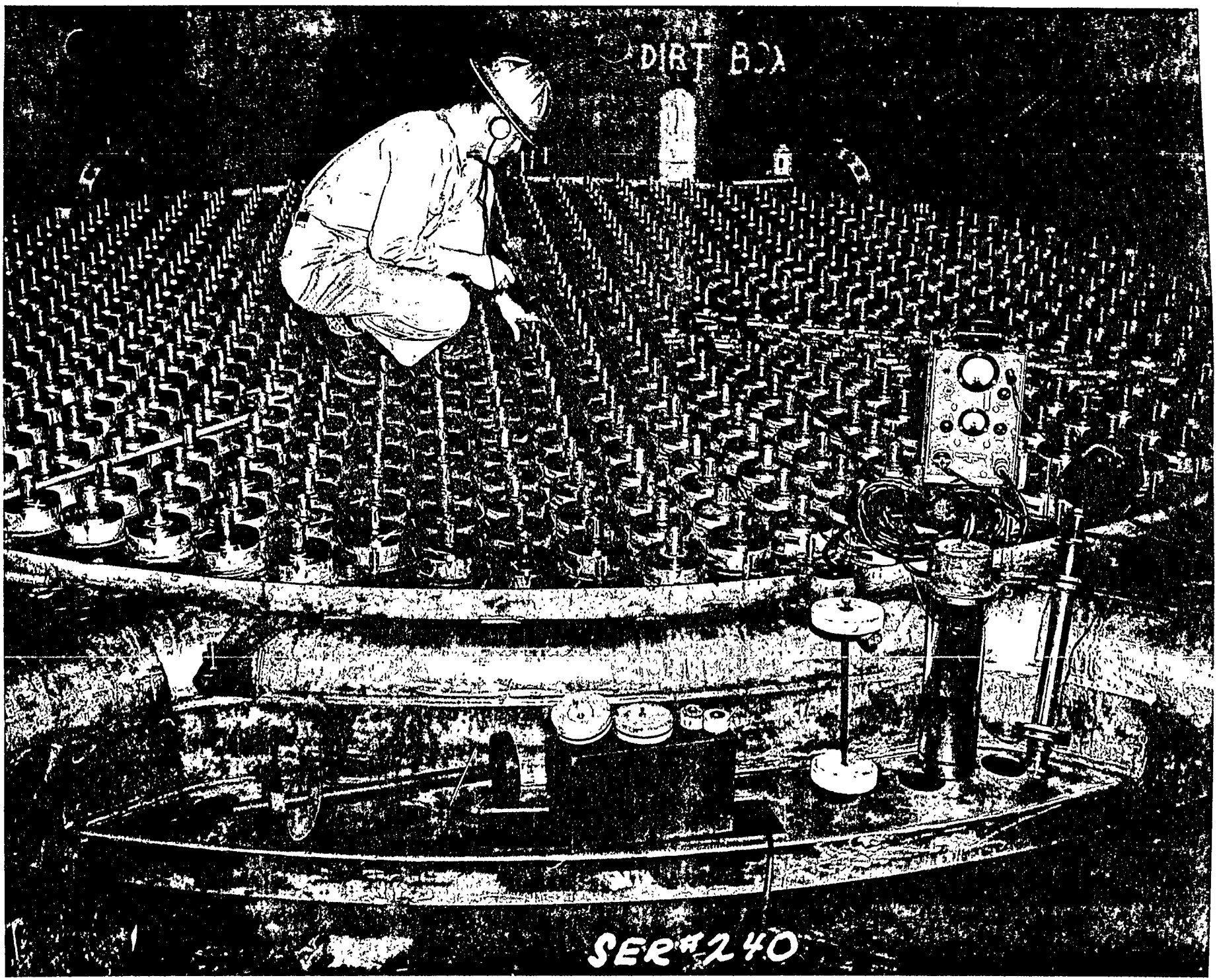
3. Wooden rod tube caps for sandblasting.

4. Temporary wooden caps were intended to be used for sandblasting.

5. "O" ring test plug was used to blank tubes in "X" test assembly and to hydrostatic test "R" Unit.

6. "O" ring cleaning plug was used on "P" unit to circulate solution in the plenum chamber. 15 - 1/16" holes are drilled in the pipe for circulating.

7. The "O" ring plugs (similar to #6) in the "P" unit plenum chamber tubes are being used for final freon testing.


DIRT BOX
SER#240

After the unit was filled with water, the venting holes were sealed off and the internal pressure was raised to 375 psi using a Watson-Stillman hand pump. This pressure was held for one hour and then lowered to 315 psi (1¼ x 250# design pressure) for the hammer test. The top side of the unit was hammer tested using a special drop hammer with a 10# weight dropping a distance of 2 feet. The top side of the unit was hammered in the center of each triangleshaped tube cluster. This was done to test the tube welding. All other welding on nozzles and bulges on the top side was hammered every 6". The vertical butt welds in the bulge and nozzle sections were hammered using a 3# hammer with a sharp swinging blow. (Hammer testing technique was taken from the 1949 Edition of the ASME Boiler Code for Unfired Pressure Vessels, Paragraph U-77). Next, the pressure was released and the internal water level (in unit) was lowered approximately 1" below the top tube plate. Then the top plate of the assembly was hammered again in the same manner described above. The unit was again filled with water, venting as described above until the unit was completely full of water. Finally, the internal pressure was raised to 375 psi (1½ x 250# design pressure) with the hand pump and all tube welds, bulge and nozzle welding on the top side was then visually inspected for leakage. None were found and the top side of the unit was accepted.

The internal pressure was then lowered to a nominal pressure and held in order that venting (when the unit was turned over) would not be necessary. This was imperative since venting from the bottom side was not possible using the present equipment designed for sealing off the unit while hydrostatically testing the plenum chamber in this position. After turning the unit (bottom side up), the same procedure discussed above was followed for testing and inspecting the bottom side. Two leaks were found on this side around the weld on the following large tubes: X50-Y24 and X36-Y48. The pressure was released, and the unit was partially drained in order to repair the faulty welds. The welds were chipped and then re-welded using a hand operated Aircomatic Welding Machine. Re-welding was ground smooth and then visually inspected and accepted. The above procedure outlined in paragraph one was duplicated. No other leaks were found and the unit was accepted as being water tight.

(6) Skirt Welding Inspection

At this time the du Pont Inspection Department introduced dy-chedking on welds that could not be hydrostatically tested or x-rayed. This method of weld examination started on "P" unit sub-assemblies and was incorporated into the inspection procedures for "L", "K" and "C" units. A standard dy-chek kit was purchased for this purpose. Since this was a commercial kit, instructions for the application of the liquids for determining cracks, pin holes and other mechanical defects not visible to the naked eye in welding was followed. For

the purpose of illustration, the following method of dy-chek was adhered to in all cases when using for weld inspection on the NYX Project.

a. A clean cloth is saturated with dye remover (a solvent) and the weld (or any other surface) to be checked is swabbed and then wiped clean with another cloth. This process is repeated until weld is clean.

b. Dy-chek penetrant is applied with a nylon paint brush and allowed to set for 10 to 15 minutes.

c. Dye remover was applied with a clean cloth and the dy-chek pentrant removed by swabbing until clean. The weld was allowed to dry (this takes about 2 minutes)

d. Dy-chek developer was applied with a nylon paint brush and allowed to dry.

e. The weld is visually inspected and results interpreted.

With the foregoing procedure now in effect, all welding on the plenum chamber skirt (that could not be x-rayed or hydrostatically tested) was checked as outlined in the above procedure. For location of skirt welding that was dy-cheked, see Dwg. 3-1 in Section 11B-(1) of this manual.

(7) Plenum Chamber Hoods for Top Tube Sheet Lifting Lugs

Four hoods of revised design were fabricated for this unit to replace those substituted for "R" unit. (See section 14A-(7) of this manual for explanation of this revision) Before fabrication of the hoods started, it was ascertained through inspection that the lifting lug holes in the plenum skirt would not allow the four lifting lugs (on top tube sheet) to pass through when the units were mated and in an operating position. (See Exhibit #4 which covers this inspection.) In view of this fact, it was necessary to enlarge the four lifting lug holes in the plenum skirt to allow the lifting lugs on the top tube sheet to pass through. As a result of this, plenum chamber hoods for this unit had to be made oversize to fit the enlarged lifting lug skirt holes. All four lifting lug holes in the plenum skirt were enlarged to the same size in order that the four hoods be fabricated to the same dimensions. No drawing was issued covering this revision. For original dimensions, refer to du Pont drawing number D110283 Revision 2, equipment piece #155-P.

After fabricating the new type hoods, all welding was ground smooth and visually inspected for mechanical defects prior to x-ray. Minor repairs were made, and then the welding on each of the four hoods were x-rayed, radiographs examined, repairs made, and re-x-rayed (see #

EXHIBIT #4

DETERMINING THE RELATIONSHIP BETWEEN THE TOP TUBE SHEET LIFTING LUGS AND THE CORRESPONDING OPENINGS IN THE PLENUM SKIRT

E. I. DU PONT DE NEMOURS & CO., INC.

Report Number 476-P

Construction Division

[redacted]

CC: H. W. Gosney, F.P.M.
R. K. Mason - D. A. Hauser
Savannah River Plant (3)
R. K. Mason - E.M. Vass-SRP
H. L. Bunker - J. G. Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
J. B. Johnson - File

April 24, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE
R. E. Chaney-O.R. Frandsen-C. H. Heist

FROM J. R. Stewart - F. J. Jarczynski DATE January 15, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Plenum Chamber & Top Special Tube Sheet EQ.PC.NO. 154-P, 155-P

DRAWING NOS. W-131365 R. 27 - W-131155 R.11 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Inspection performed 1/15/53

Scope:

To determine the dimensional relationship between the top special lifting eyes and the corresponding opening in the plenum skirt while units are in line boring position. Also to determine dimensional position of the lifting eye with respect to the top special wrapper plate.

Procedure:

A six-foot steel tape was used to measure the clearance around the lifting eye, (see attached sketch), and also the size of the opening in the skirt.

A six-foot straight edge and 6" steel scale were used to measure the position (angle and deviation of ℄'s) of the lifting eye with respect to the top special wrapper plate.

Results: See attached sheets.

Note: The openings in the plenum skirt had to be enlarged to accommodate the lifting lugs.

[redacted]

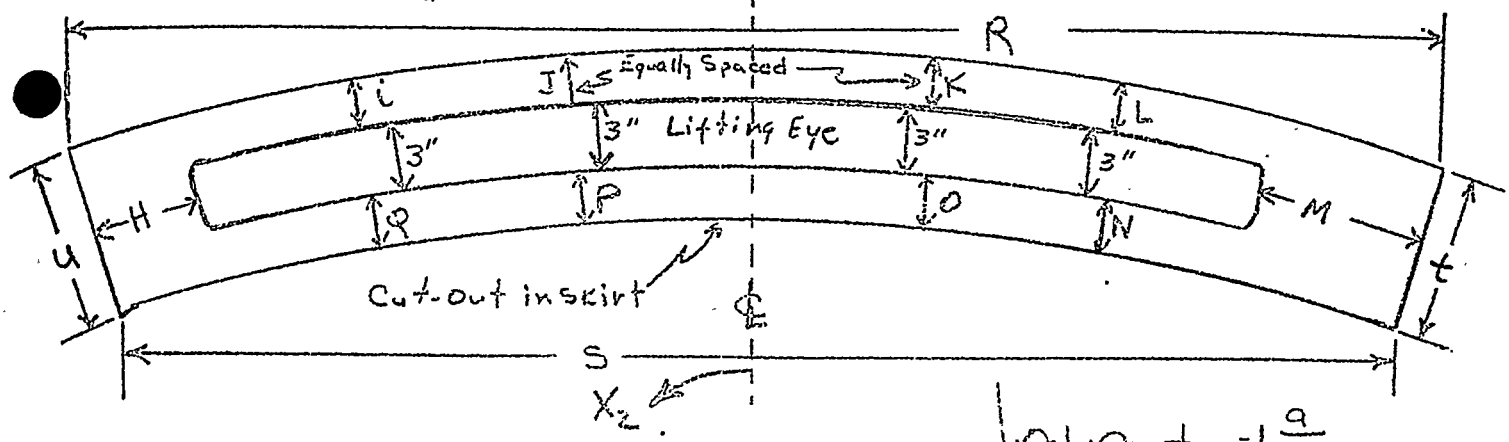
lmw
attach. 2

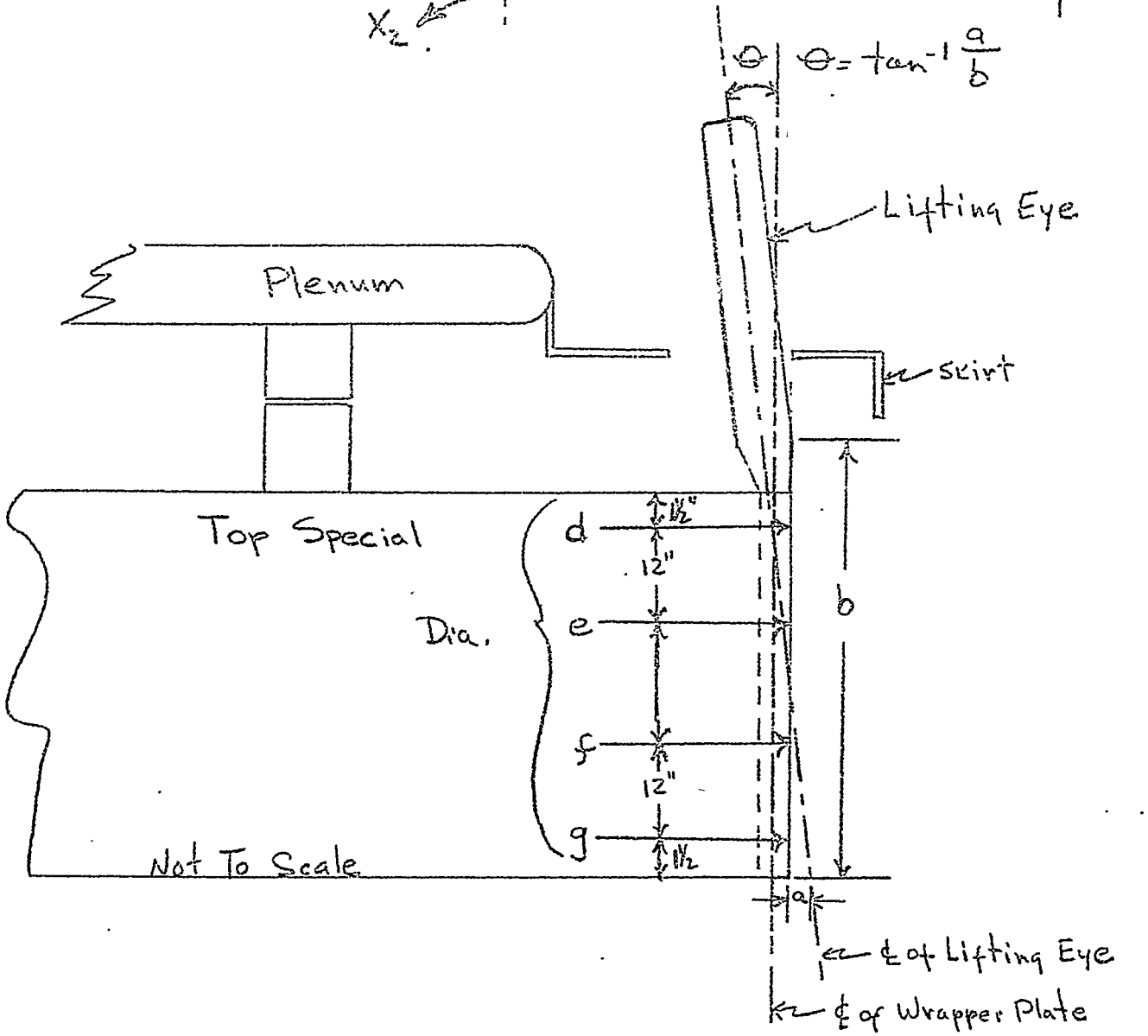
Skirt Cut-Out & Lifting Eye Dimensions 1/15/53

Lifting Eyes Numbered Clockwise with the 1st eye to right of X_2

Dim.	Lifting Eye #1		Lifting Eye #2		Lifting Eye #3		Lifting Eye #4	
	Actual	Dwg	Act	Dwg	Actual	Dwg	Actual	Dwg
a	1 5/8"	0"	1 25/32"	0"	1 29/32"	0"	2 1/16"	0"
b	47"	47"	47"	47"	47"	47"	47"	47"
d	18'8 11/64"	18'8 1/4"		~~18'8 1/4"~~		~~18'8 1/4"~~		~~18'8 1/4"~~
e	18'7 53/64"	18'8 1/4"						
f	18'7 29/32"	18'8 1/4"						
g	18'8 11/64"	18'8 1/4"						
H	1 1/2"	*	1"	*	3/4"	*	9/16"	*
i	2 3/16"		1 7/8"		1 3/8"		1 15/16"	
J	2 1/16		1 15/16		1 3/4		1 15/16	
K	2 1/16		1 15/16		1 3/4		1 15/16	
L	2 1/32		1 3/4		1 11/16		1 15/16	
M	7/16		3/4		15/16		1 3/16	
N	5/16		1/2		1/8		3/8	
O	9/32		1/2		3/16		1/4	
P	11/32		5/8		1/4		1/4	
Q	5/16		5/8		1/4		1/4	
R	22 1/2	APP. 22"	22 3/8	APP. 22"	22 1/2	APP. 22"	22 1/2	APP. 22"
S	21 3/8	*	21 1/4	*	21 1/2	*	21 3/8	*
t	5 17/32	5"	5 3/8	5"	5 1/4	5"	5 3/8	5"
U	5 9/16	5"	5 9/16	5"	5 1/4	5"	5 1/4	5"
⊖	2°	0°	2.2°	0°	2.3°	0°	2.5°	0°
℄ disp. Eye from weldment	11/16"	0"	17/32	0"	17/32	0"	9/16	0"

* - No B/P Dim.


R
i
J
Equally Spaced
K
L
3"
3" Lifting Eye
3"
3"
H
P
P
O
N
M
U
t
Cut-out in skirt
℄
S
X-X


θ
θ = tan⁻¹ a/b
Lifting Eye
Plenum
Skirt
Top Special
d
½"
12"
Dia.
e
b
f
12"
g
½
Not To Scale
a
℄ of Lifting Eye
℄ of Wrapper Plate

dwg. 3-4) All welding was considered satisfactory and accepted.

Next, each of the four hoods were given a dimensional check using a six foot steel tape graduated in 1/16". Results of the measurements are shown on Sketch #30. These measurements were considered satisfactory and accepted.

The four hoods were then prepared for hydrostatic testing. Each was filled with city water and then the pressure was raised to 10 psi using a hand water pump and held for fifteen minutes. All welding was visually inspected for leaks. None were found and the four hoods were accepted.

With the plenum and top tube sheet assemblies in operating position, the four hoods were then fit over the lifting lugs on the top tube sheet and lifting lug holes in the plenum skirt. Fit-up was satisfactory and the four hoods were accepted by the du Pont Inspection Department. Each hood was stenciled with appropriate identification numbers to allow for the proper mating of the hood to its coresponding lifting lug for final installation in the field.

(8) Dimensional Check of Plenum Skirt

a. Outside Diameter

The outside diameter of the plenum skirt was measured at three locations to determine whether or not it was within drawing tolerances. This was done by placing two straight edges flush against the skirt 180° apart on the outside circumference of the skirt. A 100' stainless steel tape was used to measure the distance between the two straight edges. Sketch #31 illustrates how this was done, the location at which these measurements were taken, and the results of the inspection.

(9) Stenciling of Tube Numbers on Tube Ends

Heretofore, much confusion was encountered in identifying a tube by X-Y coordinates during line boring and at later tube inspection and assembly of other parts of the unit. The conventional method of locating a tube by number was to match up a pattern drawing with the pattern and count coordinates on both. The short-cut, color-number method used during line boring required unsafe and complicated tube - counting under running machinery and over slick surfaces, oil and air lines, boxes, tools, etc.

To eliminate the above conditions, a member of the du Pont Inspection Department at New York Ship suggested that the tube coordinates be stamped on the top ends of all large tubes near the O.D. with 1/8" size numbers and then file the surface flush. Also, it was suggested

1 "P" UNIT PLENUM CHAMBER HOODS FOR T.T.S.
LIFTING LUGS



HOOD #	LENGTH (L)	WIDTH (W)	HEIGHT (H)
1	$22\frac{3}{32}$"	6"	$14\frac{1}{2}$"
2	$22\frac{3}{32}$"	6"	$14\frac{7}{16}$"
3	$22\frac{1}{8}$"	6"	$14\frac{15}{32}$"
4	$22\frac{1}{8}$"	6"	$14\frac{15}{32}$"

ENGINEERING SKETCH SHEET
E. I. DU PONT de NEMOURS & CO.

PROJ. No.

SIGNATURE:

PROJ. TITLE SKETCH #30

DATE

SUBJECT

No. E-12454

ENGINEERING SKETCH-SHEET
E. I. DU PONT DE NEMOURS & CO.

PROJ. TITLE

SKETCH #31

PROJ. No.

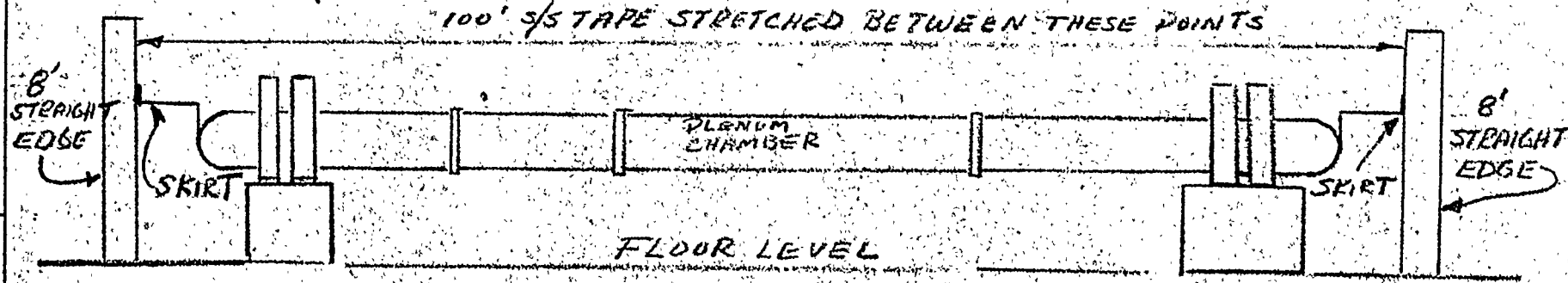
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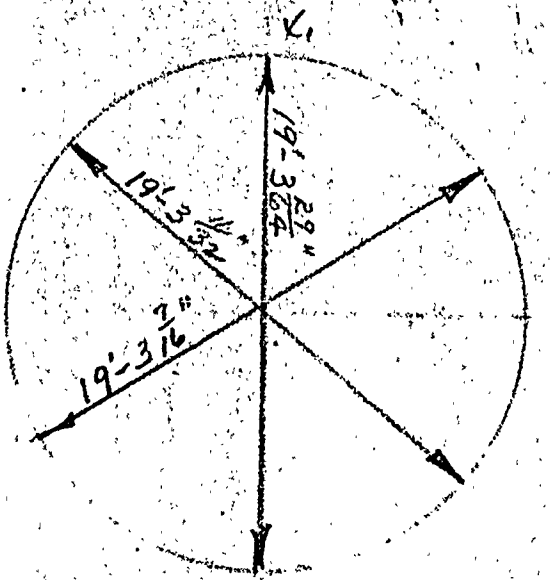
DATE

SUBJECT

No. E-12122

"P" PLENUM CHAMBER





y1

y2

1. O.D. OF HOOD B/P 19'-3 3/8"

2. THESE DIMENSIONS WERE CONSIDERED ACCEPTABLE. NO TOLERANCES WERE SPECIFIED ON DW'G.

LOCATION AT WHICH MEASUREMENTS WERE TAKEN

A B C D E F G H I K

that rod tube numbers be stenciled near the tube on the top side of the top tube sheet. This suggestion was adopted for "P" and subsequent plenum chambers for tube identification purposes during the line boring operation and subsequent inspections.

(10) Plenum Chamber Instrument Hood Plates

Inspection was performed identical to that described in Section 14C-(11) of this manual.

(11) Establishing Preliminary X & Y Axes on Bottom of Plenum Chamber and Top of Top Tube Sheet

For the purpose of aligning the plenum chamber and top tube sheet before line boring, $X_1 - X_2$ and $Y_1 - Y_2$ axes were established on the bottom of the plenum chamber and top of the top tube sheet assembly. These lines were established in an identical manner described in Part II, Section 13-A. The axes served no other purpose other than act as guide lines when setting up for line boring. After this the lines were disregarded and new ones established at a later date.

C. "L" Unit

(1) Nozzle Flange Inspections

a. Welding

After welding flanges to the six plenum nozzles, the circumferential welding joining the flange to the nozzle was visually inspected (after grinding) for pin holes, cracks, undercutting and other mechanical defects. Necessary repairs were made, re-inspected, and released for x-raying. Flange welding was then x-rayed, radiographs examined, repairs made, re-x-rayed, and accepted.

b. Checking Inside Diameter of Plenum Nozzle Flanges

Each of the six nozzle flanges were measured on the inside diameter to determine whether or not they were within drawing tolerances. (This inspection was not performed on "R" and "P" units,) Four diameters were taken on each nozzle flange; the first in a vertical position with the unit resting top side up parallel to the floor. The other three measurements were taken in 45° increments from this in a clockwise direction. All measurements were taken with a 11-12" inside micrometer, and 1/4" in from the face of the flange. The nozzle on the Y_2 end of the Y axis was #6 and the next one in a clockwise direction was #1. The others were numbered consecutively from the latter in a clockwise direction.

Results of this inspection was as follows:

DRAWING DIM. 12" ± 1/16"

Nozzle #1		Nozzle #2		Nozzle #3	
Dia. No.	Dia.	Dia. No.	Dia.	Dia. No.	Dia.
1	11.989"	1	12.028"	1	12.009"
2	11.988"	2	12.020"	2	11.992"
3	11.977"	3	12.011"	3	11.992"
4	11.987"	4	12.015"	4	11.997"

Nozzle #4		Nozzle #5		Nozzle #6	
Dia. No.	Dia.	Dia. No.	Dia.	Dia. No	Dia.
1	11.997"	1	12.022"	1	12.012"
2	11.986"	2	12.016"	2	12.013"
3	11.982"	3	11.997"	3	12.008"
4	12.002"	4	11.998"	4	12.005"

The above dimensions were reviewed by the Inspection Department and considered acceptable.

c. Zy-glo Testing of Welds Joining Solid Vanes to Six Plenum Nozzles

The fillet welds connecting the three solid vanes to the top and bottom plates of the plenum nozzles were inspected by the Zy-glo process. Of the six plenum nozzles tested, only one (#4) was found to have three (3) small transverse cracks. These were approximately 1/8" long x 1/32" deep. These cracks were ground out, re-zy-gloed and accepted. Plenum nozzles #1, #2, #3, #5 and #6 were tested in a similar manner; however, no defects were found and they were accepted.

(2) Deburring Tube Ends

Inspection was performed the same as outlined in paragraph 14A-(4) of this manual.

(3) Indexing Devices

Inspection was performed the same as outlined in paragraph 13B-3 of this manual. See Exhibit #5 which covers the visual inspection of the six (6) centering tongues welded to the bottom side of this unit.

(4) Inspections on Plenum Water Retainer or Dam

A profile was taken on the top side of the plenum both before and after the dam was welded. An 18' straight edge was placed on top of the tubes in both

EXHIBIT #5

VISUAL INSPECTION OF WELDS JOINING GROOVE BLOCKS TO BOTTOM PLATE OF "L" PLENUM CHAMBER

Construction Division

[redacted]

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J. B. Johnson - File

July 22, 1953
New York Ship - Camden, N. J.

NOT

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M&E FILE

FROM H. Neicen DATE April 25, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Centering groove blocks (6) EQ.PC.NO. 155-L

DRAWING NOS. W-132841 Rev. 2-Section "Z-Z" & D-110273-Rev.2 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Scope: Visual inspection of welds joining groove blocks to bottom plate of "L" plenum chamber.

Procedure: Welds were visually inspected for minor defects after welding.

Results: Where defects were found, they were repaired and found to be acceptable after re-inspection.

lmw

[redacted]

the X and Y directions. Feeler gages were then used to measure the distance (.001") between the face of the straight edge and the top end of the tubes. Since the unit during welding of the dam was supported on the periphery at four places and in the center of the unit, "before and after" measurements indicated no appreciable change in profile due to this additional welding.

After trimming the top edge of the dam to size and assembling and welding of all additional parts of the dam to the unit, the following inspections were performed by du Pont Inspectors:

a. Height of drainage dam taken from top plate at 6" intervals. For results of this inspection, see Exhibit #6.

b. Drain pipe locations were checked for location using 100' stainless steel tape. It was also used to measure the distance around the outer circumference of the dam. As per drawing dimensions, one drain was located 10°-24' off the X axis on the X_2 side in a counter-clockwise direction from the top side. (See du Pont drawing W-134200). The remaining five (5) drains were spaced 60° apart. All of the above dimensions checked were within tolerance and accepted.

c. Probe pin recesses were checked using a 6' stainless steel tape and accepted.

d. All welding joining the dam to the top plate of the plenum was visually inspected for cracks, pin holes, undercutting and other mechanical defects. Repairs were made, re-inspected and accepted. See Dwg. 3-1 in paragraph 10A-2 of this manual for location of dam.

(5) Sandblasting and Acid Washing of Unit

To prepare the unit for sandblasting and acid washing, the tube ends and nozzle flanges were blanked off in an identical manner described in paragraph 13B-5 of this manual. The unit was placed under conical shaped steel hood supported by "H" beams. A drop curtain was suspended around the periphery of the hood to keep the blasting sand confined to one area during the sandblasting operation. Also, at the apex of the conical hood an exhaust duct was connected to provide ventilation. The unit was sandblasted on the top and bottom sides and then visually inspected for evidence of free iron, dirt, grease, and other foreign material. None was found and the unit was released for acid washing.

First, the top side of the unit was acid washed, and then the unit was turned and the bottom side was done in a similar manner. All cleaning was done at room temperature using the following solution:

EXHIBIT #6

HEIGHT OF DRAINAGE DAM TAKEN FROM

TOP PLATE AT 6" INTERVALS

E. I. DU PONT DE NEMOURS & CO., INC. Report Number 543-L

Construction Division

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July 23, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M&E FILE

FROM R. R. Baker DATE May 7, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AEC-167½

EQUIPMENT Plenum Chamber EQ.PC.NO. 155-L

DRAWING NOS. W-134200 Rev. 10 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Scope: Height of drainage dam taken from top plate at 6" intervals.

Procedure: The print dimension of 1" was checked at 6" intervals in a clockwise direction from the X_1 axis with a 6" combination square with level. The sq.head with level was placed on the dam and the height was measured with a 6" scale.

Results: There were 88 measurements taken; the highest reading was 1 3/32" and the lowest reading was 15/16". The average reading was 1 1/64".

Note: Height of dam is considered acceptable. No tolerance is specified.

lmw

3 qts. of HNO_3 - 13%

5 gal. of H_2O - 85%

1 pt. of HF - 2%

Nitric acid Std. 42% BE (1.41 sp. gr.)

Hydrofluoric acid - 60%

Care was taken during application and removal of the solution not to let it come in contact with the mild steel flange caps used to blank off the tube ends because contamination of the unit would result. After each side was acid washed, the unit was flushed with city water. The entire surface of the unit was inspected visually and then ferroxyl tested at random. Visual examination and ferroxyl testing proved satisfactory and the unit was accepted.

(6) Tube Weld Inspection (Final)

After sandblasting and acid washing both top and bottom sides, all tube welding was visually inspected prior to preliminary hydrostatic test for pin holes, cracks, undercutting, rollovers, and other mechanical defects. This inspection was performed in an identical manner as described in paragraph 6A-f of this manual. For results of this inspection, see Exhibit #7.

(7) Preliminary Hammer and Hydrostatic Test Prior to Line Boring

This inspection was performed in a similar manner as that described in paragraph 13B-5, except after the initial filling of the unit with de-ionized water in a horizontal position (top side up) subsequent fillings (required during test) were performed with the unit in a vertical position. In this latter case, venting was done through the top three nozzles while the unit was being filled with water. This method of venting was necessary only when the unit was placed bottom side up. For results of this inspection, see Exhibit #8.

(8) Plenum Chamber Hoods for Top Tube Sheet Lifting Lugs

a. X-ray, Visual, Dimensional, and Fit-up Inspections

The above inspections were performed as discussed in report number 547-L presented herewith as Exhibit #9.

b. Hydrostatic Test

This test was performed as discussed in Report Number 546-L presented herewith as Exhibit #10.

(9) Skirt Welding Inspection

This inspection was performed in an identical

EXHIBIT #7

TUBE WELD INSPECTION

E. I. DU PONT DE NEMOURS & CO., INC. Report Number 545-L

Construction Division

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July 23, 1953
New York Ship - Camden, N. J.

NOT

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM F.J.Jarczynski, D.M.Leland,H.E.Dahlke DATE May 12, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Plenum Chamber EQ.PC.NO. 155-L

DRAWING NOS. W-132842 Rev. 3 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

This report covers the final tube weld inspection completed on May 2,1953.

Scope: To visually inspect all tube welds, (top and bottom),for holes, cracks, roll over and overlays.
Note: This inspection was made immediately after sandblasting.

Procedure: Using a magnifying glass and flashlight, all tube welds were visually inspected. This included top and bottom sides, large and rod tubes.

Results: Many tube welds were found to be defective, primarily at large and rod tube welds. In each case of defect, before the inspection continued, the defective weld was either ground out or chipped out and re-welded,if necessary,until the tube weld was found to be acceptable. The inspection was carried out in this manner until the entire unit was covered and found to be acceptable.

lmw

EXHIBIT #8

RESULTS OF PRELIMINARY HAMMER AND HYDROSTATIC TEST

PRIOR TO LINE BORING ON THE "L" PLENUM CHAMBER

E. I. DU PONT DE NEMOURS & CO., INC.

Construction Division

Report Number 544-L

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July 23, 1953
New York Ship - Camden, N. J.

1003

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE
R. E. Chaney, O. R. Frandsen, C. H.Heist,

FROM F. J. Jarczynski, I. Louder DATE May 11, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AKC-167½

EQUIPMENT Plenum Chamber EQ.PC.NO. 155-L

DRAWING NOS. M-132842 Rev. 3 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Inspection performed 5/4/53 thru 5/5/53

Scope: Hydrostatic and hammer test of subject unit prior to line boring.

Procedure: Initial filling of unit with city water was accomplished with unit in horizontal position top side up. Unit was vented thru tapped holes in each tube plug. Subsequent fillings (2) were performed with unit in a vertical position. Unit was vented thru top three (3) nozzles and placed in bottom side up position.

Hammer test - area adjacent to each weld hammered with special 10# drop-type hammer.

1. Pressure - 312.5 psig
2. Pressure - "O" ring and water level 2" below top and bottom plates respectively. (Hammering at 0 psi was done as an aid in cleaning.)

Hydrostatic test

1. Pressure 375 psig allowed to stand 1 hour before visual inspection of the entire assembly including all welds. All welds were visually inspected after each repair job.

Results: The following tubes welds leaked and were repaired:

Top Side - X20, Y42 (repaired twice); X49, Y63

Bottom Side - X23, Y39

Final inspection: No leaks observed.

lmw

EXHIBIT #9

X-RAY, VISUAL, DIMENSIONAL, AND FIT-UP INSPECTIONS PERFORMED ON PLENUM CHAMBER HOODS FOR TOP TUBE SHEET LIFTING LUGS

E. I. DU PONT DE NEMOURS & CO., INC. Report Number 547-L

Construction Division

[redacted]

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R. V. Graham - File

August 4, 1953
New York Ship - Camden, N. J.

#102

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM W. J. Laughlin, H. E. Dills DATE May 25, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Plenum Chamber Hoods (4) for TTS Lifting Lugs EQ.PC.NO. 155-L

DRAWING NOS. D-110298 Rev. 0 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

This report covers the final inspection completed 5-25-53.

Scope: To x-ray and visually inspect all welds, check inside dimensions, and actually fit the hoods over the lifting lugs.

Procedure: X-rays were examined in accordance with 1949 ASME Code and the 1952 Standards for porosity. Welds were visually checked for undercuts and other undesirable defects. Inside dimensions were taken with a steel tape.

Results: X-rays and visual inspection of welds accepted. Hoods were tried and found to fit over lifting lugs. The following are the inside dimensions of the hoods.

Hood No.	Length	Width	Height
1	22 1/16"	5"	14 3/8"
2	22"	5"	14 7/16"
3	22"	5"	14 5/16"
4	22"	5"	14 3/8"

Note: Specified drawing dimensions are 22 1/16", 5 1/16" and 14 3/8" respectively with a tolerance on each of ±1/16". All measurements were within the allowable tolerances.

lmw

[redacted]

EXHIBIT #10

HYDROSTATIC TESTING OF PLENUM CHAMBER

HOODS FOR TOP TUBE SHEET LIFTING LUGS

E. I. DU PONT DE NEMOURS & CO., INC.

Construction Division

Report Number 546-L

CC: J. B. Johnson
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August 4, 1953
New York Ship - Camden, N. J.

[redacted]

187

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M&E FILE

FROM R.E.Chaney, I.R.Louder, H.E.Dills DATE May 25, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AEC-167½

EQUIPMENT Plenum Chamber Hoods for TTS
Lifting Lugs (4) EQ.PC.NO. 155-L

DRAWING NOS. D-110298 Rev. 0 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Inspection performed 5/22/53

Scope: Hydrostatic test for four (4) plenum chamber hoods, (4-1, 4-2, 4-3, 4-4), for "L" TTS lifting lugs.

Procedure: Each hood, filled with city water, was placed in an inverted position and capped. The pressure was brought up to 10 psig @ 75°F and allowed to stand 40 minutes. Each hood, including all seam welds, was then examined visually for leaks.

Results: No leaks were observed.

lmw

[redacted]

manner as that discussed in paragraph 13B-6 of this manual.

Report Number 538-L covering the inspection and results found on "L" plenum skirt is presented herewith as Exhibit #11.

(10) Profile Across Tube Ends on X & Y Axes

Profile readings on tube ends on the X and Y axes were taken on both the top and bottom sides of the plenum chamber prior to line boring. As a matter of fact, "R" and "P" units top plate were "dished" toward the center of the unit approximately 1/4". In an effort to determine if any additional distortion resulted after other miscellaneous welding and fabrication was completed, profile readings were taken at various stages of fabrication on "L" plenum chamber. It was thought that the manner in which the units were being supported contributed to some additional distortion of the tube plate (top side) and tube ends (both sides). "R" and "P" units were supported only on the periphery. It was surmised that by supporting "L" unit in the same manner, but providing additional support in the center throughout all fabrication operations would lessen the amount of the tube plate and tube end distortion. This was done on "L" only. Profile readings were taken at various stages of fabrication on "L" plenum chamber, and after analyzing all results, it was ascertained that no appreciable amount of distortion resulted from additional welding and fabrication.

(11) Plenum Chamber Instrument Hood Plates

Two instrument hood plates were fabricated for this unit. These fit into holes cut out in the plenum skirt for use as instrument lead-in terminals.

After all fabrication was completed, the two instrument hood plates were dimensionally and visually inspected. All dimensions were within drawing tolerances and acceptable. (See du Pont drawing D-112873 Rev. 2 & D-112908 - Rev. 1) After cleaning they were ferroxyl tested and found satisfactory.

Four legs (2/ instrument hood plate) that support the instrument hood plates were dimensionally and visually inspected after fabricating. All dimensions were within drawing specifications. Welds were visually examined for soundness, and then all surfaces of legs were passivated. (For details, see above mentioned drawings) All conditions, soundness of welds and surfaces of material free of rust, dirt, or grease were satisfactory. were

These legs were released for shipping to Savannah River Plant and were not attached to plates by vendor as shown on above drawings. They were shipped loose and field welded to plates to aviod possible damage due to shipping.

INSPECTIONS PERFORMED BY DU PONT ON "R", "P", & "L" UNITS

PART VII-SECTION I (Cont.)
Paragraphs 15 thru 16
"R", "P",& "L" PLENUM CHAMBERS

REPORT

OF

MATERIAL & EQUIPMENT

SECTION'S

ACTIVITIES

AT

NEW YORK SHIPBUILDING CORP.
DURING FABRICATION

OF

AXC 167 1/2

STARTING MAY 18, 1951
PART VII - SECTION I (CON'T)
PARAGRAPHS 15 THRU 16

BY: JAMES RAY STEWART

APRIL 3, 1954

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1. Exhibit #12 - Results of Line Boring Operation - "R" Unit
2. Sketch #31-A - Plenum Chamber Straight Tube
3. Sketch #32 - P.C. Tube Discrepancies
4. Photo Serial #60 - "P" P.C. Honing Operation
5. Exhibit #13 - Preliminary Freon Test After Replacing 18 Defective Tubes
6. Sketch #34 - Set-up for measuring P.C. Tube Overhang
7. Sketch #34-A - P.C. Rod Tube
8. Exhibit #13-A - Results of Rod Tube Line Boring Operation, "P" Unit
9. Exhibit #13-B - Results of "P" Unit Line Boring Operation
10. Sketch #34-A1 - Functional Gaging of P.C. and T.T.S. Tubes
11. Exhibit #13-C - Results of Rod Tube Line Boring Operation "L" Unit
12. Exhibit #13-D - Results of Large Tube Line Boring, "L" Unit
13. Exhibit #14 - "V" Slot Inspection (Final)
14. Drawing 2-1 - Plenum Chamber Large Tube
15. Exhibit #15 - "R" Unit P.C. Rod Tube Finish (RMS) & I.D. in Top Land
16. Exhibit #15-A - Final Rod Tube Verticality
17. Exhibit #16 - P.C. Tube Pattern - Top and Bottom Sides
18. Exhibit #17 - P.C. Rod Tube Locations - Top and Bottom Sides
19. Sketch #35 - Procedure for Transferring Axes from Top of P.C. to Bottom of P.C. and Top of T.T.S.
20. Drawing 1-2 - Tube Sealing Areas - P.C. and B.T.S.
21. Exhibit #18 - Results of Pattern Coordinates Taken on Top and Bottom Sides of the "P" P.C.
22. Exhibit #19 - Final Report on "V" Slot Inspection Made on "P" P.C.
23. Exhibit #20 - Dimensional Check on Height of Water Retaining Wall
24. Exhibit #21 - "P" Unit P.C. Final Cleaning Procedure
25. Exhibit #22 - Dowell Cleaning and Results
26. Sketch #35-A - P.C. Slot to Hole Location Measurements

27. Exhibit #23 - Final Inspection of T.T.S. Rod Tubes in Conjunction with Repair of P.C. Rod Tubes

28. Exhibit #24 - Determining Clearance Between Mating Ports of Centering Devices Welded to P.C. and T.T.S.

29. Exhibit #25 - "P" P.C. Tube End Profile, Bottom Side

30. Exhibit #26 - "P" P.C. Tube End Profile While in Operating Position on T.T.S. Assembly, Top Side

31. Exhibit #27 - Visual Inspection of "P" P.C. for External Cleanliness Prior to Shipping to SRP

32. Exhibit #28 - "V" Slot Inspection (Final)

33. Exhibit #29 - 1. Dimensional Check and Squareness of Nozzle Flanges After Finish Machining

2. Machining of "L" Unit P.C. Nozzle Flange Faces and Inspection Procedure

34. Exhibit #30 - Results of Pattern Coordinates Taken on Top & Bottom Sides of the "L" Plenum Chamber

35. Exhibit #31 - "L" Unit P.C. Final Cleaning Procedure

36. Exhibit #32 - Dowell Cleaning & Results

37. Photo Serial #229-Drying Set-up for "L" Top Tube Sheet Assembly

38. Sketch #36 - B.T.S. & T.T.S. Block Diagram for Internal Drying Set-up

39. Sketch #37 - P.C. Block Diagram for Internal Drying Set-up.

40. Sketch #38 - Shipping Plugs for "L" Plenum Tubes

15. Line Boring Inspections

A. "B" Unit

(1) Preliminary Set-up

a. Leveling Top Tube Sheet Assembly

Prior to aligning the plenum chamber on the top tube sheet assembly, the latter was set and leveled on special foundations. The Wild N111 Precision Level and target was used to level the unit. Refer to Part III-J which discusses the use of this instrument for leveling units.

b. Installation of Centering Plugs in Top Ends of Rod Tubes

Centering plugs were inserted in the top tube sheet rod tubes (top side) by New York Ship mechanics. These plugs were used later as centering points from which rod tube base plates were aligned and leveled. Before aligning the plenum chamber on the top tube sheet, du Pont Inspectors visually checked to see that all centering plugs were seated properly in the top end of all rod tubes.

c. Setting Plenum Chamber on Top Tube Sheet

After setting the plenum chamber on top of the top tube sheet assembly, the top side of the plenum was checked for levelness using the Wild N111 level and target. The maximum differential between all points checked was found to be approximately .015". Inspection Department accepted this figure as being within the degree of levelness required.

d. Inspection for Correct Seating of Units

Bearing surfaces between the bottom ends of the plenum tube and top ends of the top tube sheet tubes were checked for mating conditions. This inspection was performed by inserting a feeler gage between the mating tube end surfaces to determine how accurate the machined planes matched. Then the centerlines on the plenum X and Y axes were checked for coincidence with the top tube sheet X and Y axes and relative positions recorded for future reference.

Next, plenum tube overhang at X1, X2, Y1 and Y2 were measured with a "V" block gage (modified depth gage, see photo serial number 202, Part II-11b). These were used as reference measurements for determining shrinkage (if any) after all plenum tubes had been bored. Successive measurements from day to day by the du Pont Inspection Department indicated no appreciable movement of the unit due to line boring of tubes. For results of this inspection and other orientation measurements taken on the plenum chamber at various times, see Part 6 of this section.

e. Chip Stoppers

Chip stoppers were placed in each of the three plenum chamber tube weir slots (See Part II-A, photo serial #198). These were first put into the tubes during assembling and welding of the plenum nozzle and bulge sections. They are checked at this stage of fabrication and those that have fallen out were replaced. The purpose of these chip stoppers was to prevent metal chips, dirt, oil, and other foreign material from entering the plenum chamber from the outside during the various fabrication operations particularly during line boring. In other words, these chip stoppers serve as a cleanliness preventive measure throughout the entire fabrication of the plenum chamber.

(2) Inspections Performed During Line Boring Operation

a. Base Plate

This inspection was performed identical to that discussed in Part II-A, section 15-b(1).

b. Boring Bar Verticality

This inspection was performed identical to that discussed in Part II-A, section 15-b(2).

c. Inspections After First Boring Operation

After all plenum tubes had been rough bored to 4.250" diameter, measurements were again taken with a "V" block gage at X1, X2, Y1 and Y2 plenum tube overhand points and compared with reference measurements. (See 14A, section 1-d above. Also, X and Y axes on the bottom of the plenum tubes and top of top tube sheet tubes were checked and compared with reference measurements. In both cases, no appreciable shrinkage or rotation was evident. There were no other inspections performed by du Pont after the first boring operation.

d. Inspections After Second Boring Operation

After rough boring all large tubes to 4.250" diameter, they were again semi-finished bored to 4.340" diameter in the same manner as before, except no pertinent inspections were made; however, all machining was witnessed by a du Pont inspector.

(3) Inspections Performed on Finished Bored Plenum Tubes

These inspections were performed in an identical manner as described in Part II-A, section 15-b, (5) except as follows:

(a) Eccentricity Measurements

Eccentricity readings were taken with a du Pont mechanical gage designed for this purpose. For use of this gage, see Part III,

section H. The electronic gage could not be used in taking final measurements because it was undergoing major repairs throughout the line boring of "R" unit. For the electronic gage story, see Part III, section F.

b. Line Boring Result Sheet

For purposes of illustration exemplified in report form, a result sheet representing final measurements taken on finished bored plenum tubes is presented herewith as Exhibit #12.

Explanation of result sheet is as follows:

The purpose of this result sheet was to record systematically the (1) I.D. (2) Surface finish (RMS) (3) Centrality and (4) Verticality. This was a permanent record drawn up and submitted to the du Pont Design Division.

A detailed description of the above referenced steps is outlined in the following procedure:

1. Inside Diameter (I.D.)

The I.D. of each tube was measured with a standard dial indicator bore gage and ring gage to the nearest thousandths of an inch. Readings were taken at the top of the top land and at the top and bottom of the bottom land. (Sketch #31-A for identification of "lands".) In all cases these measurements were taken in the X and Y direction. (See Part II-A, photo serial #56-6.

2. Surface Finish (RMS)

The surface finish (RMS) of the top and bottom lands was checked in an axial direction using a profilometer. Photo serial #56-6A in Part II-A illustrates the use of the instrument.

3. Centrality

The centrality of the centerline of the plenum tube bore with respect to the mid-point of the bore of the top tube sheet tube was checked with a mechanical gage especially designed for this purpose. For use of gage, see Part III, section H. Symbols N, E. S, and W (on "R" line boring result sheet) refer respectively to X1, Y1, X2, Y2.

4. Verticality

The verticality of each large tube was taken using a specially designed calibrated verticality gage which indicates the inclination of the tube with the vertical. For operation and use of gage, see part III - section L

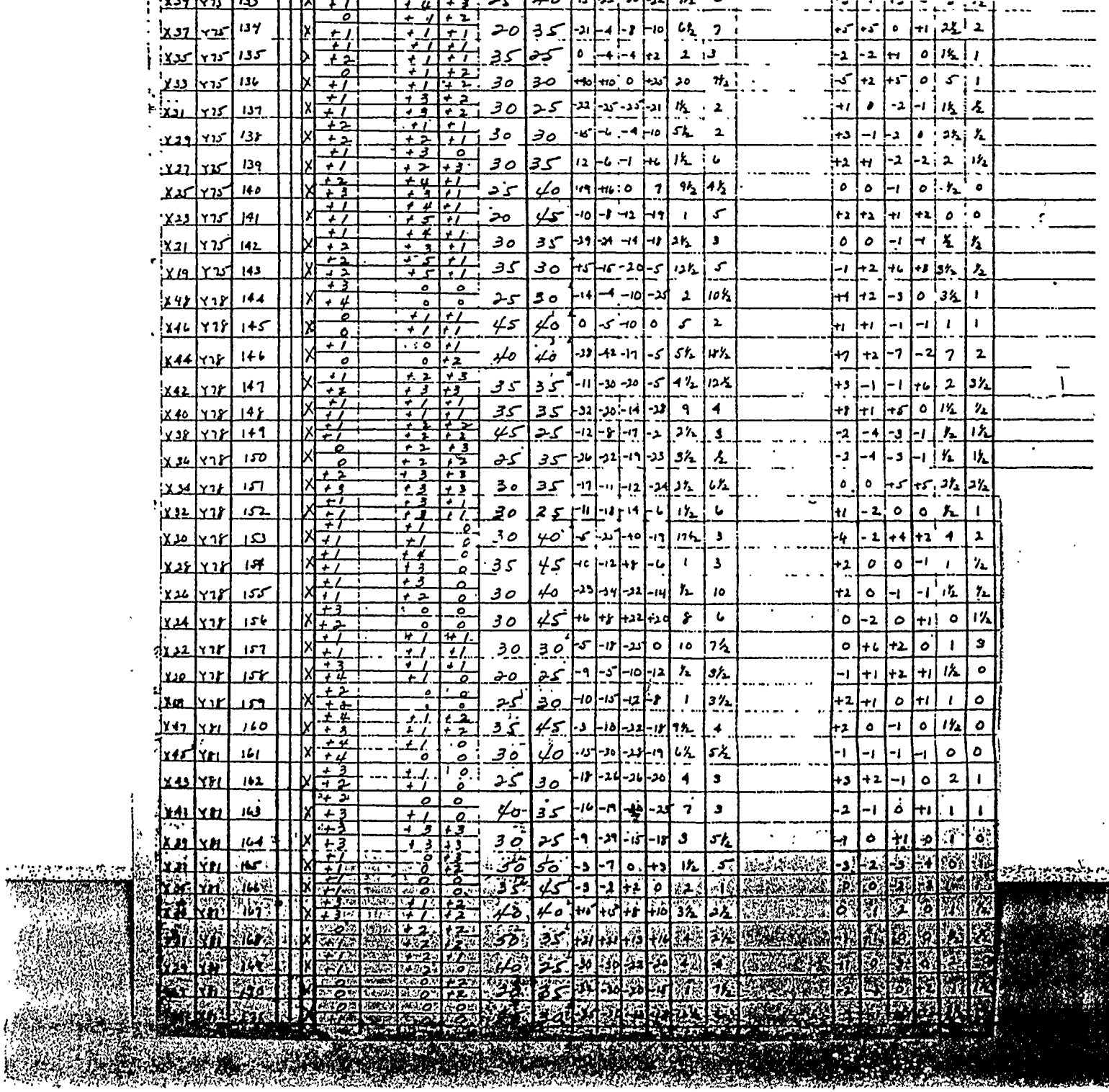
EXHIBIT #12

RESULTS OF LINE BORING OPERATION - "R" UNIT

RESULTS OF LINE BORING OPERATION

"R" UNIT

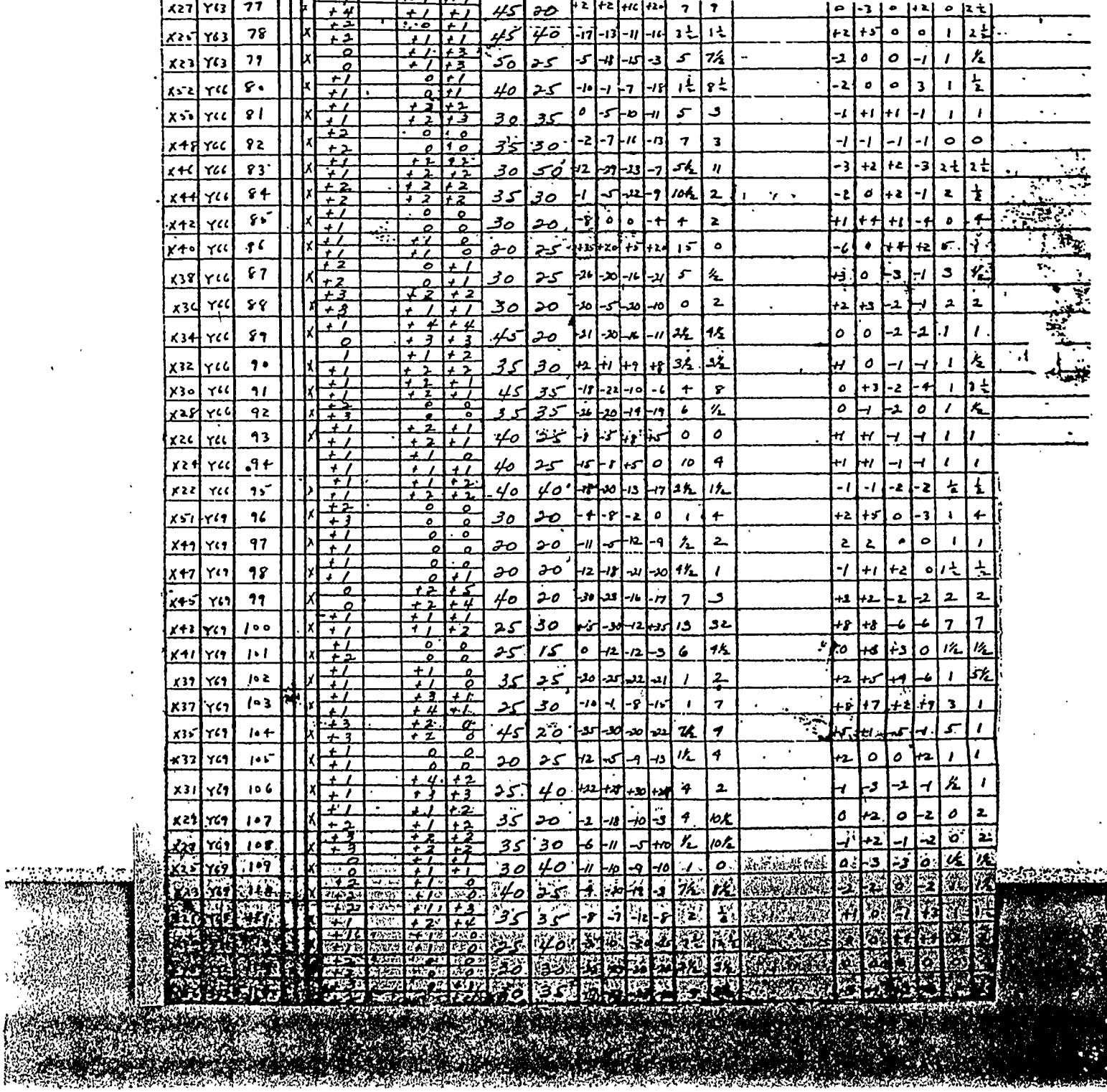
IDENFICATION OF TUBES						BORE MEASUREMENTS (EACH SIDE ± .005)						CENTRALITY READING							VERTICALITY READING						
TUBE NO		NEW YORK SHIP NO.	RED	BLUE	YELLOW	TOP LAND		BOTTOM LAND		SURFACE FINISH		DIRECTION				AVERAGE CENTRALITY		REMARKS	DIRECTION				AVERAGE VERTICALITY		REMARKS
						TOP OF LAND	BOTTOM OF LAND	TOP OF LAND	BOTTOM OF LAND	TOP LAND	BOTTOM LAND	N	E	S	W	N-S	E-W		N	E	S	W	N-S	E-W	
X24	Y72	115			X	+5		+4	+6	25	30	-15	-15	-25	-20	5	5½		-1	+4	0	-5	½	4½	
X42	Y72	116			X	+3		+2	+20	40	25	-10	-10	-9	-10	½	0		-1	+3	0	0	½	1½	
X40	Y72	117			X	+3		+2	0																
X38	Y72	118			X	+2	0	+2	0	30	25	+9	-20	-10	+2	14	11		-4	+2	+3	-4	3½	3	
X36	Y72	119			X	0		+4	+5	35	35	-9	+15	+16	0	12½	7½		-1	+4	+1	-4	1	4	
X34	Y72	120			X	+1		+1	+1	25	25	-5	-7	-1	+1	2	4		-2	-3	-2	-1	0	1	
X32	Y72	121			X	0		+2	+1	35	30	-12	-5	-10	-10	1	2½		+3	0	-2	0	2½	0	
X30	Y72	122			X	+1		+2	+1	35	25	-30	-22	-23	-31	1	1½		+10	+10	+10	+9	0	½	
X28	Y72	123			X	+3		+3	+1	35	30	-22	-10	0	-10	11	0		+4	+2	+1	+1	1½	½	
X26	Y72	124			X	+1		+3	+1	35	28	-12	-7	-8	-14	2	3½		+4	+4	+1	+3	1½	½	
X24	Y72	125			X	+2		+2	+2	30	25	-20	-22	-20	-15	0	3½		-1	-1	-1	-1	0	0	
X22	Y72	126			X	+1		0	0	20	30	-25	-25	-10	-24	7½	½		+5	0	-3	+2	4	1	
X20	Y72	127			X	+3		+3	0																
X49	Y75	128			X	+4		+3	+1	40	35	-23	-26	-21	-15	1	5½		0	+4	-1	-6	½	5	
X47	Y75	129			X	+1		+1	+2	35	40	+9	+13	-1	+17	10	2		0	0	0	0	0	0	
X45	Y75	130			X	+1		+1	+1	45	35	-12	-18	-9	-3	11½	7½		+3	+4	+2	0	½	2	
X43	Y75	131			X	0		+2	+1																
X41	Y75	132			X	+3		0	0	40	30	-18	-30	-25	-12	3½	9		0	+2	0	-2	0	2	
X39	Y75	133			X	+2		+2	+2	30	40	+2	-5	-6	+5	4	5		-2	0	0	-2	1	1	
X37	Y75	134			X	+2		+2	+3	35	25	-2	+10	-10	+5	4	4½		-4	+1	+1	-3	2½	2	
X35	Y75	135			X	+1		+2	+2																
X33	Y75	136			X	+2		+1	0	35	20	-12	-3	-8	-10	2	1		+2	+3	0	-2	1	2½	
X31	Y75	137			X	+3		+1	0																
X29	Y75	138			X	+3		+4	+3																
X27	Y75	139			X	+1		+4	+3	25	40	-15	-22	-20	-32	7½	0		-3	-1	+3	0	3	½	
X25	Y75	140			X	0		+1	+2																
X23	Y75	141			X	+1		+1	+2	30	30	+10	+10	0	+20	20	7½		-5	+2	+5	0	5	1	
X21	Y75	142			X	+1		+3	+2	30	25	-22	-25	-23	-21	1½	2		+1	0	-2	-1	1½	½	
X19	Y75	143			X	+2		+1	+1																
X48	Y78	144			X	+2		+1	+1	30	30	-16	-6	-4	-10	5½	2		+3	-1	-2	0	2½	½	
X46	Y78	145			X	+1		+3	0																
X44	Y78	146			X	+1		+2	+3	30	35	12	-6	-1	+6	1½	6		+2	+1	-2	-2	2	1½	
						+3		+4	+1																
						+3		+3	+1	25	40	119	116	0	7	9½	4½		0	0	-1	0	½	0	
						+1		+4	+1																
						+1		+5	+1	20	45	-10	-8	-12	-19	1	5		+2	+2	+1	+2	0	0	
						+1		+4	+1																
						+2		+3	+1	30	35	-29	-24	-19	-18	2½	3		0	0	-1	-1	½	½	
						+2		-5	+1																
						+2		+5	+1	35	30	+5	-15	-20	-5	12½	5		-1	+2	+6	+3	3½	½	
						+3		0	0																
						+4		0	0	25	30	-14	-4	-10	-25	2	10½		+1	+2	-3	0	3½	1	
						0		+1	+1																
						0		+1	+1	45	40	0	-5	-10	0	5	2		+1	+1	-1	-1	1	1	
						+1		0	+1																
						0		0	+2	40	40	-33	-42	-17	-5	5½	14½		+7	+2	-7	-2	7	2	



RESULTS OF LINE - BORING OPERATION 12-10

"R" UNIT

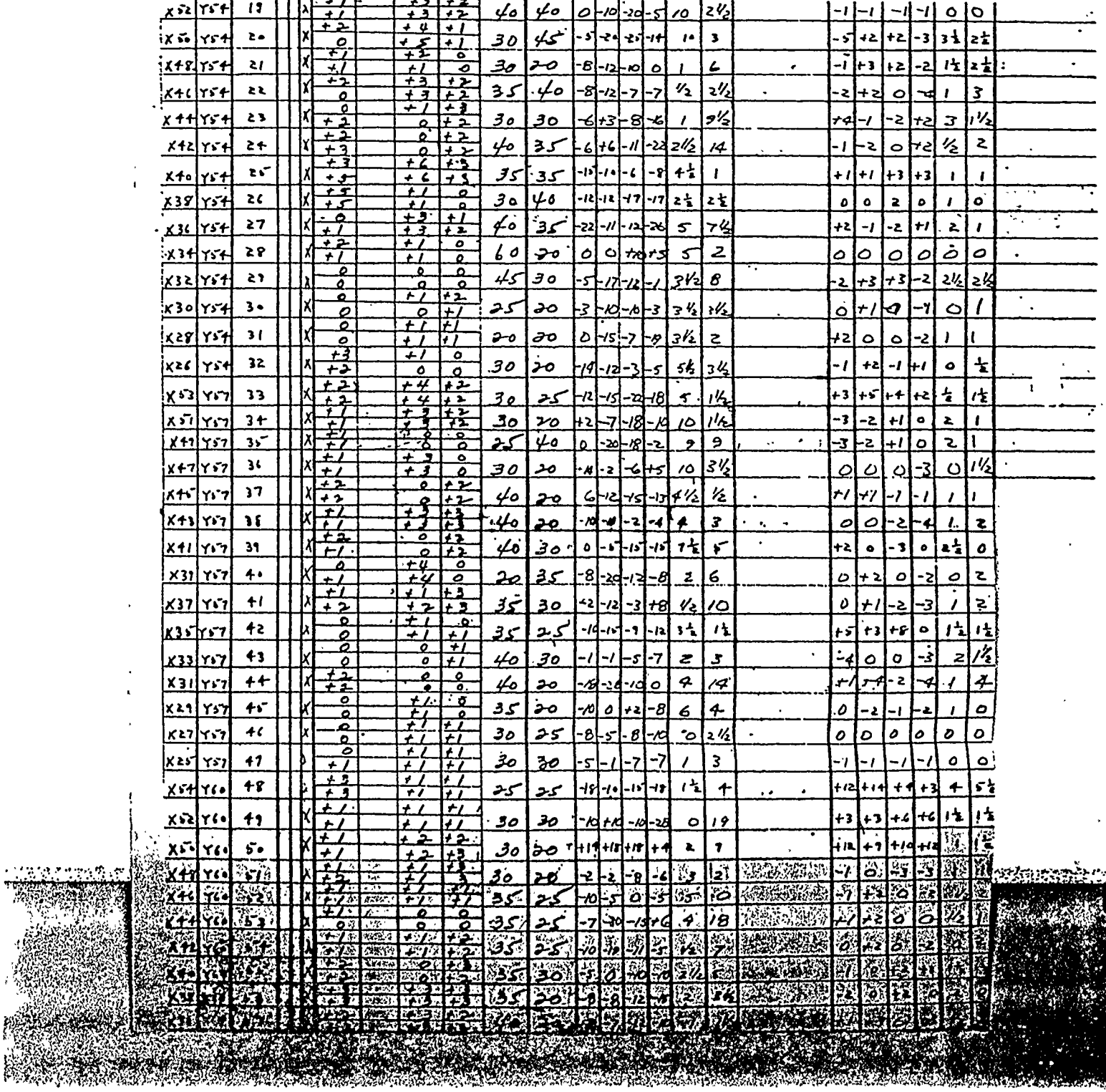
IDENTIFICATION OF TUBES				BORE MEASUREMENTS (BASIC STROKE 4.305)						CENTRALITY READING							VERTICALITY READING						
				TOP LAND		BOTTOM LAND		SURFACE FINISH		DIRECTION							DIRECTION						
TUBE NO		NEW YORK SHIP NO		TOP OF LAND	BOTTOM OF LAND	TOP OF LAND	BOTTOM OF LAND	TOP LAND	BOTTOM LAND	N	E	S	W	AVERAGE CENTRALITY N-S	AVERAGE CENTRALITY E-W	REMARKS.	N	E	S	W	AVERAGE VERTICALITY N-S	AVERAGE VERTICALITY E-W	REMARKS
X34	Y60	58	X	+1		+2	+1	40	25	+5	-8	-17	-10	11	1		+3	0	-5	0	4	0	
				+1		+2	+1																
X32	Y60	59	X	+1		+1	+1	50	20	-8	-3	-6	-5	1½	3½		-1	-1	-1	-1	0	0	
				+1		+1	0																
X30	Y60	60	X	+2		+3	+3	40	20	-15	-12	-16	-20	1½	4		-1	-1	-1	-1	0	0	
				+1		+3	+2																
X28	Y60	61	X	0		+1	+1	40	20	-20	0	+10	+5	15	2		+4	0	-6	-2	5	1	
				0		+1	+1																
X26	Y60	62	X	+1		+1	+3	45	40	-11	-15	-18	-19	3½	2		+5	-5	-1	0	2	2½	
				+1		+1	+2																
X24	Y60	63	X	+2		0	+2	40	30	-35	-15	0	-20	17½	2½		0	-3	0	+3	0	5	
				+2		0	+2																
X53	Y63	64	X	+2		+2	+2	45	20	-13	-19	-8	+2	2½	10½			2	0	-3	1	2½	
				+2		+2	+2																
X51	Y63	65	X	+2		+2	+2	45	25	+12	-18	-36	0	21	9		0	+3	+4	+1	2	1	
				+2		+1	+1																
X49	Y63	66	X	+3		+2	+2	30	25	+25	-6	+15	-12	10	3		-5	+5	+5	0	5	2½	
				+3		+2	+2																
X47	Y63	67	X	+3		0	0	45	20	-17	-14	-28	-28	5	5½		+2	0	-2	+2	2	1	
				+3		0	0																
X45	Y63	68	X	+2		0	0	35	25	+8	+5	-6	-5	7	5		0	0	0	0	0	0	
				+2		0	0																
X43	Y63	69	X	+3		0	0	40	20	-18	-33	-19	-13	½	5		-1	+1	+2	-2	1½	1½	
				+3		0	0																
X41	Y63	70	X	+1		+2	+1	45	40	0	-6	-2	+1	1	3½		0	+1	0	-2	0	1½	
				+1		+2	+1																
X39	Y63	71	X	+4		+4	+1	40	25	-14	-22	-33	-15	2½	3½		+1	+5	-2	-4	1½	4½	
				+4		+3	+1																
X37	Y63	72	X	+8		+4	+2	40	35	+8	-20	-20	+2	19	11		-3	-2	0	-3	1½	½	
				+8		+3	+2																
X35	Y63	73	X	+3		+2	+2	45	30	-10	-5	+3	0	6½	2½		-2	0	0	-2	1	1	
				+2		+2	+1																
X33	Y63	74	X	+3		+2	+3	35	25	-10	-10	0	0	5	5		+1	+5	+1	-2	0	3½	
				+3		+2	+3																
X31	Y63	75	X	0		+1	+1	40	20	-4	-8	0	+2	2	5		0	0	0	0	0	0	
				0		+1	+1																
X29	Y63	76	X	+3		+2	+2	40	25	-18	-7	-9	+2	7	4½		-1	0	+2	+2	1½	1	
				+3		+2	+2																
X27	Y63	77	X	+4		+1	+1	45	20	+2	+2	+16	+20	7	9		0	-3	0	+2	0	2½	
				+4		+1	+1																
X25	Y63	78	X	+2		+1	+1	45	40	-17	-13	-11	-16	3½	1½		+2	+5	0	0	1	2½	
				+2		+1	+1																
X23	Y63	79	X	0		+1	+3	50	25	-5	-18	-15	-3	5	7½		-2	0	0	-1	1	½	
				0		+1	+3																
X52	Y66	80	X	+1		0	+1	40	25	-10	-1	-7	-15	1½	8½		-2	0	0	3	1	½	
				+1		0	+1																
X50	Y66	81	X	+1		+2	+2	30	35	0	-5	-10	-11	5	3		-1	+1	+1	-1	1	1	
				+1		+2	+3																
X48	Y66	82	X	+2		0	+0	35	30	-2	-7	-11	-13	7	3		-1	-1	-1	-1	0	0	
				+2		0	+0																
X46	Y66	83	X	+1		+2	+2	30	50	+2	-19	-23	-7	5½	11		-3	+2	+2	-3	2½	2½	
				+1		+2	+2																
X44	Y66	84	X	+2		+2	+2	35	30	-1	-5	-22	-9	10½	2		-2	0	+2	-1	2	½	
				+2		+2	+2																
X42	Y66	85	X	+1		0	0	30	20	-8	0	0	-4	4	2		+1	+4	+1	-4	0	4	
				+1		0	0																
X40	Y66	86	X	+1		+1	0	20	25	+35	+20	+5	+20	15	0		-6	0	+4	+2	5	4	
				+1		+1	0																
X38	Y66	87	X	+2		0	+1	30	25	-26	-20	-16	-21	5	½		+3	0	-3	-1	3	1½	
				+2		0	+1																
X36	Y66	88	X	+3		+2	+2	30	20	-30	-5	-30	-10	0	2		+2	+3	-2	-1	2	2	
				+3		+1	+1																
X34	Y66	89	X	+1		+4	+4	45	20	-31	-20	-16	-11	2½	1½		0	0	-2	-2	1	1	
				0		+3	+3																
				1		+1	+2																



RESULTS OF LINE - BORING OPERATION

"R" UNIT

IDENFICATION OF TUBES		NEW YORK SHIP NO	ACID	BLUE	GREEN	BORE MEASUREMENTS (BASIC BORE 4.325)						CENTRALITY READING						REMARKS	VERTICALITY READING						REMARKS
						TOP LAND		BOTTOM LAND		SURFACE FINISH		DIRECTION							DIRECTION						
TUBE NO						TOP OF LAND	BOTTOM OF LAND	TOP OF LAND	BOTTOM OF LAND	TOP LAND	BOTTOM LAND	N	E	S	W	AVERAGE CENTRALITY N-S	AVERAGE CENTRALITY E-W		N	E	S	W	AVERAGE VERTICALITY N-S	AVERAGE VERTICALITY E-W	
X54	Y48	1			X	+3 +2		+4 +3	+3 +2	55	30	-10	+7	-2	-19	4	13		-2	-2	+2	+2	2	2	
X52	Y48	2			X	+2 +3		+4 +3	+2 +2	40	30	0	+3	-10	-10	5	6½		-2	+3	+2	-3	2	3	
X50	Y48	3			X	+2 +2		+1 +1	+2 +2	35	25	+1	-11	-10	+2	5½	6½		0	+1	-	-	-	½	
X55	Y51	4		)		+1 +1		+2 +3	+2 +2	40	35	+13	+19	+18	+11	2	4		0	0	0	0	0	0	
X53	Y51	5		)		+2 +3		+3 +5	0 +2	30	45	0	-10	-10	0	5	5		-1	+1	+3	0	.2	½	
X51	Y51	6		)		+1 +2		+3 +3	+2 +1	35	35	+10	+7	+18	+7	4	1		+10	+6	+6	+11	.2	+1½	
X49	Y51	7			X	+1 +1		+3 +3	0 +1	20	35	-8	-10	-8	-6	0	2		+1	+1	+2	+1	½	0	
X47	Y51	8			X	+1 +1		+1 0	0 0	40	40	-2	-18	-9	+5	3½	11½		-2	+1	0	-1	1	1	
X45	Y51	9			X	+1 +1		+4 +6	+4 +4	35	35	-11	+1	-2	-16	4½	8½		0	-2	+1	+1	½	1½	
X43	Y51	10			X	0 +1		+1 +1	+1 +2	30	40	-10	-14	-8	-6	1	4		+1	+2	+4	+2	1½	0	
X41	Y51	11			X	+1 +1		+1 +1	+1 +1	30	25	-9	-11	-8	-5	1½	3		-3	-2	-2	-3	½	½	
X39	Y51	12		)		+2 +3		+2 +2	+2 +2	35	25	-10	-5	0	0	5	2		-1	+1	+1	-1	1	1	
X37	Y51	13			X	0 +1		+2 +2	+2 +2	35	35	-16	-12	-15	-19	1½	3½		+1	0	+2	+1	½	½	
X35	Y51	14			X	+4 +4		+2 +2	+5 +3	45	40	+10	+6	-15	-4	12	5		-4	-4	+2	+2	3	3	
X33	Y51	15			X	0 0		+2 +2	+1 +1	45	50	-24	0	-5	-24	7	10		+2	+2	+2	+2	0	0	
X31	Y51	16			X	+1 +1		+1 +1	+1 +1	40	30	-13	-10	-18	-4	2½	3		+1	0	0	-1	½	½	
X29	Y51	17			X	+2 +2		+2 +3	0 0	40	25	-10	+1	-8	-20	1	10½		0	0	+1	+2	½	1	
X54	Y54	18			X	0 0		+3 +2	+1 0	25	30	+2	-10	-10	+2	6	6½		0	+4	+10	+5	5	½	
X52	Y54	19			X	+1 +1		+3 +3	+2 +2	40	40	0	-10	-20	-5	10	2½		-1	-1	-1	-1	0	0	
X50	Y54	20			X	+2 0		+4 +5	+1 +1	30	45	-5	-24	-25	-14	10	3		-5	+2	+2	-3	3½	2½	
X48	Y54	21			X	+1 +1		+2 +1	0 0	30	20	-8	-12	-10	0	1	6		-1	+3	+2	-2	1½	2½	
X46	Y54	22			X	+2 0		+3 +3	+2 +2	35	40	-8	-12	-7	-7	½	2½		-2	+2	0	-4	1	3	
X44	Y54	23			X	0 +2		+1 0	+3 +2	30	30	-6	+3	-8	-16	1	7½		+4	-1	-2	+2	3	1½	
X42	Y54	24			X	+2 +3		0 0	+2 +2	40	35	-6	+6	-11	-22	2½	14		-1	-2	0	+2	½	2	
X40	Y54	25			X	+3 +5		+6 +6	+3 +3	35	35	-15	-10	-6	-8	4½	1		+1	+1	+3	+3	1	1	
X38	Y54	26			X	+5 +5		+1 +1	0 0	30	40	-12	-12	-17	-17	2½	2½		0	0	2	0	1	0	
X36	Y54	27			X	0 +1		+3 +3	+1 +2	40	35	-22	-11	-12	-26	5	7½		+2	-1	-2	+1	2	1	
X34	Y54	28			X	+2 +1		+1 +1	0 0	60	20	0	0	+10	+5	5	2		0	0	0	0	0	0	
X32	Y54	29			X	0 0		0 0	0 0	45	30	-5	-17	-12	-1	3½	8		-2	+3	+3	-2	2½	2½	
X30	Y54	30			X	0 0		+1 0	+2 +1	25	20	-3	-10	-16	-3	3½	3½		0	+1	-9	-4	0	1	
X28	Y54	31			X	0 +3		+1 +1	+1 0	20	20	0	-15	-7	-19	3½	2		+2	0	0	-2	1	1	



RESULTS OF LINE - BORING OPERATION

"R" UNIT

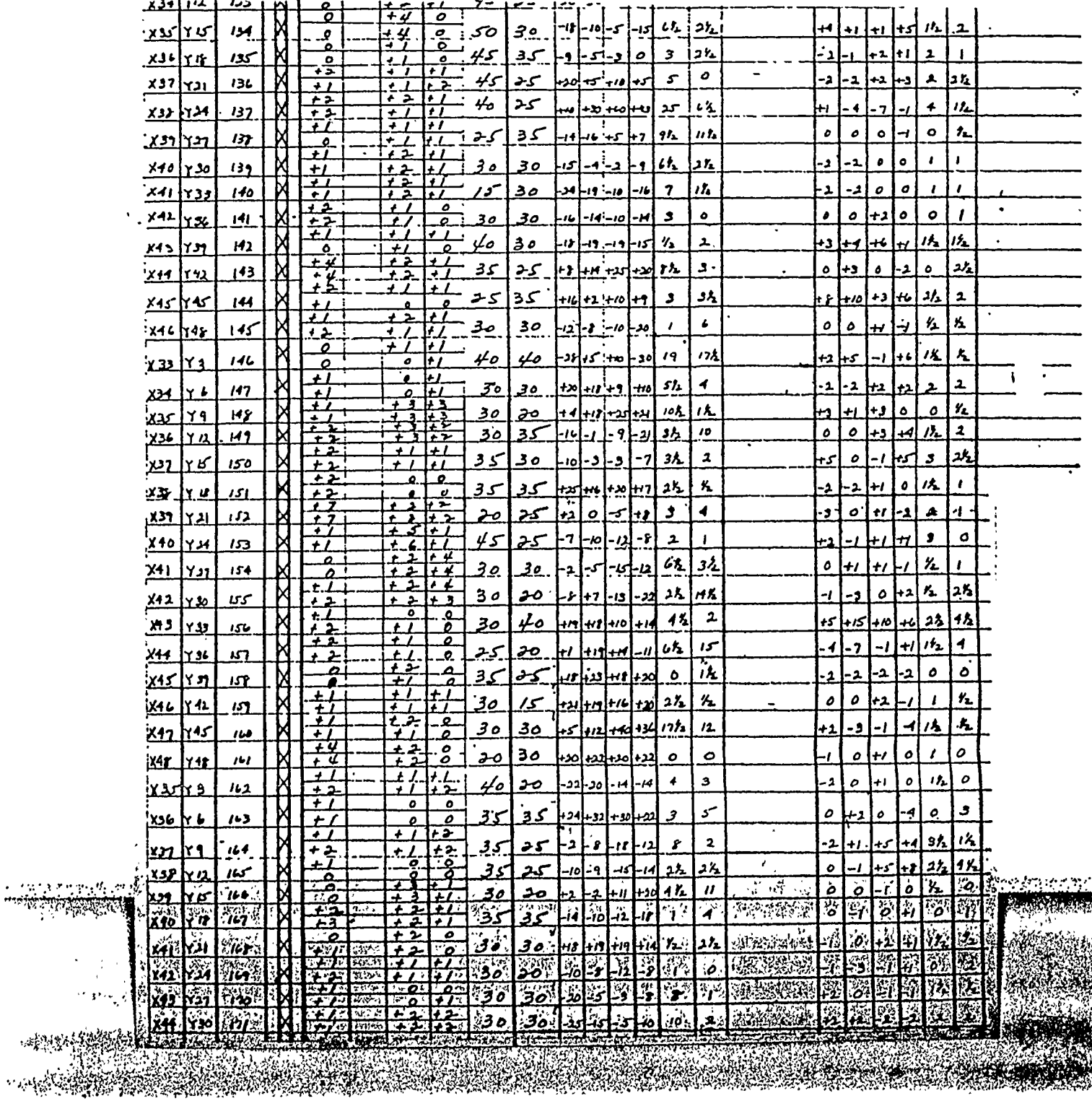
IDENFICATION OF TUBES						BORE MEASUREMENTS (EPSIC BORE 4.386)						CENTRALITY READING							VERTICALITY READING						
						TOP LAND		BOTTOM LAND		SURFACE FINISH		DIRECTION							DIRECTION						
TUBE NO		NEW YORK SHIP NO	RED	BLUE	GREEN	TOP OF LAND	BOTTOM OF LAND	TOP OF LAND	BOTTOM OF LAND	TOP LAND	BOTTOM LAND	N	E	S	W	AVERAGE CENTRALITY N-S	AVERAGE CENTRALITY E-W	REMARKS	N	E	S	W	AVERAGE VERTICALITY N-S	AVERAGE VERTICALITY E-W	REMARKS
X45	Y53	173		X		+3		0	-0	30	20	-5	+5	+12	-4	8½	4½		+1	0	0	-1	½	½	
						+2		0	+1																
X46	Y36	173		X		+1		+1	+2	35	25	-28	-18	0	-17	14	½		-1	-7	-3	+2	1	4½	
						+1		+1	+2																
X47	Y39	174		X		+1		0	0	40	20	-8	+15	+12	-2	10	8½		+3	-3	-3	+3	3	3	
						+1		0	0																
X48	Y42	175		X		0		0	+3	45	30	0	+16	0	-12	0	14		-2	-2	+2	+2	2	2	
						+1		0	+4																
X49	Y45	176		X		+1		0	+3	35	35	0	-2	-5	-2	2½	0		-2	0	0	-2	1	1	
						+1		0	+3																
X38	Y6	177		X		-0		+1	+1	35	25	-20	-10	-8	-15	6	2½		0	-2	+1	+3	½	2½	
						+1		+1	+1																
X39	Y9	178		X		+1		+2	+1	35	30	-3	+9	-8	-7	2½	5		+1	-3	-1	+3	1	3	
						+1		+2	+1																
X40	Y12	179		X		0		+3	+5	40	30	-50	-40	-50	-40	0	10		0	-1	0	+3	0	2	
						0		+3	+4																
X41	Y15	180		X		0		+1	0	30	20	-7	+2	-3	-17	2	9½		-2	-2	0	0	1	1	
						+1		0	0																
X42	Y18	181		X		+1		+2	+3	35	25	10	-6	+4	-3	7	1½		+3	0	0	+4	1½	2	
						+2		+2	+3																
X43	Y21	182		X		+1		+2	+2	35	25	-10	0	-7	-15	1½	7		-2	-3	+3	+2	2½	2½	
						+2		+2	+2																
X44	Y24	183		X		+2		+3	+2	30	30	-5	0	0	-5	2	2		+1	0	-1	0	1	0	
						+3		+3	+2																
X45	Y27	184		X		0		0	0	30	25	+2	-7	-25	-19	13½	6		+6	-2	+1	0	2	1	
						0		0	0																
X46	Y30	185		X		0		0	0	30	40	-12	-11	-11	-8	0	1		-3	-2	+1	0	2	1	
						0		0	0																
X47	Y33	186		X		+2		0	0	20	40	-2	+2	-7	-11	2½	6½		-3	0	+1	-1	2	½	
						+2		0	0																
X48	Y36	187		X		0		+1	0	30	25	+5	+10	0	-5	2	7		-1	-3	+1	+3	1	3	
						0		+1	0																
X49	Y39	188		X		+3		+3	+1	30	30	-17	-20	-6	-5	5½	7½		+3	+2	+2	+1	½	½	
						+2		+2	+1																
X50	Y42	189	X			+3		+2	0	45	35	+19	+3	-8	+19	13½	8		-2	-1	0	-1	1	0	
						+2		+1	0																
X51	Y45	190		X		+1		+1	0	35	20	-9	-8	-3	-6	3	1		0	-1	-2	-1	1	0	
						+1		+1	0																
X40	Y6	191		X		+1		+1	+1	30	45	-20	-8	-12	-20	4	6		+1	-5	+1	+7	0	6	
						+1		+1	+1																
X41	Y9	192		X		+1		+1	+1	25	25	-16	-10	-10	-15	3	2½		+2	+3	+1	+3	½	0	
						+1		+1	0																
X42	Y12	193		X		0		+1	0	40	40	-14	-3	+3	-8	5½	2½		0	-4	-4	+2	2	3	
						+3		+3	+1																
X43	Y15	194		X		+3		+3	+1	30	30	+12	-5	-3	+8	7½	6½		+2	0	-2	0	2	0	
						+1		+2	+1																
X44	Y18	195		X		+1		+2	+1	35	30	+3	-8	-19	+8	8	0		-4	-3	+2	+1	3	2	
						0		+1	+1																
X45	Y21	196		X		+1		+1	0	40	35	-28	-30	-10	-8	9	11		+1	0	0	0	½	0	
						0		0	0																
X46	Y24	197		X		+1		0	0	40	25	-20	-10	-6	-11	7	½		+5	+10	+10	+9	2½	½	
						+3		+1	+1			THIN WALL JACK SCREW BENT TOP OF TUBE													
X47	Y27	198		X		+3		+1	+1	35	20								+1	0	-1	-3	2½	1½	
						+6		0	0																
X48	Y30	199		X		+6		0	0	20	30	-2	-10	-1	0	½	5		+3	+1	-1	-1	2	1	
						+3		+2	+1																
X49	Y33	200		X		+5		+2	+1	25	25	-8	-12	-19	-22	5½	5		+11	+12	+13	+11	1	½	
						+2		+1	+1																
X50	Y36	201		X		+3		+1	+1	30	20	-9	-29	-6	+8	1½	15½		-2	+1	+2	-4	2	1½	
						+2		+1	+2																
X51	Y39	202		X		+2		+1	+2	30	15	+3	-5	-2	+5	2½	5		-2	0	0	-2	1	1	
						+2		+1	+1																
X52	Y42	203		X		+3		+1	+1	35	25	+2	-9	-10	0	6	4		-2	0	0	-2	1	1	

X40	Y6	191		+1		+1	+1	30	45	-20	-8	-12	-20	4	6		+1	-5	+1	+7	0	6
X41	Y9	192		+1		+1	+1	25	25	-16	-10	-10	-15	3	2½		+2	+3	+1	+3	½	0
X42	Y12	193		+1		+1	0	40	40	-14	-9	+3	-8	5½	2½		0	-4	-4	+2	2	3
X43	Y15	194		0		+1	0															
				+3		+3	+1															
X44	Y18	195		+3		+3	+1	30	30	+12	-5	-3	+8	7½	6½		+2	0	-2	0	2	0
X45	Y21	196		+1		+2	+1	35	30	+3	-8	-19	+8	8	0		-4	-3	+2	+1	3	2
X46	Y24	197		0		+1	+1															
X47	Y27	198		+1		+1	0	40	35	-28	-30	-10	-8	9	11		+1	0	0	0	½	0
X48	Y30	199		0		0	0	40	25	-20	-10	-6	-11	7	½		+5	+10	+10	+9	2½	½
X49	Y33	200		+3		+1	+1	35	20	THIN WALL JACK SCREW BEAM TOP OR TUBE							+4	0	-1	-3	2½	1½
X50	Y36	201		+6		0	0															
X51	Y39	202		+6		0	0	20	30	-2	-10	-1	0	½	5		+3	+1	-1	-1	2	1
X52	Y42	203		+3		+2	+1															
X53	Y45	204		+5		+2	+1	25	25	-8	-12	-19	-22	5½	5		+11	+12	+13	+11	1	½
X54	Y9	205		+2		+1	+1															
X55	Y12	206		+3		+1	+1	30	20	-9	-23	-6	+8	1½	15½		-2	+1	+2	-4	2	1½
X56	Y15	207		+2		+1	+2															
X57	Y18	208		+2		+1	+2	30	15	+3	-5	-2	+5	2½	5		-2	0	0	-2	1	1
X58	Y21	209		+2		+1	+1															
X59	Y24	210		+3		+1	+1	35	25	+2	-8	-10	0	6	4		-2	0	0	-2	1	1
X60	Y27	211		+3		+1	0															
X61	Y30	212		+4		+1	0	30	20	-11	+3	-3	-12	4	8½		0	0	0	-2	0	1
X62	Y33	213		+3		+3	0															
X63	Y36	214		+2		+3	+1	35	25	-25	0	+5	-15	15	7½		+2	+2	-1	-2	1½	2
X64	Y39	215		+4		+3	+1															
X65	Y42	216		+3		+3	0	35	20	-18	-13	-16	-17	1	2		1	1	2	2	½	½
X66	Y45	217		+2		+3	0															
X67	Y15	218		+2		+2	+1	35	25	0	-7	-10	-2	5	2½		-5	0	+5	+3	5	1½
X68	Y18	219		+2		+2	+1															
X69	Y21	220		+2		+2	+1	30	50	-15	-6	+8	-6	11½	0		0	-1	+1	+1	½	1
X70	Y24	221		+1		+3	+2															
X71	Y27	222		+3		+3	+1	30	25	+5	+12	-5	-13	5	15		-5	-7	0	+3	2½	4½
X72	Y30	223		+2		+1	+1															
X73	Y33	224		+2		+1	+1	35	25	0	-6	-7	+4	3½	5		0	0	-1	-1	½	½
X74	Y36	225		+4		+1	+2															
X75	Y39	226		+4		+1	+2	30	20	-20	-9	+10	-0	15	4½		-1	-6	0	+2	½	4
X76	Y42	227		+2		0	0															
X77	Y45	228		+2		0	0	20	50	0	-3	-10	-8	5	2½		+7	+7	+10	+11	1½	2
X78	Y15	229		+2		0	0															
X79	Y18	230		+2		0	0	20	25	-2	-12	-10	+6	4	9		-2	+3	+1	-4	1½	3½
X80	Y21	231		+2		0	0															
X81	Y24	232		+2		0	0	25	25	+8	+9	+5	+9	1½	0		+12	+10	+12	+10	0	2
X82	Y27	233		+3		0	0															
X83	Y30	234		+3		0	0	30	25	-8	-4	-16	-23	4	9½		0	0	3	3	1½	1½
X84	Y33	235		+2		+1	+1															
X85	Y36	236		+2		+1	+1	30	30	-18	-18	-12	-5	3	6½		1	1	1	0	0	½
X86	Y39	237		+2		+2	+1															
X87	Y42	238		+2		+2	+1	35	20	+14	+18	+10	-2	2	10		+10	-2	+2	+6	4	4
X88	Y45	239		+1		+4	+1															
X89	Y15	240		+1		+4	+1	30	30	-16	-10	-9	-13	3½	1½		-2	-2	+3	+3	2½	2½
X90	Y18	241		+1		+3	+1															
X91	Y21	242		+1		+2	0	50	40	+14	+18	+20	+10	3	4		-2	-2	+1	0	1½	1
X92	Y24	243		+1		+4	+4															
X93	Y27	244		+1		+5	+5	35	40	-2	-11	-15	-5	6½	3		-4	+1	+3	-1	3½	1
X94	Y30	245		+2		+4	+1															
X95	Y33	246		+2		+4	+1	40	35	-4	-2	0	-1	2	½		+43	+40	+32	+36	5½	2
X96	Y36	247		+3		+3	+2															
X97	Y39	248		+1		+1	+1	20	20	-9	-6	+2	+5	5½	5½		0	0	+1	+2	½	1
X98	Y42	249		+1		+1	0															
X99	Y45	250		+2		+1	+1	20	20	-14	-16	-7	-4	3½	6		0	-2	-2	0	-1	1
X100	Y15	251		+2		+1	+1															
X101	Y18	252		+2		+1	+1	30	20	-19	-8	-7	-15	6	3½		-1	-10	0	0	½	3½
X102	Y21	253		+2		+2	+1															
X103	Y24	254		+2		+2	+1	35	30	+19	+9	+11	+13	9	½		0	-1	-0	+2	0	

RESULTS OF LINE - BORING OPERATION

"R" UNIT

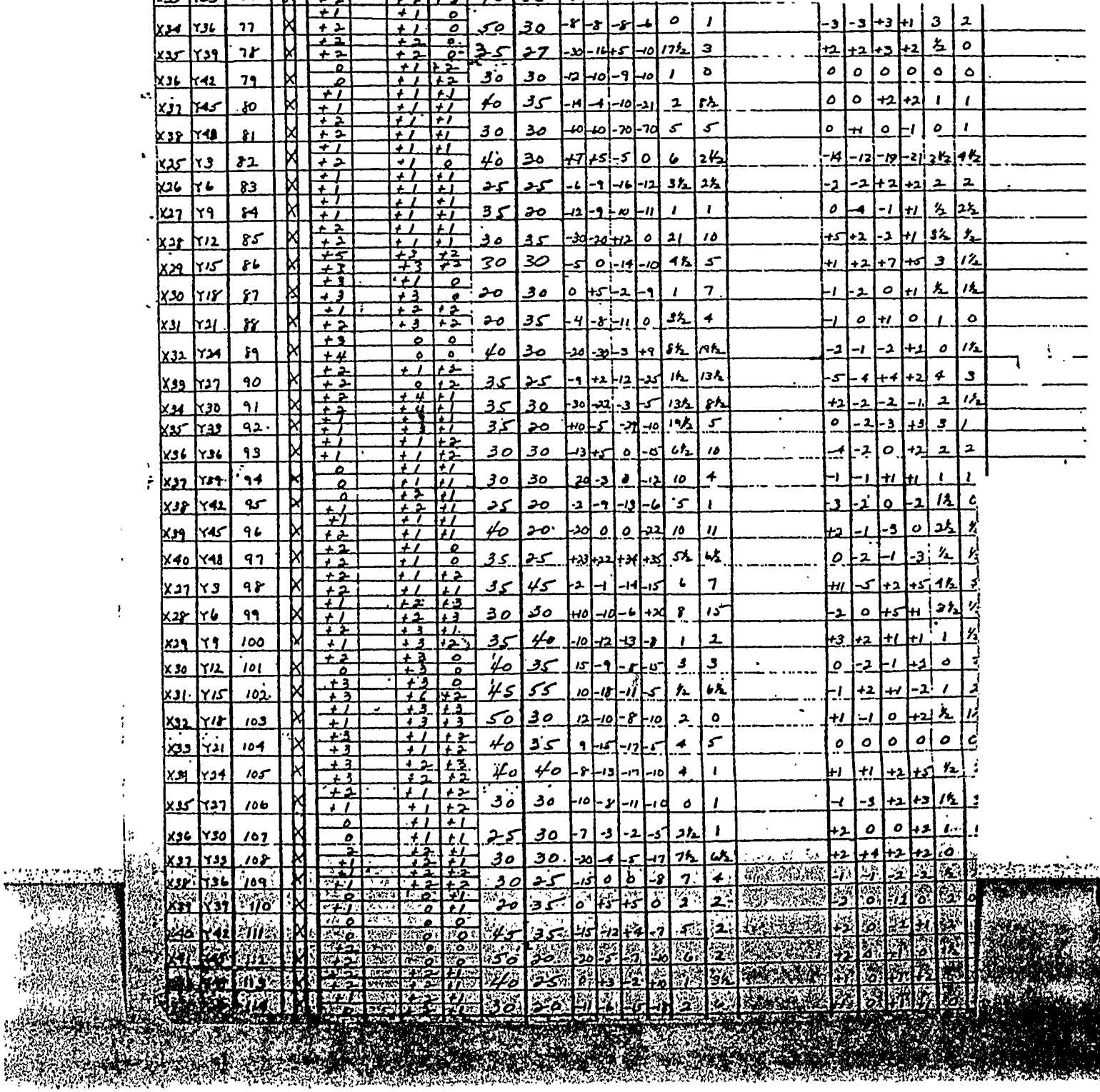
IDENFICATION OF TUBES			BORE MEASUREMENTS (Basic Bore 4.255)						CENTRALITY READING							VERTICALITY READING						
			TOP LAND		BOTTOM LAND		SURFACE FINISH		DIRECTION							DIRECTION						
TUBE NO		NEW YORK SHIP NO	TOP OF LAND	BOTTOM OF LAND	TOP OF LAND	BOTTOM OF LAND	TOP LAND	BOTTOM LAND	N	E	S	W	AVERAGE CENTRALITY N-S	AVERAGE CENTRALITY E-W	REMARKS	N	E	S	W	AVERAGE VERTICALITY N-S	AVERAGE VERTICALITY E-W	REMARKS
X30	Y6	115	+1		0	0	25	30	-35	-42	-40	-40	2½	1		-2	-1	+2	0	2	½	
			+2		0	0																
X31	Y9	116	+1		+4	13	30	30	+45	+44	+48	+45	1½	½		-1	0	-3	0	1	0	
			+1		+4	+3																
X32	Y12	117	+2		+3	+1	30	45	+25	+24	+30	+20	2½	2		-1	0	0	0	½	0	
			+2		+5	+1																
X33	Y15	118	+2		+3	+4	20	25	-22	-19	-18	-24	2	2½		0	-2	0	+2	0	2	
			+1		+3	+4																
X34	Y18	119	0		+2	0	40	20	+30	0	+4	-30	8	15		+2	+2	-4	-4	3	3	
			0		+1	+1																
X35	Y21	120	+1		+1	+4	20	30	-18	-16	-30	-60	1	9		0	0	0	0	0	0	
			+2		+1	+4																
X36	Y24	121	+1		+3	+4	40	35	-5	-15	-5	-2	0	6½		0	0	-1	-2	½	1	
			+1		+3	+2																
X37	Y27	122	+1		+2	+4	35	35	-5	-10	-20	-5	7½	2½		+1	0	+2	0	1	0	
			+1		+1	+3																
X38	Y30	123	+1		+2	+3	35	35	0	+5	+5	0	2	2		-2	0	+2	0	2	0	
			0		+2	+3																
X39	Y33	124	+1		+2	+3	30	40	+30	+35	+38	+30	4	3½		-4	0	-4	0	4	0	
			+1		+2	+3																
X40	Y36	125	+1		+1	+1	35	30	-21	-12	0	-11	10½	½		+2	0	0	+2	1	1	
			+1		+1	+1																
X41	Y39	126	+1		+2	+1	35	25	-15	-3	-10	-19	2½	8		+12	+10	+10	+11	1	½	
			+1		+2	+1																
X42	Y42	127	+2		+2	+1	30	35	-30	-6	-5	-10	7½	2		-1	-2	-1	-1	0	½	
			+2		+2	+1																
X43	Y45	128	+1		0	0	30	30	0	-2	0	-8	0	3		+1	0	+1	+1	0	½	
			+1		0	+1																
X44	Y48	129	+2		+2	+1	35	50	-10	-3	-2	-2	4	½		+3	+4	+1	+1	1	1½	
			+2		+1	+2																
X31	Y3	130	+1		+1	+1	25	20	+3	+30	+37	+10	16½	5		0	0	0	0	0	0	
			0		+1	+1																
X32	Y6	131	0		+2	0	40	25	-18	-9	-12	-16	3	3½		-1	-1	0	+1	0	1	
			0		+5	0																
X33	Y9	132	0		+5	0	40	40	-30	0	+5	-12	12½	6		+1	-2	0	+5	½	3½	
			+1		+2	+1																
X34	Y12	133	0		+2	+1	45	25	-20	-20	-10	-5	5	7½		+1	0	0	+3	½	1½	
			0		+4	0																
X35	Y15	134	0		+4	0	50	30	-18	-10	-5	-15	6½	2½		+4	+1	+1	+5	1½	2	
			0		+1	0																
X36	Y18	135	0		+1	0	45	35	-9	-5	-3	0	3	2½		-2	-1	+2	+1	2	1	
			+2		+1	+1																
X37	Y21	136	+1		+1	+2	45	25	+20	+5	+10	+5	5	0		-2	-2	+2	+3	2	3½	
			+2		+2	+1																
X38	Y24	137	+2		+1	+1	40	25	+40	+30	+40	+40	25	6½		+1	-4	-7	-1	4	11½	
			+1		+1	+1																
X39	Y27	138	0		+1	+1	25	35	-14	-16	+5	+7	9½	11½		0	0	0	-1	0	½	
			+1		+2	+1																
X40	Y30	139	+1		+2	+1	30	30	-15	-4	-3	-9	6½	3½		-2	-2	0	0	1	1	
			+1		+2	+1																
X41	Y33	140	+1		+2	+1	15	30	-24	-19	-10	-16	7	1½		-2	-2	0	0	1	1	
			+2		+1	0																
X42	Y36	141	+2		+1	0	30	30	-16	-14	-10	-14	3	0		0	0	+2	0	0	1	
			+1		+1	+1																
X43	Y39	142	0		+1	0	40	30	-18	-19	-19	-15	1½	2		+3	+4	+6	+1	1½	1½	
			+4		+2	+1																
X44	Y42	143	+4		+2	+1	35	25	+3	+14	+25	+20	7½	3		0	+3	0	-2	0	2½	
			+2		+1	+1																
X45	Y45	144	+1		0	0	25	35	+16	+2	+10	+9	3	3½		+5	+10	+3	+6	3½	2	
			+1		+2	+1																
X46	Y48	145	+2		+1	+1	30	30	-12	-8	-10	-30	1	6		0	0	+1	-1	½	½	
			0		+1	+1																
X33	Y3	146	0		0	+1	40	40	-28	+5	+10	-30	19	17½		+2	+5	-1	+6	1½	½	
			+1		0	+1																



RESULTS OF LINE - BORING OPERATION

"R" UNIT

IDENFICATION OF TUBES						BORE MEASUREMENTS (BASIC BORE .1585)						CENTRALITY READING							VERTICALITY READING						
						TOP LAND		BOTTOM LAND		SURFACE FINISH		DIRECTION							DIRECTION						
TUBE NO		NEW YORK SHIP NO	RED	BLUE	GREEN	TOP OF LAND	BOTTOM OF LAND	TOP OF LAND	BOTTOM OF LAND	TOP LAND	BOTTOM LAND	N	E	S	W	AVERAGE CENTRALITY N-S	AVERAGE CENTRALITY E-W	REMARKS	N	E	S	W	AVERAGE VERTICALITY N-S	AVERAGE VERTICALITY E-W	REMARKS
X29	Y27	58		X		+1		0	+1	30	30	-12	-9	-9	-12	1½	1½		+14	+13	+13	+13	½	0	
						+1		+1	+1																
X30	Y30	59		X		+1		0	+1	30	30	-21	-12	-4	-11	6	0		0	-3	-5	-2	2½	½	
						+1		0	+1																
X31	Y33	60		X		+1		+1	+2	35	30	0	0	0	0	0	0		0	-0	0	0	0	0	
						+1		+1	+2																
X32	Y36	61		X		+1		0	0	35	40	-20	-20	-25	-25	5	2½		-2	-3	-4	-3	1	0	
						+1		0	0																
X33	Y39	62		X		+1		0	+2	40	40	-12	-12	-7	-10	2½	1		0	-1	0	0	0	½	
						+2		0	+2																
X34	Y42	63		X		+1		+2	0	35	20	-20	-2	+2	-19	11	8		0	-5	-2	+3	1	4	
						+1		+2	0																
X35	Y45	64		X		0		+2	+1	30	30	+3	+3	-3	-7	3	5		0	0	+1	+1	½	½	
						+1		+2	+1																
X36	Y48	65		X		+1		+3	+1	40	20	-8	-17	-10	-5	1	1½		-1	-2	0	0	½	1	
						+1		+3	+1																
X23	Y3	66		X		+1		+1	0	40	20	-3	-3	+10	+10	6½	6½		-15	-12	-18	-20	1½	4	
						+4		+1	0																
X24	Y6	67		X		+2		+1	+1	45	35	0	+20	+2	-18	1	19		-21	-13	-14	-23	3½	5	
						+1		+1	+1																
X25	Y9	68		X		+2		0	0	35	30	-10	-17	-10	-9	0	6½		-1	0	0	0	½	0	
						+2		0	0																
X26	Y12	69		X		+2		+2	0	30	45	-10	-20	-5	-5	2½	7½		-3	-3	0	-1	1½	1	
						+2		+4	+1																
X27	Y15	70		X		+4		0	0	30	30	-30	-12	+9	-8	19	2		+2	+2	+7	+3	2½	½	
						+2		0	0																
X28	Y18	71		X		+3		+6	+2	35	30	-20	-10	-6	-12	7	1		+2	-1	0	+3	1	2	
						+3		+6	+2																
X29	Y21	72		X		+1		+2	0	50	25	-20	+6	+2	-23	11	14½		+2	-5	-3	+5	2	5	
						+1		+2	0																
X30	Y24	73		X		+1		+2	+1	30	35	-20	-15	-10	-20	5	2		+2	-1	-2	-1	2	0	
						+1		+2	+1																
X31	Y27	74		X		+1		+2	+2	25	30	+5	+3	-7	6	6	1½		-5	-3	+5	+3	5	3	
						+2		+3	+2																
X32	Y30	75		X		+1		+1	+1	25	30	-10	-11	-11	-10	½	½		0	-2	-0	+2	0	2	
						+1		+1	+1																
X33	Y33	76		X		+2		+2	+2	40	35	-18	-1	-8	-20	5	9		0	+2	+2	0	1	1	
						+2		+2	+3																
X34	Y36	77		X		+1		+1	0	50	30	-8	-8	-8	-6	0	1		-3	-3	+3	+1	3	2	
						+2		+1	0																
X35	Y39	78		X		+2		+2	0	35	27	-30	-16	+5	-10	17½	3		+2	+2	+3	+2	½	0	
						+2		+2	0																
X36	Y42	79		X		0		+1	+2	30	30	-12	-10	-9	-10	1	0		0	0	0	0	0	0	
						0		+1	+2																
X37	Y45	80		X		+1		+1	+1	40	35	-14	-4	-10	-21	2	8½		0	0	+2	+2	1	1	
						+1		+1	+1																
X38	Y48	81		X		+2		+1	+1	30	30	-60	-60	-70	-70	5	5		0	+1	0	-1	0	1	
						+2		+1	+1																
X25	Y3	82		X		+1		+1	+1	40	30	+7	+5	-5	0	6	2½		-14	-12	-19	-21	2½	4½	
						+2		+1	0																
X26	Y6	83		X		+1		+1	+1	25	25	-6	-9	-16	-12	3½	2½		-2	-2	+2	+2	2	2	
						+1		+1	+1																
X27	Y9	84		X		+1		+1	+1	35	20	-12	-9	-10	-11	1	1		0	-4	-1	+1	½	2½	
						+1		+1	+1																
X28	Y12	85		X		+2		+1	+1	30	35	-30	-20	+12	0	21	10		+5	+2	-2	+1	3½	½	
						+2		+1	+1																
X29	Y15	86		X		+5		+3	+2	30	30	-5	0	-14	-10	4½	5		+1	+2	+7	+5	3	1½	
						+3		+3	+3																
X30	Y18	87		X		+3		+1	0	20	30	0	+5	-2	-9	1	7		-1	-2	0	+1	½	1½	
						+3		+3	0																
X31	Y21	88		X		+1		+2	+2	20	35	-4	-8	-11	0	3½	4		-1	0	+1	0	1	0	
						+2		+3	+2																
X32	Y24	89		X		+3		0	0	40	30	-20	-31	-3	+9	8½	19½		-3	-1	-2	+2	0	1½	
						+4		0	0																



RESULTS OF LINE - BORING OPERATION

"R" UNIT

IDENFICATION OF TUBES						BORE MEASUREMENTS (BASIC BORE 4.125)						CENTRALITY READING							VERTICALITY READING						
						TOP LAND		BOTTOM LAND		SURFACE FINISH		DIRECTION				AVERAGE CENTRALITY		REMARKS	DIRECTION				AVERAGE VERTICALITY		REMARKS
TUBE NO		NEW YORK SHIP NO	CAST	FORGE	BORE	TOP OF LAND	BOTTOM OF LAND	TOP OF LAND	BOTTOM OF LAND	TOP LAND	BOTTOM LAND	N	E	S	W	N-S	E-W		N	E	S	W	N-S	E-W	
X22	Y30	1			X	+1		0	-0	25	20	-6	-6	+6	+8	6	7		0	-3	-1	0	1	1	
X23	Y33	2			X	+1		0	0																
						+4		+1	+2	30	30	-10	-10	+5	0	7	5		0	-2	0	+2	0	2	
X24	Y36	3			X	+4		+1	+2																
						+1		+3	+2	25	25	-20	0	-5	-20	7	10		+1	-2	0	+3	1/2	2 1/2	
X25	Y39	4			X	+1		+3	+3																
						+1		+2	0	25	25	-16	-13	-6	-13	5	0		+12	+10	+10	+13	1	1 1/2	
X16	Y6	5			X	+2		+1	0																
						+1		0	0	20	30	+15	+17	+11	+22	2	3 1/2		0	+1	0	-1	0	1	
X17	Y9	6			X	+1		0	0																
						+1		+2	+2	20	30	-7	+9	-1	-12	3	10 1/2		-2	-5	-2	+2	0	3 1/2	
X18	Y12	7			X	+1		+2	+2																
						+1		+2	+4	20	30	-3	0	-17	-13	7	6 1/2		-2	-2	+1	+2	1 1/2	1 1/2	
X19	Y15	8			X	+2		+2	3																
						0		+1	+2	40	25	+12	+14	+8	+9	3	2 1/2		0	0	0	0	0	0	
X30	Y18	9			X	0		+1	+2																
						0		+2	+2	40	35	10	-10	-10	-10	0	0		+1	+1	+6	+6	3 1/2	3 1/2	
X31	Y21	10			X	0		+2	+2																
						+2		0	0	50	35	+1	+2	-10	-17	7	9 1/2		+2	+5	-2	-4	2	4 1/2	
X32	Y24	11			X	+2		+2	0																
						+1		+2	0	25	50	-19	-5	0	-10	9 1/2	2 1/2		-1	-1	-1	+1	0	1	
X33	Y27	12			X	+2		+1	+2																
						+2		0	+2	30	20	-58	-21	-30	-35	14	7		-7	-3	+1	-2	4	1/2	
X34	Y30	13			X	+1		+6	+1																
						+1		+5	+2	35	20	-26	-20	0	-11	13	4 1/2		-1	-3	-3	-3	1	0	
X35	Y33	14			X	+2		+1	0																
						+2		+1	0	20	35	-24	-12	+2	-16	13	2		+11	+15	+16	+12	2	1 1/2	
X36	Y36	15			X	+2		+2	+4																
						+2		+1	+4	25	15	+29	-2	-22	+2	25 1/2	2		-12	-10	-20	-21	4	5 1/2	
X27	Y39	16			X	+1		+1	+2																
						+2		+1	+2	25	25	+11	+18	-14	-8	12 1/2	10 1/2		-10	-14	-20	-24	5	5	
X38	Y42	17			X	+2		+1	1																
						0		+1	+1	40	30	-10	-5	+5	0	7	2		0	+2	-1	+1	0	1	
X29	Y45	18			X	+2		+1	+1																
						+2		+1	0	25	25	+2	-5	-7	+2	4 1/2	3 1/2		-7	-2	+2	-3	4 1/2	5 1/2	
X30	Y48	19			X	0		0	0																
						+1		0	0	30	25	+31	+31	+31	+31	0	0		0	0	+2	+3	1	1 1/2	
X18	Y6	20			X	+1		+3	+2																
						+1		+3	+2	25	30	-20	-13	-2	-5	9	4		+1	0	-1	0	1	0	
X19	Y9	21			X	0		0	0																
						0		0	0	20	25	-20	-11	+8	-5	14	3		+3	+1	-3	-1	3	1	
X20	Y12	22			X	+3		0	0																
						+3		0	0	30	30	-6	-11	-8	-9	1	1		+2	-1	+1	+4	1 1/2	2 1/2	
X21	Y15	23			X	+3		0	0																
						+3		0	0	30	40	-8	+2	-5	-10	1 1/2	6		-1	-2	-1	+2	0	2	
X22	Y18	24			X	+1		+1	0																
						+1		+1	0	30	40	-8	-8	-8	+2	0	10		0	-1	0	+1	0	1	
X23	Y21	25			X	+3		+2	+1																
						+3		+2	+1	40	40	-9	+2	+1	-7	5	4 1/2		0	-3	1	0	1/2	1 1/2	
X24	Y24	26			X	+5		0	+1																
						+5		0	+1	35	30	-12	-2	0	-20	6	9		-2	0	+1	-2	1 1/2	1	
X25	Y27	27			X	+1		+1	+1																
						+2		+1	+1	40	15	+10	+5	-5	-4	7 1/2	4 1/2		-2	-4	+2	0	2	2	
X26	Y30	28			X	+1		+2	+2																
						+1		+1	+2	30	20	-5	+7	+11	-2	8	4 1/2		+1	-3	-1	+2	1	2 1/2	
X27	Y33	29			X	+2		+2	+2																
						+2		0	+2	30	30	+8	-9	-16	+10	12	9 1/2		-17	-9	-20	-24	1 1/2	7 1/2	
X28	Y36	30			X	+1		+2	0																
						+1		+1	0	25	20	-11	-2	+18	+8	14 1/2	5		-16	-15	-17	-19	1/2	2	
X29	Y39	31			X	0		+2	0																
						+1		+2	0	25	25	-20	+18	+17	-16	18 1/2	17		-13	-12	-18	-19	2 1/2	3 1/2	
X30	Y42	32			X	+2		+1	0																
						+2		0	0	30	20	-12	-9	0	-5	6	2		-1	0	0	-1	1/2	1/2	

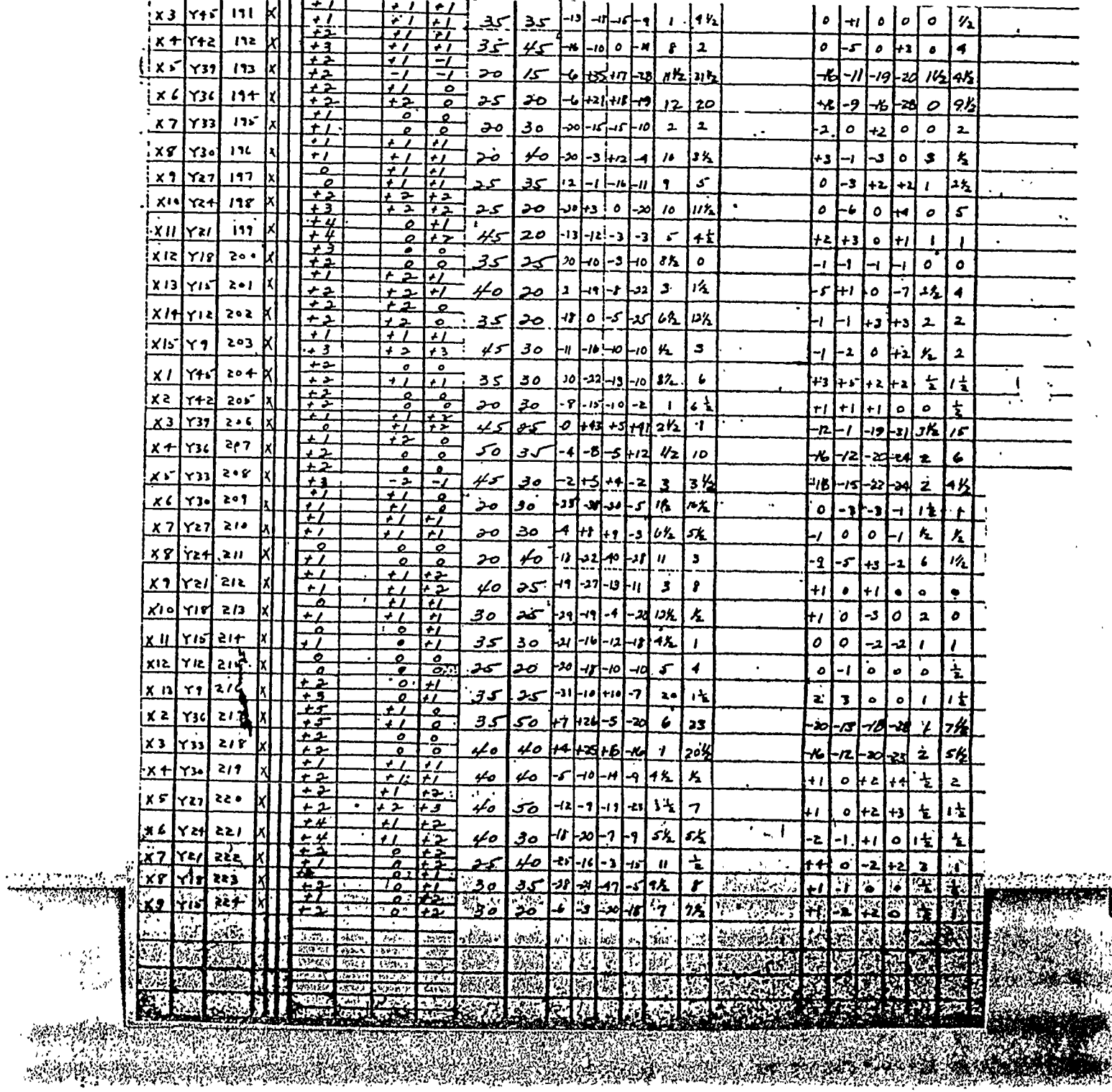
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RESULTS OF LINE - BORING OPERATION 12-4

"R" UNIT

12-4

IDENFICATION OF TUBES						BORE MEASUREMENTS (Basic Sheet 4-385)						CENTRALITY READING							VERTICALITY READING						
						TOP LAND		BOTTOM LAND		SURFACE FINISH		DIRECTION				AVERAGE CENTRALITY			DIRECTION				AVERAGE VERTICALITY		
TUBE NO.		NEW YORK SHIP NO	ADD	ALTER	ABAN	TOP OF LAND	BOTTOM OF LAND	TOP OF LAND	BOTTOM OF LAND	TOP LAND	BOTTOM LAND	N	E	S	W	N-S	E-W	REMARKS	N	E	S	W	N-S	E-W	REMARKS
X16	Y18	172	X			+4		0	-0																
						+4		0	0	30	40	-20	+6	+8	-20	14	13		+2	-4	-2	+4	2	4	
X17	Y15	173	X			+1		+1	+1																
						+1		+1	+1	30	20	-4	-17	-15	-1	6½	8		-2	0	-9	-4	1	2	
X2	Y54	174	X			+1		+1	0																
						+1		+1	+1	45	30	-20	0	-5	-16	7½	8		-1	+5	0	-4	½	4½	
X3	Y51	175	X			+2		0	0																
						+3		0	0	40	35	-22	-22	+4	0	13	11		0	-5	-2	+5	1	5	
X4	Y48	176	X			+1		+1	+2½																
						+1		+1	+3	20	30	-24	-12	-5	-10	9½	1		+1	-1	-2	0	1½	½	
X5	Y45	177	X			0		+2	0																
						0		+2	-0	30	30	+10	+23	+33	+26	7½	1½		+2	-2	-3	-1	2½	½	
X6	Y42	178	X			+1		+1	+1																
						+1		+1	+1	25	25	-22	-15	+5	-5	13½	5		0	-2	-2	0	1	1	
X7	Y39	179	X			0		+2	+2																
						0		+2	+2	20	25	-2	-4	+10	+8	6	4		0	-1	-2	-1	1	0	
X8	Y36	180	X			+5		+1	+1																
						+5		+1	+1	20	45	-12	-5	-5	-12	3½	3½		0	-2	-1	+1	½	1½	
X9	Y33	181	X			+2		+3	+1																
						+2		+3	+1	20	40	-29	-25	-27	-23	1	1		+1	0	-2	+1	1½	½	
X10	Y30	182	X			+5		+3	+2																
						+5		+3	+2	20	40	-20	-10	+4	-7	12	1½		+5	-1	-5	0	5	½	
X11	Y27	183	X			+1		+2	+2																
						+1		+2	+2	20	25	-23	-25	-28	-27	½	½		+10	+11	+11	+12	½	½	
X12	Y24	184	X			+3		+2	+1																
						+3		+2	+1	35	35	32	0	+16	-26	21	10		-4	+12	+3	-8	3½	10	
X13	Y21	185	X			+2		+2	+2																
						+3		+2	+2	30	40	-20	-10	-10	-20	5	5		0	-2	0	+2	0	2	
X14	Y18	186	X			+2		+1	+2																
						+2		+1	+2	35	25	-12	-4	-4	-14	6½	5		+18	+5	+7	+10	5½	2½	
X15	Y15	187	X			+2		+1	+1																
						+3		0	0	35	20	-13	-12	-8	-15	2½	1½		-1	-1	+1	+3	1	2	
X16	Y12	188	X			+2		+1	+1																
						+2		0	+1	30	30	-9	-12	-18	-5	4½	1½		-4	-3	-1	-1	1½	1	
X1	Y51	189	X			+1		+2	+1																
						+1		+1	-8	45	30	-12	-7	-8	-13	2	3		+16	+11	+14	+10	1	2	
X2	Y48	190	X			+3		+3	0																
						+2		+3	0	20	40	-7	-12	-2	+9	2½	10½		+6	-1	-6	0	6	½	
X3	Y45	191	X			+1		+1	+1																
						+1		+1	+1	35	35	-13	-11	-16	-9	1	9½		0	+1	0	0	0	½	
X4	Y42	192	X			+2		+1	+1																
						+3		+1	+1	35	45	-16	-10	0	-14	8	2		0	-5	0	+2	0	4	
X5	Y39	193	X			+2		+1	-1																
						+2		-1	-1	20	15	-6	+35	+17	-28	11½	21½		-16	-11	-19	-20	16½	4½	
X6	Y36	194	X			+2		+1	0																
						+2		+2	0	25	20	-6	+21	+18	-19	12	20		+12	-9	-16	-28	0	9½	
X7	Y33	195	X			+1		0	0																
						+1		0	0	20	30	-20	-15	-15	-10	2	2		-2	0	+2	0	0	2	
X8	Y30	196	X			+1		+1	+1																
						+1		+1	+1	20	40	-20	-3	+12	-4	10	3½		+3	-1	-3	0	3	½	
X9	Y27	197	X			0		+1	+1																
						0		+1	+1	25	35	12	-1	-16	-11	9	5		0	-3	+2	+2	1	2½	
X10	Y24	198	X			+2		+2	+2																
						+3		+2	+2	25	20	-30	+3	0	-20	10	11½		0	-6	0	+9	0	5	
X11	Y21	199	X			+4		0	+1																
						+4		0	+2	45	20	-13	-12	-3	-3	5	4½		+2	+3	0	+1	1	1	
X12	Y18	200	X			+3		0	0																
						+2		0	0	35	25	20	-10	-3	-10	8½	0		-1	-9	-1	-1	0	0	
X13	Y15	201	X			+1		+2	+1																
						+2		+2	+1	40	20	2	-19	-8	-32	3	1½		-5	+1	0	-7	2½	4	
X14	Y12	202	X			+2		+2	0																
						+2		+2	0	35	20	18	0	-5	-25	6½	12½		-1	-1	+3	+3	2	2	
X15	Y9	203	X			+1		+1	+1																
						+3		+2	+3	45	30	-11	-16	-10	-10	1½	3		-1	-2	0	+2	½	2	

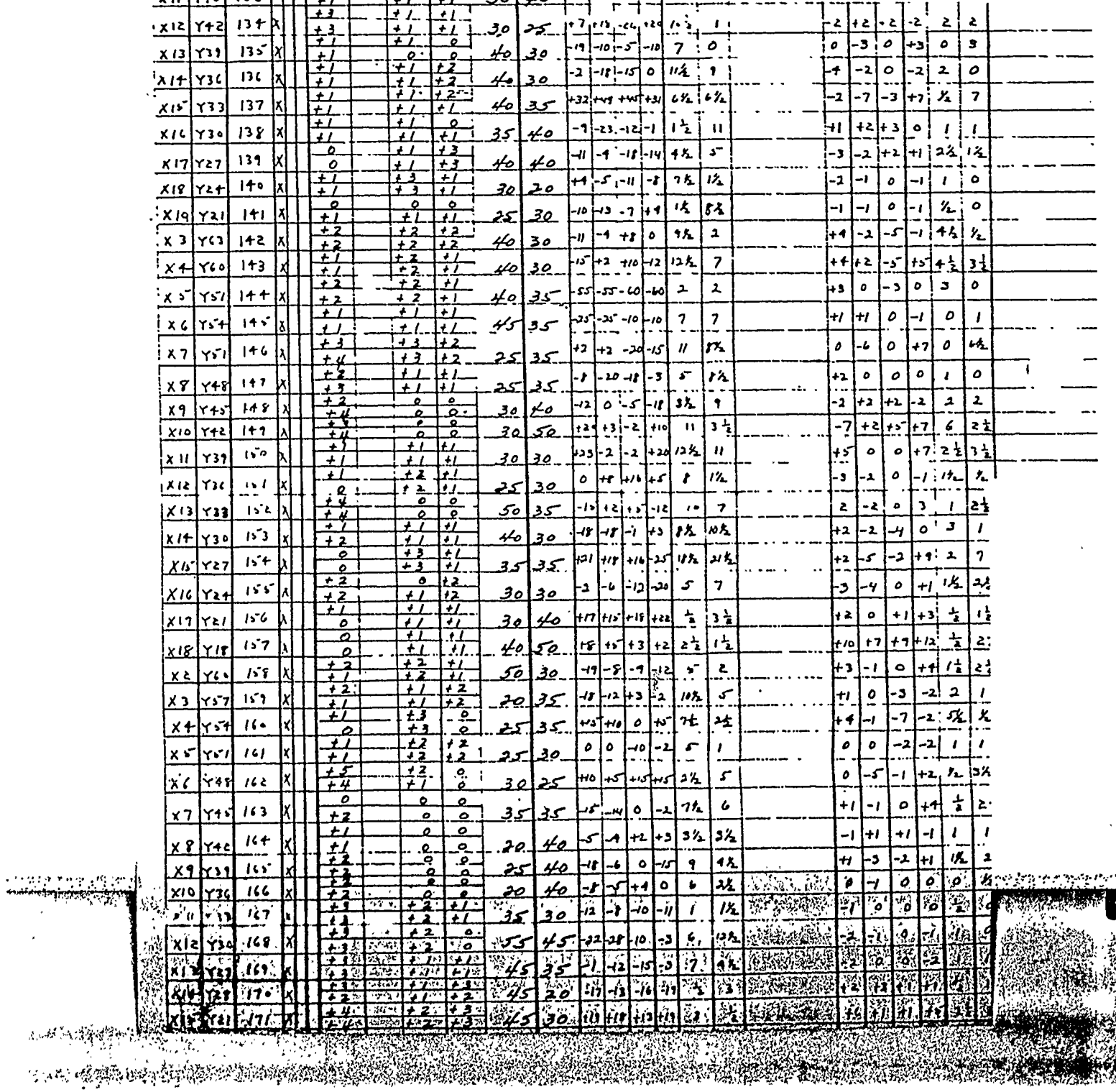


RESULTS OF LINE - BORING OPERATION

"R" UNIT

BASIC BORE 4.306

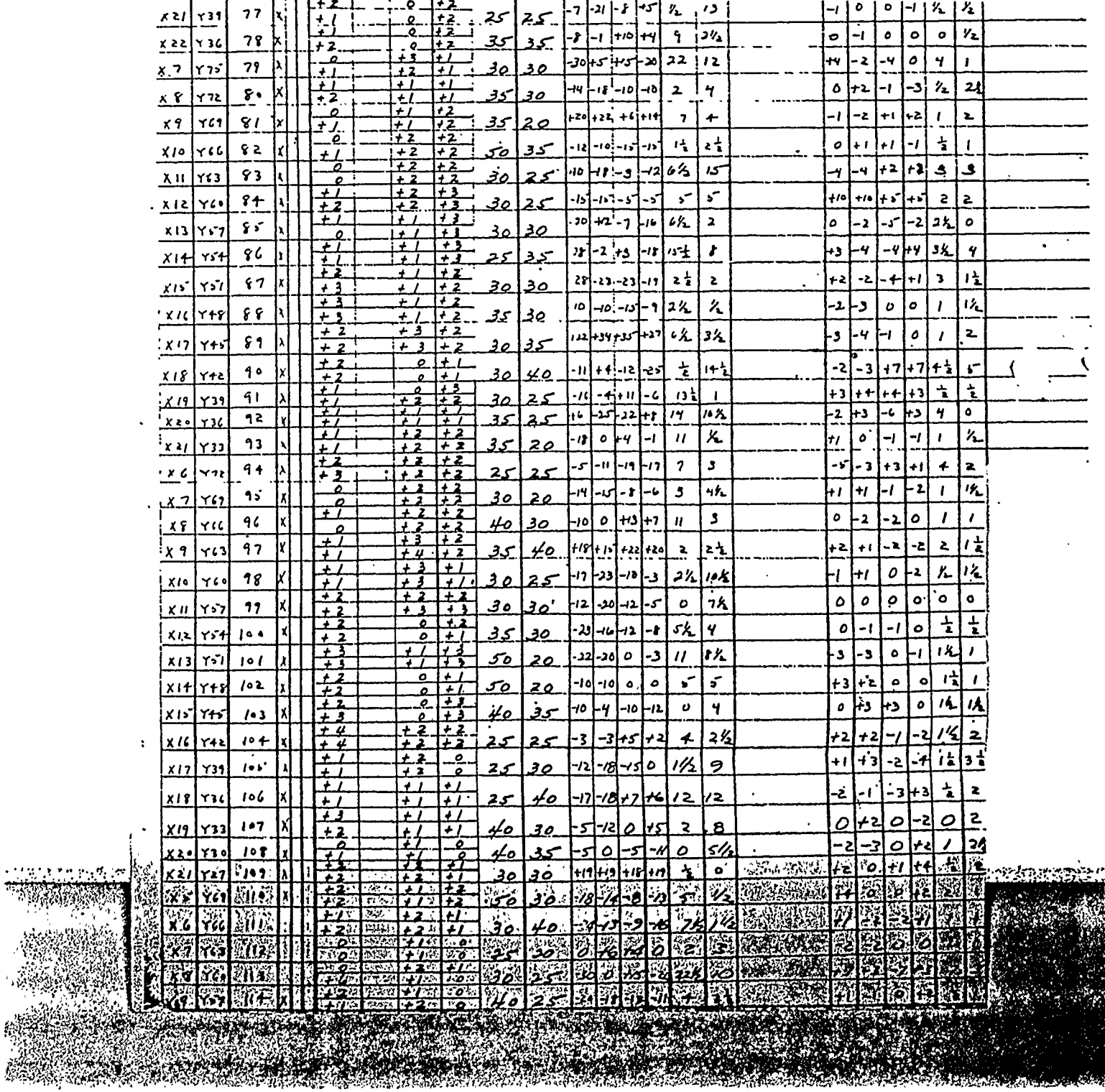
IDENFICATION OF TUBES						BORE MEASUREMENTS						CENTRALITY READING							VERTICALITY READING						
TUBE NO		NEW YORK SHIP NO	RED	BLUE	GREEN	TOP LAND		BOTTOM LAND		SURFACE FINISH		DIRECTION						REMARKS	DIRECTION						REMARKS
						TOP OF LAND	BOTTOM OF LAND	TOP OF LAND	BOTTOM OF LAND	TOP LAND	BOTTOM LAND	N	E	S	W	AVERAGE CENTRALITY N-S	AVERAGE CENTRALITY E-W		N	E	S	W	AVERAGE VERTICALITY N-S	AVERAGE VERTICALITY E-W	
X10	Y54	115	X			+2 +2		+2 +2	0 0	45	20	+8	-2	-28	-12	14	5		0	-1	0	0	0	½	
X11	Y51	116	X			0 +1		+2 +3	0 0	40	25	-9	+3	+19	+4	14	½		+2	-3	-3	+2	2½	2½	
X12	Y48	117	X			+2 +3		0 0	+2 +2	45	35	-13	-18	-8	-8	2½	5		+1	0	-1	0	1	0	
X13	Y45	118	X			+4 +4		+1 +1	+1 +1	40	25	-15	-11	-10	-10	2½	½		0	3	0	0	0	1½	
X14	Y42	119	X			+4 +4		+1 +1	+2 +2	45	25	-9	-9	-5	-13	½	5		0	0	0	0	0	0	
X15	Y39	120	X			+1 +3		+1 +1	+2 +2	40	30	-2	-18	-12	+3	5	11½		-5	-2	+3	0	4	1	
X16	Y36	121	X			+1 +2		+2 +1	0 +1	30	45	-26	-27	-22	-25	2	1		+12 +2	+8 +1	+10 0	+13 +2	1 1	2½ ½	
X17	Y33	122	X			+1 0		+1 +1	+1 +1	30	45	+11	-6	-21	-6	16	0		-4	-1	+4	+1	4	4	
X18	Y30	123	X			+1 +1		+1 +2	+2 +2	35	40	-29	-12	-5	-9	9½	1½		0	+1	0	-1	0	1	
X19	Y27	124	X			+1 +2		+1 +1	0 0	35	35	-18	-16	-3	-3	7½	6½		+2	+1	0	+1	1	0	
X20	Y24	125	X			+1 +1		+1 +1	0 +1	50	30	-15	-8	-9	-19	3	2½		-1	-2	0	0	½	1	
X4	Y66	126	X			+1 +1		+1 +1	0 0	25	35	-9	-9	-11	-10	1	½		-1	-1	-1	+1	0	1	
X5	Y63	127	X			0 0		+1 0	+2 +2	35	25	-5	-7	0	+7	2½	7		+2	0	-2	0	2	0	
X6	Y60	128	X			+3 +3		+1 +1	0 0	40	35	-5	-5	+7	+10	6	7½		+2	-1	-1	+2	1½	1½	
X7	Y57	129	X			+1 +1		+1 +1	+1 +1	40	40	+6	-5	+11	-4	2½	½		+2	+3	-2	0	2	1½	
X8	Y54	130	X			+1 +1		+1 +1	+2 +2	45	40	+17	+19	+19	+19	0	0		+1	+1	+1	+2	0	½	
X9	Y51	131	X			+4 +4		+1 0	+2 +2	30	45	0	-5	-15	-10	7	2		-1	-4	+1	+4	1	4	
X10	Y48	132	X			+2 +2		+1 +1	0 0	35	30	-9	-18	-2	+5	2	13		0	-2	-1	-5	1	3	
X11	Y45	133	X			+1 +1		+1 +1	+1 +1	50	40	0	-7	-5	-23	7½	8		-3	-6	+2	+5	2½	5½	
X12	Y42	134	X			+3 +3		+1 +1	+1 +1	30	25	+7	+18	-24	+25	12½	1		-2	+2	+2	-2	2	2	
X13	Y39	135	X			+1 +1		+1 0	0 0	40	30	-19	-10	-5	-10	7	0		0	-3	0	+3	0	3	
X14	Y36	136	X			+1 +1		+1 +1	+2 +2	40	30	-2	-18	-15	0	11½	9		-4	-2	0	-2	2	0	
X15	Y33	137	X			+1 +1		+1 +1	+2 +1	40	35	+32	+49	+47	+31	6½	6½		-2	-7	-3	+7	½	7	
X16	Y30	138	X			+1 +1		+1 +1	0 +1	35	40	-9	-23	-12	-1	1½	11		+1	+2	+3	0	1	1	
X17	Y27	139	X			0 0		+1 +1	+3 +3	40	40	-11	-9	-18	-14	4½	5		-3	-2	+2	+1	2½	1½	
X18	Y24	140	X			+1 +1		+3 +3	+1 +1	30	20	+9	-5	-11	-8	7½	1½		-2	-1	0	-1	1	0	
X19	Y21	141	X			0 +1		0 +1	0 +1	25	30	-10	-13	-7	+1	1½	8½		-1	-1	0	-1	½	0	
X3	Y63	142	X			+2 +2		+2 +2	+2 +2	40	30	-11	-9	+8	0	9½	2		+4	-2	-5	-1	4½	½	
X4	Y60	143	X			+1 +1		+2 +2	+1 +1	40	30	-15	+2	+10	-12	12½	7		+4	+2	-5	+5	4½	3½	
X5	Y51	144	X			+2 +2		+2 +2	+1 +1	40	35	-55	-55	-60	-60	2	2		+3	0	-3	0	3	0	
X6	Y54	145	X			+1 +1		+1 +1	+1 +1	45	35	-25	-25	-10	-10	7	7		+1	+1	0	-1	0	1	
X7	Y51	146	X			+3 +4		+3 +3	+2 +2	25	35	+2	+2	-20	-15	11	8½		0	-6	0	+7	0	6½	



RESULTS OF LINE - BORING OPERATION

"R" UNIT

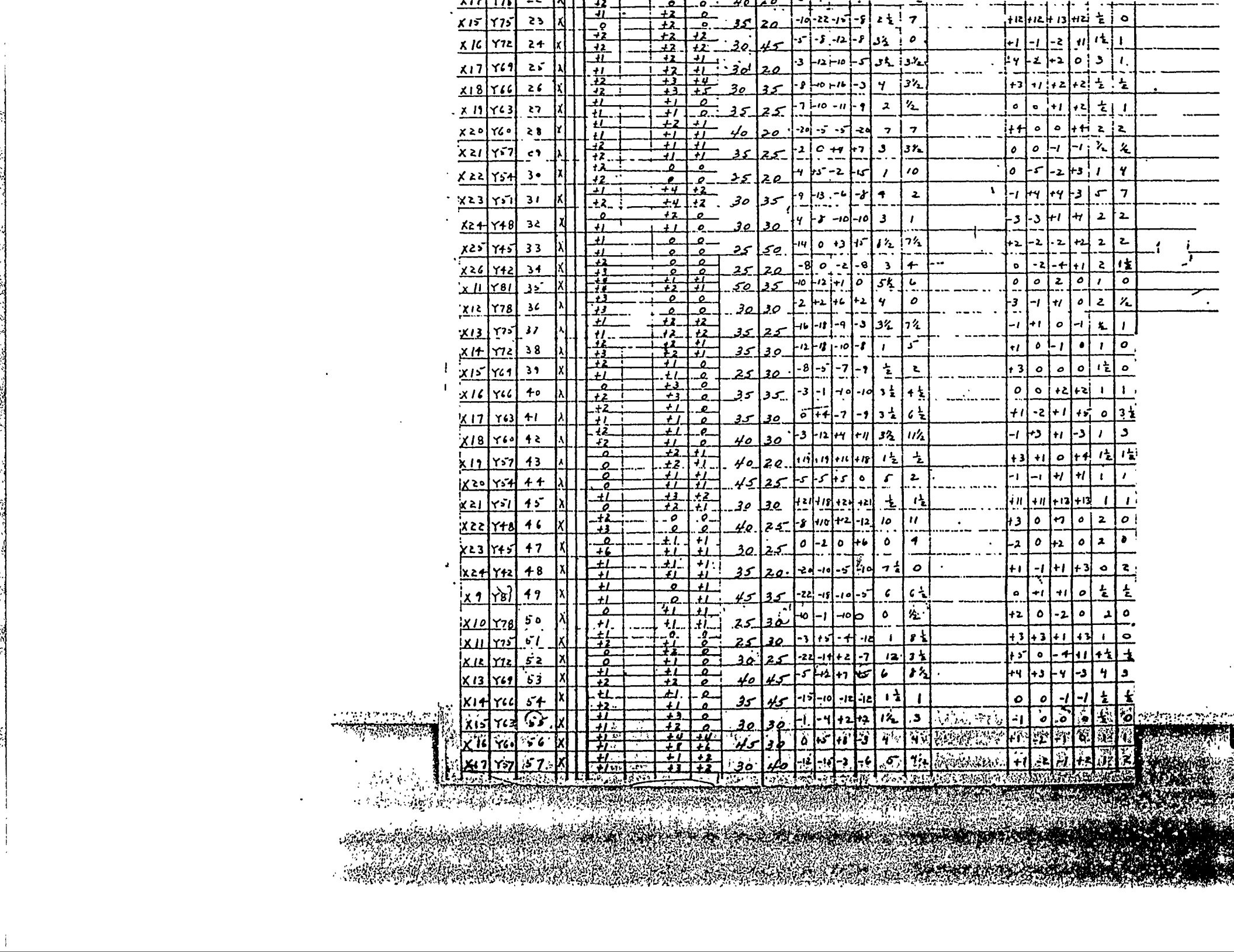
IDENFICATION OF TUBES						BORE MEASUREMENTS (BASIC BORE 4.385")						CENTRALITY READING							VERTICALITY READING						
						TOP LAND		BOTTOM LAND		SURFACE FINISH		DIRECTION							DIRECTION						
TUBE NO		NEW YORK SHIP NO	RED	BLUE	GREEN	TOP OF LAND	BOTTOM OF LAND	TOP OF LAND	BOTTOM OF LAND	TOP LAND	BOTTOM LAND	N	E	S	W	AVERAGE CENTRALITY N-S	AVERAGE CENTRALITY E-W	REMARKS	N	E	S	W	AVERAGE VERTICALITY N-S	AVERAGE VERTICALITY E-W	REMARKS
X18	Y54	58	X			+2		0	+1	40	20	-20	-2	-10	-22	5"	10		-3	+2	0	-2	1½	2	
						+1		0	+1																
X19	Y51	59	X			+2		+1	0	25	30	-12	-19	-9	-5"	1½	7		-2	-1	0	+1	0	1	
						+2		0	0																
X20	Y48	60	X			+2		+4	+3	20	25	-10	13	-6	-18	2	7½		-1	-2	0	+1	½	1½	
						+2		+4	+3																
X21	Y45	61	X			+2		+1	+1	20	20	+10	0	-22	-10	16	5"		-5"	-4	+5"	+4"	5	4	
						+2		+1	+1																
X22	Y42	62	X			+2		0	+1	25	20	-12	-1	-2	-15"	5"	7		+3	+2	-2	-2	2½	2	
						0		0	+1																
X23	Y39	63	X			+2		+1	0	40	45	-10	-5"	-9	-15"	½	5"		0	-1	-1	+1	½	1	
						0		+1	0																
X8	Y78	64	X			+5		0	0	30	30	-14	-20	-2	0	6	10		+2	0	-3	-3	2½	1½	
						+5		0	0																
X9	Y75	65	X			+4		0	0	30	25	-8	-9	-12	-11	2	1		-1	-1	+1	+1	1	1	
						+3		0	+1																
X10	Y72	66	X			+1		+2	+1	35	20	-3	-12	-16	-9	6½	1½		0	+1	+2	0	1	½	
						+1		+2	+1																
X11	Y69	67	X			+2		+1	+2	35	35	-25"	-6	+18	-2	20±	2		+7	+3	-7	-2	7	2½	
						+3		+1	+3																
X12	Y66	68	X			+2		+2	+2	25	30	-5"	-20	-10	0	2	10		-2	0	+2	-1	2	0	
						+2		+1	+1																
X13	Y63	69	X			+1		+2	+4	25	30	+9	-5"	-8	+10	8½	7±		0	+1	0	-2	0	1½	
						+2		+2	+4																
X14	Y60	70	X			+2		+1	+3	30	40	18	8	5"	10	6½	1		+10	+13	+17	+15"	3½	1	
						+2		+1	+3																
X15	Y57	71	X			+3		0	+2	35	25	-20	-10	0	-10	10	0		+1	-2	-1	+2	1	2	
						+2		0	+3																
X16	Y54	72	X			+1		+1	+2	25	40	-12	-7	-10	-15"	8½	4		0	-1	0	+1	0	1	
						+1		+1	+2																
X17	Y51	73	X			+1		0	+2	20	20	+15"	-8	-15"	+10	15"	9		-1	-1	-4	+2	1½	1½	
						+2		0	0																
X18	Y48	74	X			+1		+3	+2	25	25	-15"	-16	0	-8	7½	1		+1	-2	0	+2	0	2	
						+1		+3	+1																
X19	Y45	75	X			+2		+1	+1	30	40	-23	-21	0	-4	11½	8½		+1	+2	+1	0	-	1	
						+2		+1	+1																
X20	Y42	76	X			0		+2	0	20	30	+13	+5"	+10	+12	1½	3½		1	0	1	2	0	1	
						0		+3	0																
X21	Y39	77	X			+2		0	+2	25	25	-7	-21	-8	+5"	½	13		-1	0	0	-1	½	½	
						+1		0	+2																
X22	Y36	78	X			+1		0	+2	35	35	-8	-1	+10	+4	9	3½		0	-1	0	0	0	½	
						+2		0	+2																
X7	Y75	79	X			0		+3	+1	30	30	-30	+5"	+15"	-20	22	12		+4	-2	-4	0	4	1	
						+1		+2	+1																
X8	Y72	80	X			+1		+1	+1	35	30	-14	-18	-10	-10	2	4		0	+2	-1	-3	½	2½	
						+2		+1	+1																
X9	Y69	81	X			0		+1	+2	35	20	+20	+25	+6	+14	7	4		-1	-2	+1	+2	1	2	
						+1		+1	+2																
X10	Y66	82	X			0		+2	+2	50	35	-12	-10	-15"	-15"	1½	2½		0	+1	+1	-1	½	1	
						+1		+2	+2																
X11	Y63	83	X			0		+2	+2	30	25	-10	-18	-9	-12	6½	15"		-4	-4	+2	+2	4	3	
						0		+2	+2																
X12	Y60	84	X			+1		+2	+3	30	25	-15"	-15"	-5"	-5"	5"	5"		+10	+10	+5"	+5"	2	2	
						+2		+2	+3																
X13	Y57	85	X			+1		+1	+3	30	30	-20	+2"	-7	-16	6½	2		0	-2	-5"	-2	2½	0	
						0		+1	+3																
X14	Y54	86	X			+1		+1	+3	25	35	-28	-2	+3	-18	15±	8		+3	-4	-4	+4	3½	4	
						+1		+1	+3																
X15	Y51	87	X			+2		+1	+2	30	30	-28	-23	-23	-19	2⅛	2		+2	-2	-4	+1	3	1½	
						+3		+1	+2																
X16	Y48	88	X			+3		+1	+2	35	30	-10	-10	-15"	-9	2½	½		-2	-3	0	0	1	1½	
						+3		+1	+2																
X17	Y45	89	X			+2		+3	+2	30	35	-22	+34	+35"	+27	6½	3½		-3	-4	-1	0	1	2	
						+2		+3	+2																



RESULTS OF LINE - BORING OPERATION

"R" UNIT

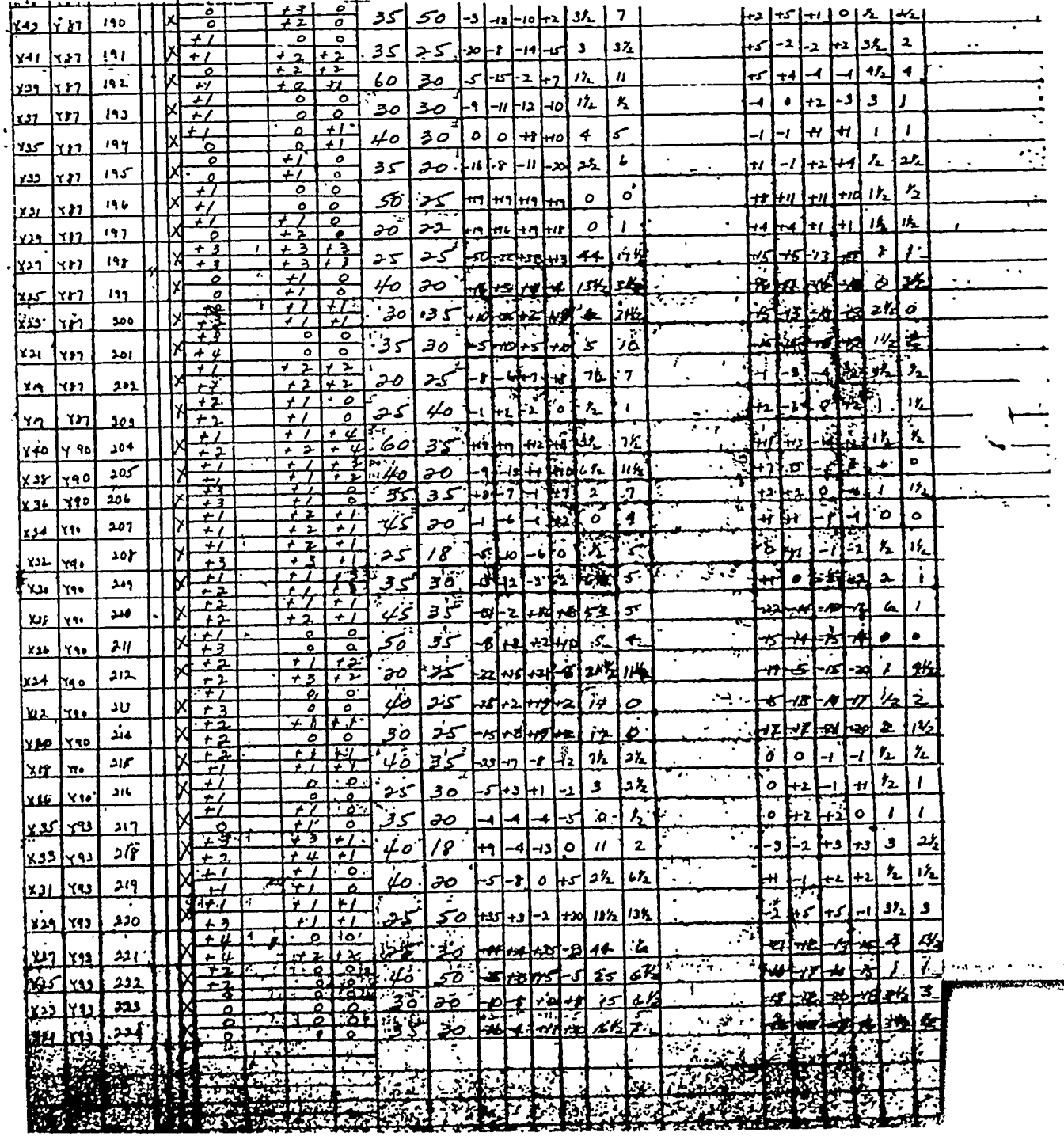
IDENFICATION OF TUBES					BORE MEASUREMENTS (Basic Bore 4.385)						CENTRALITY READING							VERTICALITY READING						
TUBE NO		NEW YORK SHIP NO	X-ray Issue	Green	TOP LAND		BOTTOM LAND		SURFACE FINISH		DIRECTION				AVERAGE CENTRALITY		REMARKS	DIRECTION				AVERAGE VERTICALITY		REMARKS
					TOP OF LAND	BOTTOM OF LAND	TOP OF LAND	BOTTOM OF LAND	TOP LAND	BOTTOM LAND	N	E	S	W	N-S	E-W		N	E	S	W	N-S	E-W	
X15	Y87	1	X		0		+1	+1	45	25	-18	-10	-5	-12	5	1		+3	0	-2	0	2½	0	
					0		+1	+1																
X16	Y84	2	X		0		+1	+1	40	25	-5	-15	-20	-15	7½	0		0	-1	-1	0	½	½	
					+2		+1	+1																
X27	Y51	3	X		+1		0	0	30	30	+10	-2	-10	+3	10	2½		-9	-1	+6	0	7½	½	
					+1		0	0																
X28	Y48	4	X		+2		+1	+1	25	35	18	20	14	11	2	+1½		0	-1	0	+1	0	1	
					+3		+1	+1																
X13	Y87	5	X		+1		+1	+2	30	35	-18	-10	-27	0	4½	5		+3	-2	+1	+2	1	2	
					+2		+1	+2																
X14	Y84	6	X		+1		+1	0	30	40	-16	32	0	+10	5	16		0	0	0	-1	0	½	
					+1		+1	0																
X15	Y81	7	X		+1		0	0	40	30	-3	-20	-12	+9	4½	14½		0	4	2	0	1	2	
					+2		0	0																
X16	Y78	8	X		+1		+1	+1	30	25	-2	-4	-5	-2	1½	1		0	+2	+2	0	1	1	
					+1		+1	+1																
X17	Y75	9	X		+1		+3	+1	30	35	-6	-11	-20	-9	7	1		0	+2	+3	+2	1½	0	
					+2		+3	+1																
X18	Y72	10	X		+1		+2	+1	40	45	-16	-8	0	-7	8	½		+1	-1	-3	-1	2	0	
					+3		+2	+1																
X19	Y69	11	X		+2		+1	+2	30	30	-11	-12	-13	-15	1	1½		+2	+2	-2	-2	2	2	
					+1		+1	+3																
X20	Y66	12	X		+2		+2	+3	35	25	-11	-16	-11	0	0	8		0	0	-1	-1	½	½	
					+1		+2	+2																
X21	Y63	13	X		+3		+2	+2	35	30	-12	-22	-9	-10	1½	6		+2	+4	0	-2	1	3	
					+3		+2	+1																
X22	Y60	14	X		+3		+2	+1	30	40	+5	0	0	-5	7	7		+1	-4	-1	+4	1	4	
					+2		+2	+1																
X23	Y57	15	X		+1		+2	0	30	30	+10	+9	+2	+2	4	3½		-1	0	0	-2	0	1	
					+1		+2	0																
X24	Y54	16	X		+1		+4	+2	30	40	-10	-9	-5	-3	2½	3		+1	0	-2	-2	1½	1	
					+2		+4	+2																
X25	Y51	17	X		+3		+3	+1	35	30	-15	-10	-15	-15	0	0		0	0	+1	+3	½	1½	
					+3		+1	+1																
X26	Y48	18	X		+2		+1	+2	35	25	-9	-9	-14	-12	2½	1½		-7	-3	+3	+1	3½	2	
					+1		+1	+2																
X27	Y45	19	X		+2		+1	0	35	30	-9	-9	-14	-12	2½	1½		-4	-3	+3	+1	3½	2	
					+2		+1	0																
X12	Y84	20	X		+1		+1	+1	40	25	-1	+2	-8	+2	3½	0		-2	0	0	-2	1	1	
					+1		+1	+1																
X13	Y81	21	X		+1		+1	0	45	40	-20	-6	-2	-8	9	1		-1	-1	0	+4	½	2½	
					+2		+1	0																
X14	Y78	22	X		+1		0	0	40	20	0	-12	-20	-7	10	2½		-2	+1	+1	-2	1½	0	
					+2		0	0																
X15	Y75	23	X		+1		+2	0	35	20	-10	-22	-15	-8	2½	7		+12	+12	+13	+12	½	0	
					0		+2	0																
X16	Y72	24	X		+2		+2	+2	30	45	-5	-8	-12	-8	5½	0		+1	-1	-2	+1	1½	1	
					+2		+2	+2																
X17	Y69	25	X		+1		+2	+1	30	20	-3	-12	-10	-5	5½	3½		-4	-2	+2	0	3	1	
					+1		+2	+1																
X18	Y66	26	X		+2		+3	+4	30	35	-8	-10	-16	-3	4	3½		+3	+1	+2	+2	½	½	
					+2		+3	+5																
X19	Y63	27	X		+1		+1	0	35	25	-7	-10	-11	-9	2	½		0	0	+1	+2	½	1	
					+1		+1	0																
X20	Y60	28	X		+1		+2	+1	40	20	-20	-5	-5	-20	7	7		+4	0	0	+4	2	2	
					+1		+1	+1																
X21	Y57	29	X		+2		+1	+1	35	25	-2	0	+4	+7	3	3½		0	0	-1	-1	½	½	
					+2		+1	+1																
X22	Y54	30	X		+2		0	0	25	20	-4	+5	-2	-15	1	10		0	-5	-2	+3	1	4	
					+2		0	0																
X23	Y51	31	X		+1		+4	+2	30	35	-9	-13	-6	-8	4	2		-1	+4	+4	-3	5	7	
					+2		+4	+2																
X24	Y48	32	X		0		+2	0	30	30	-4	-8	-10	-10	3	1		-3	-3	+1	+4	2	2	
					+1		+1	0																
X25	Y45	33	X		+1		0	0	25	50	-14	0	+3	+5	8½	7½		+2	-2	-2	+2	2	2	
					+1		0	0																
X26	Y42	34	X		+2		0	0	25	20	-8	0	-2	-8	3	4		0	-2	-4	+1	2	1½	
					+3		0	0																
X11	Y81	35	X		+1		+1	+1	50	25	-10	-12	+1	0	5½	6		0	0	2	0	1	0	
					+1		+2	+1																

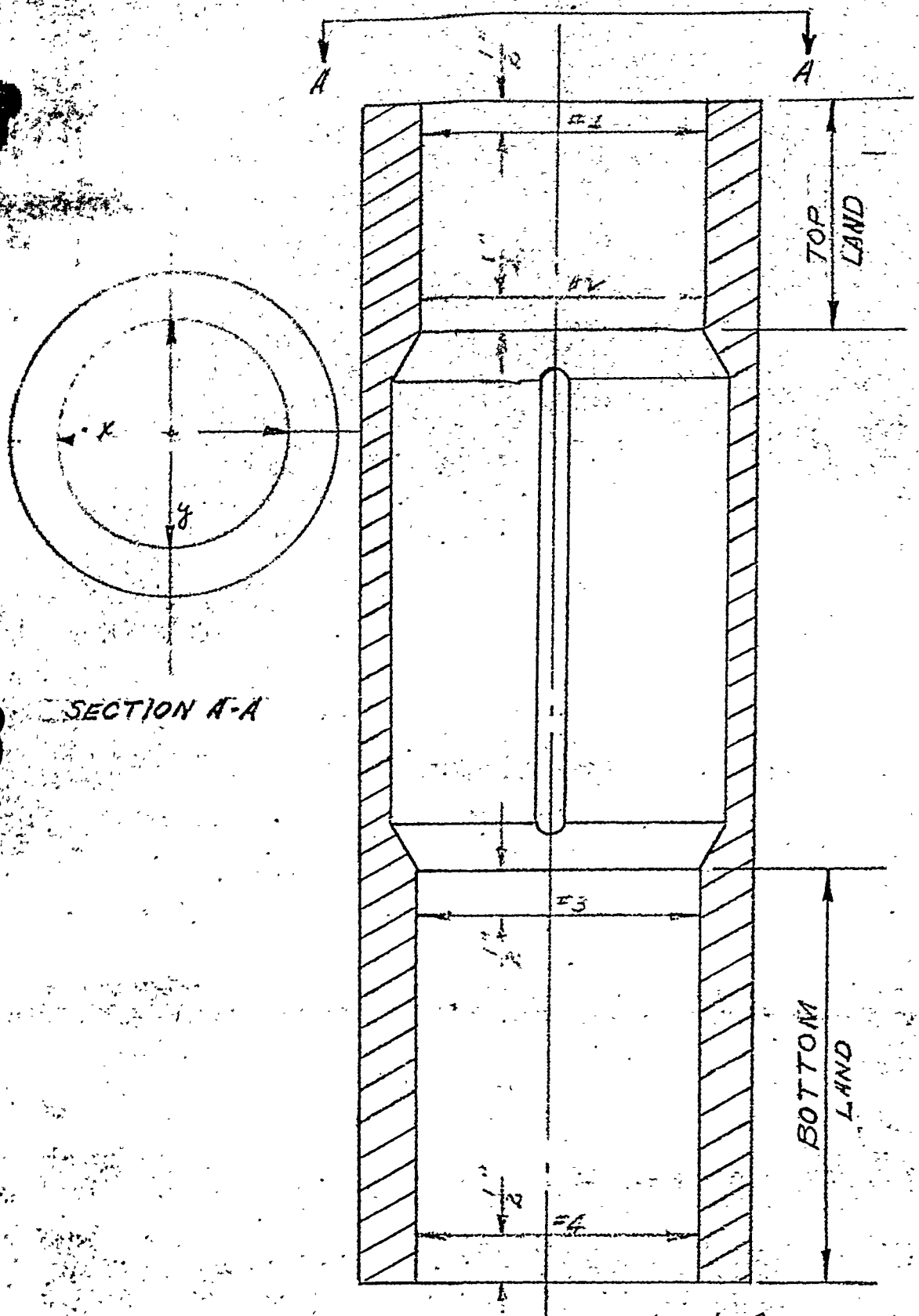


RESULTS OF LINE - BORING OPERATION

"R" UNIT

IDENFICATION OF TUBES						BORE MEASUREMENTS (BASIC SIZE 4.385)						CENTRALITY READING							VERTICALITY READING						
TUBE NO		NEW YORK SHIP NO	RED	BLUE	GREEN	TOP LAND		BOTTOM LAND		SURFACE FINISH		DIRECTION						REMARKS	DIRECTION						REMARKS
						TOP OF LAND	BOTTOM OF LAND	TOP OF LAND	BOTTOM OF LAND	TOP LAND	BOTTOM LAND	N	E	S	W	AVERAGE CENTRALITY N-S	AVERAGE CENTRALITY E-W		N	E	S	W	AVERAGE VERTICALITY N-S	AVERAGE VERTICALITY E-W	
X23	Y81	172		X		+2 / +2		+1	+1	20	30	+2	+2	+3	+5	1/2	1 1/2		+17	+7	+14	+12	1 1/2	2 1/2	
X21	Y81	173		X		+3 / +3		0	0	35	25	+12	+14	-10	-3	11	3 1/2		-3	-1	+3	0	3	1/2	
X19	Y81	174		X		+1 / +1		0	0	20	30	0	-2	+5	+5	2 1/2	3 1/2		-2	0	-4	-4	1	2	
X17	Y81	175		X		+3 / +3		0	0	35	30	-11	-5	+12	+10	11 1/2	7 1/2		+3	0	-1	0	1 1/2	0	
X44	Y84	176		X		0 / 0		0	+2 / +1	30	40	-21	-20	-25	-21	2	1/2		0	+2	-1	-4	1/2	3	
X42	Y84	177		X		+2 / +2		+1 / +1	+2 / +1	40	30	+23	-11	+9	+9	9 1/2	7 1/2		+9	+7	-6	+1	7 1/2	3	
X40	Y84	178		X		+1 / +1		0 / +1	0 / +1	55	30	+5	+2	+5	+5	0	1		-1	-2	-1	-1	0	0	
X38	Y84	179		X		+1 / +1		+1 / +1	+2 / +2	30	30	+6	+20	+23	+10	11	5		-3	0	+2	0	2 1/2	0	
X36	Y84	180		X		0 / 0		+2 / +2	+1 / +1	45	30	+2	0	-10	+10	6	5		-2	0	-1	+1	1 1/2	1/2	
X34	Y84	181		X		+1 / +1		+1 / 0	+1 / +1	50	40	-8	-12	-8	-6	0	3		+1	+2	+4	0	1 1/2	1	
X32	Y84	182		X		0 / 0		+1 / +1	+2 / +1	40	35	+2	+4	-7	-8	4 1/2	6		-1	0	+1	0	1	0	
X30	Y84	183		X		+1 / +1		+3 / +4	+3 / +3	40	25	-29	-29	-11	-18	9	5 1/2		+1	+2	-1	-2	1	2	
X28	Y84	184		X		0 / 0		0 / 0	+2 / +2	45	25	-5	0	+12	-10	3 1/2	5		0	-2	-4	-2	2	0	
X26	Y84	185		X		+1 / +3		+2 / +1	0 / 0	25	30	-30	-20	+16	+25	22 1/2	23 1/2		+18	-14	-20	-23	18	4 1/2	
X24	Y84	186		X		0 / +1		+3 / +2	+3 / +4	25	35	-23	-26	+5	+8	17	17		-22	-8	-20	-21	4	6 1/2	
X22	Y84	187		X		+1 / +2		+1 / +1	0 / 0	40	25	+21	+24	+21	+21	0	0		0	+3	+3	+2	1 1/2	1/2	
X20	Y84	188		X		+4 / +4		0 / 0	0 / 0	20	30	+4	-10	-18	-20	2	5		+11	+5	+2	+5	1/2	0	
X18	Y84	189		X		+1 / +1		+1 / +1	+1 / +1	15	30	-15	-10	-10	-12	1/2	1		+1	+7	0	0	1/2	3 1/2	
X43	Y87	190		X		0 / 0		+3 / +2	0 / 0	35	50	-3	-12	-10	+2	3 1/2	7		+2	+5	+1	0	1/2	2 1/2	
X41	Y87	191		X		+1 / +1		+2 / +2	+2 / +2	35	25	-20	-8	-19	-15	3	3 1/2		+5	-2	-2	+2	3 1/2	2	
X39	Y87	192		X		0 / +1		+2 / +2	+1 / +2	60	30	-5	-15	-2	+7	1 1/2	11		+5	+4	-1	-1	4 1/2	1	
X37	Y87	193		X		+1 / +1		0 / 0	0 / 0	30	30	-9	-11	-12	-10	1 1/2	1/2		-4	0	+2	-3	3	1	
X35	Y87	194		X		+1 / 0		0 / 0	+1 / +1	40	30	0	0	+8	+10	4	5		-1	-1	+1	+1	1	1	
X33	Y87	195		X		0 / 0		+1 / +1	0 / 0	35	20	-16	-8	-11	-20	2 1/2	6		+1	-1	+2	+1	1/2	2 1/2	
X31	Y87	196		X		+1 / +1		0 / 0	0 / 0	50	25	+19	+19	+19	+19	0	0		+8	+11	+11	+10	1 1/2	1/2	
X29	Y87	197		X		+1 / 0		+1 / +2	0 / 0	20	22	+19	+16	+19	+18	0	1		+4	+4	+1	+1	1 1/2	1 1/2	
X27	Y87	198		X		+3 / +3		+3 / +3	+3 / +3	25	25	-30	-32	+38	+43	44	17 1/2		+15	+16	-23	-20	2	1	
X25	Y87	199		X		0 / 0		+1 / +1	0 / 0	40	20	-18	+2	+8	+6	13 1/2	3 1/2		+8	+3	+6	+6	0	2 1/2	
X23	Y87	200		X		+2 / +2		+1 / +1	+1 / +1	30	35	+10	-6	+2	+6	6	2 1/2		+5	+3	+6	+5	2 1/2	0	
X21	Y87	201		X		+3 / +4		0 / 0	0 / 0	35	30	+5	+10	+5	+10	5	10		+15	+18	+8	+10	11/2	2 1/2	
X19	Y87	202		X		+1 / +2		+2 / +2	+2 / +2	20	25	-8	-6	+7	+8	7 1/2	7		+4	-3	-4	-3	3 1/2	1/2	





SKETCH # 31-A

ENGINEERING SKETCH SHEET E. I. DU PONT DE NEMOURS & CO.	PROJ. No. 8980	SIGNATURE: J Ray Stewart
PROJ. TITLE PLENUM CHAMBER STRAIGHT TUBE		DATE 3-26-53
SUBJECT:		No. E-42314

(4) Rod Tube Line Boring

After line boring and honing all large tubes, the rod tubes were line bored. The procedure for line boring rod tubes was as follows:

a. Face rod tubes to 1 3/4" from top of large tubes.
b. Place base fixture over rod tube and level.
c. Set base fixture central with corresponding rod tube in top tube sheet using all-way level.
d. Open up 7/8" diameter hole with 1¼" drill. Drill through.
e. Open up 1¼" diameter hole with 1 9/32" x 1 15/32" subland drill. Drill 9 7/8" deep.
f. Ream 1 15/32" diameter hole to 1½" using core drill to 9 7/8" deep. Check with plug gage for depth.
g. Ream 1 9/32" diameter hole to 1 5/16" using reamer.
h. Remove base plate fixture and set up for new hole.
i. Bevel top edge of rod tube to suit 10° gage. Gage to be flush with top of tube.
j. Hone top 2" land to 63 RMS or better.

After New York Ship line bored all rod tubes (numbering 165 and using the above procedure), du Pont Inspectors performed the following inspections:

1. The distance from the tops of the plenum large tubes to the face of the rod tubes (top side) was measured using a machined 1.500" block resting on the rod tube tops. To this a dial indicator was clamped to the block and registered to the face of the rod tubes. This distance was measured to determine if all rod tubes had been faced in a plane of 1/16". The range of the distance in question was from 1.825" to 1.738"; therefore, rod tubes were faced in a plane of the difference between these readings, or .087". All rod tubes were measured in the manner described above and accepted. (See "a", rod tube line boring procedure.)

2. Using a 1.484" O.D. functional gage, one hundred sixty-five (165) rod tubes were gaged and accepted. (See photo serial #56-18 in Part II-A)

3. The verticality of all rod tubes was checked with a specially designed calibrated verticality gage.

All rod tube verticalities were within required tolerances and accepted. For operation and use of gage, see Part III, section L.

4. All rod tubes were then checked with a 1.3045" diameter plug gage. (See "g", rod tube line boring procedure.) All rod tubes accepted the plug gage for the entire length of the tube.

5. After beveling or chamfering the top edge of all rod tubes to dimensions shown in Dwg. 2-2, Section 7A-(2) of this manual, a 10° prototype plug gage was used to gage the depth of the finished machined bevels. All inspections proved satisfactory.

6. The top 2" land (bore) of all rod tubes was checked for finish and bore size after honing the I.D. between 1.500" and 1.505" (See Part II-A, photo serial #56-17). All tubes were accepted by the Inspection Department for visual check, bore size, and finish (RMS).

7. Finally, measurements were taken on the top side of the plenum chamber for the purpose of determining all rod tube locations radially with respect to adjacent large tubes. Measurements were taken by means of a dial indicator graduated in thousandths of an inch attached to a bracket. With a mandrel placed in the rod tube being located, the indicator - bracket assembly was placed in the adjacent large tubes in such a fashion as to indicate the minimum distance from the inside wall of the large tube bore to O.D. of the mandrel. The use of this gage is covered in detail in Part III section B.

(5) Difficulties Encountered as a Result of Line Boring and Honing

After finish line boring approximately four hundred large tubes, it was found through concurrent inspection that two large tube bores exceeded the maximum allowable bore tolerances. These tube numbers and the results of inspection were as follows:

Tube Number X28-Y36

The inside diameter of this tube did not clean up after finish line boring. The area that did not clean up extended the full length of the plenum tube bore. (See Sketch #32) Verticality and centrality readings indicated that either the base plate was not properly set, or it moved during the first rough boring operation. Verticality and centrality readings were as follows:

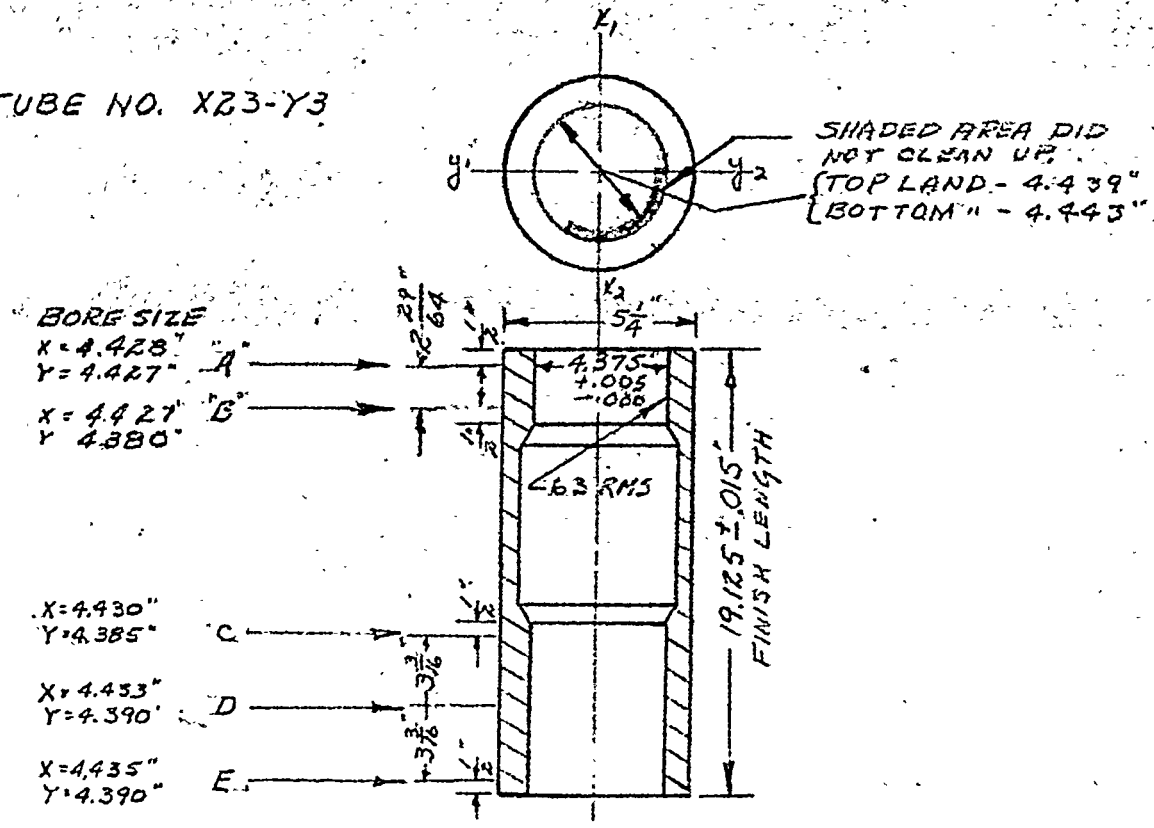
	North	East	South	West	Average N-E	Average S-W
Verticality	.019"	.017"	.008"	.003"	.0055"	.007"
Centrality	.007"	.011"	.000"	.010"	.0035"	.0005"

Tube Number X23-Y3

Tube defects were same as for X28-Y36 (See Sketch 33) except verticality and centrality readings were as follows:

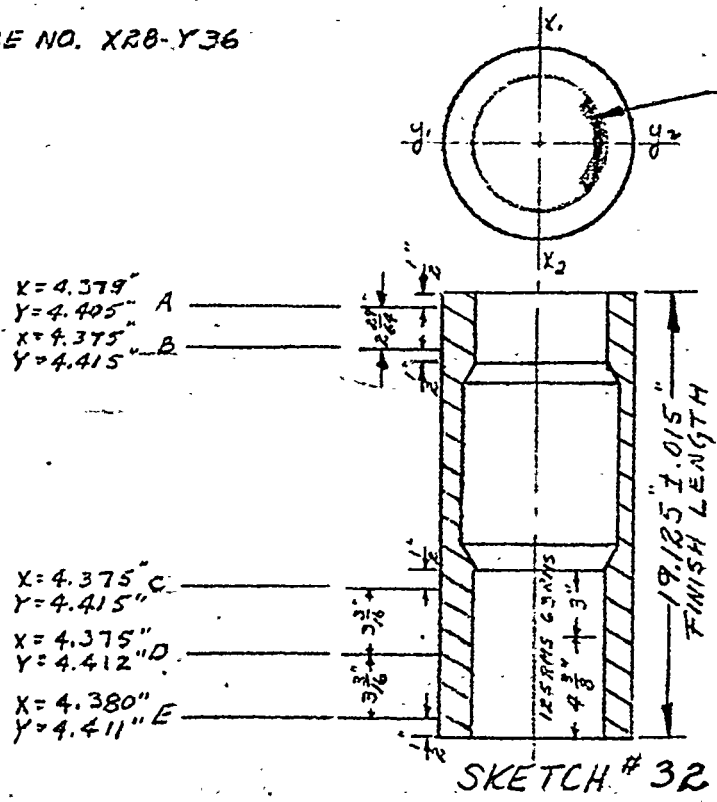
	North	East	South	West	N-E	S-W
Verticality	.003"	.011"	.005"	.008"	.001"	.0095"
Centrality	.002"	.015"	.000"	.014"	.001"	.0145"

TUBE NO. XZ3-Y3



SKETCH #33

TUBE NO. XZ8-Y36



SKETCH #32

ENGINEERING SKETCH SHEET E. I. DU PONT DE NEMOURS & CO.	PROJ. No. 8980	SIGNATURE: J Ray Stewart
PROJ. TITLE		DATE
SUBJECT:		No. E-42317

Tube Number X21-Y3

Tube defects were same as "b" above, exceptfor verticality and centrality readings.

(Note: Results could not be located in existing files in the inspection office; however, they were similar to those listed in "b" above.

It was decided by the Inspection Department to remove the above mentioned tubes and replace them based on the following reasons:

1. Tube bores were out-of-round and beyond required tolerances.

2. Bores did not clean up.

3. Inside diameters (top & bottom lands) exceeded the 4.380" maximum limit.

4. Finish in both tubes was greater than the required 63 RMS and was not acceptable.

The plenum chamber was removed from the line boring operation and the three defective tubes were machined out and replaced. The plenum chamber was again re-aligned over the top tube sheet assembly and the replaced tubes and remaining large tubes were finished line bored.

After this it was decided to hydrostatically test the unit. It was set up, prepared and tested in a similar manner described in section 13B-5 of this manual; however, this unit was not hammer tested. Tube welds, bulge and nozzle welding was visually inspected on both sides of the unit. Three large tubes were found to be leaking at the tube weld. These were chipped out and re-welded. The unit was re-tested, examined and found satisfactory.

Next, the unit was sandblasted all over. This was done outside the building. Upon completion of this operation, the unit was visually inspected and found satisfactory. Sandblasting at this stage of fabrication was requested by the Inspection Department because heretofore inspection of welding (especially tube welds) was difficult due to grease, oil, dirt, etc., covering tube welds and other adjacent areas on the top and bottom sides of the unit.

The unit was then acid washed to further remove traces of iron, rust, weld oxides and other foreign material. First, the top side of the unit was acid washed, and then the unit was turned and the bottom side was done in a similar manner. All cleaning was done at room temperature using the following solution:

3 pts. of HNO_3 - 13%

5 gal. of H_2O - 85%

1 pt. of HF - 2%
Nitric Acid Std. 42% BE (1.41 sp. gr.)
Hydrofluoric acid 60%

Care was taken during application and removal of the solution not to let it come in contact with the mild steel flange caps used to blank off tube ends because contamination of the unit would result. After each side was acid washed, the unit flushed with city water; the entire unit was inspected by du Pont Inspectors and accepted.

At this time a meeting was held between du Pont Construction, du Pont Inspection Department, and Dowell, Inc., Wilmington, Delaware, for the purpose of establishing a procedure for cleaning tube sheets and plenum chambers for the 105-R unit and all subsequent units. The following procedure for cleaning the plenum chamber was developed for "R" plenum chamber:

1. Pump hot detergent in through bottom connection and allow fluid to spill over at top of chamber.

2. Agitate hot detergent (supplied by Dowell) for 30 minutes using air lines hooked up to all available nozzles.

3. Flush detergent out bottom nozzle as rapidly as possible.

4. Repeat steps (1), (2) and (3) until a sample of detergent taken during step (3) shows no traces of soluble oil. Plenum to be turned 180° each time detergent is flushed.

5. Upon completion of step (4) immediately fill unit with hot distilled water.

6. When full, all flushing water is to be drained rapidly as possible through the bottom nozzle.

This meeting also determined the type of equipment which Dowell used while following the above procedure. A rubber line tank was to be used for the detergent. A 300 gpm. rubber lined pump with brons impeller was to be used to pump the detergent from the tank to the unit while cleaning was in progress. A strainer was also to be used in the supply line between the pump and unit to insure that any foreign matter will not enter the unit being cleaned.

Dowell, Inc., cleaned the interior of the "R" plenum chamber following the above outlined procedure. Upon completion of cleaning by Dowell, the interior of the unit was examined visually. Inspection revealed that traces of oil, grit, metal chips, filings, etc., were present in the unit. Cleaning was rejected by the Inspection Department.

It was decided to clean the interior of the unit again using the above outlined procedure. After Dowell cleaning the second time, visual inspection of the interior still indicated traces of oil, grit and other foreign material. However, cleanliness of unit was waived on the basis that it would receive another final cleaning before shipping to the field.

Following the cleaning operation and prior to line boring of rod tubes, it was decided by the Inspection Department, Construction and New York Ship to freon test the unit. The unit was set up and prepared for testing in an identical manner as described in Part II of this section. Three tube welds were found leaking. These were chipped out, rewelded and the unit re-tested. No other leaks were found in this test.

Next, all plenum rod tubes were line bored. After this it was discovered that the finish in the top 2" land (I.D.) of ten rod tubes did not clean up to a 63RMS. It was surmised that by honing this condition could be corrected in all cases, but in doing so the maximum inside diameter of 1.505" was exceeded. As a result of oversize bores, and finishes greater than 63 RMS, the following ten rod tubes were cut out of the unit and replaced:

(1)	X49-Y41	(6)	X48-Y64
(2)	X45-Y49	(7)	X38-Y68
(3)	X40-Y52	(8)	X25-Y89
(4)	X36-Y58	(9)	X32-Y68
(5)	X34-Y64	(10)	X30-Y16

After replacing and line boring the new rod tubes, they were inspected and found satisfactory.

Upon completion of line boring large tubes only, the plenum chamber was set up for honing these tube bores. (See photo serial #60) All large tube bores (top and bottom lands) were originally honed from 4.375" to 4.380". After the honing operation was completed, tube bores were measured and finishes checked. Five tube bores were found to have finishes greater than 125 RMS (specification calls for 63 RMS) and the inside diameters exceeding the top limit of 4.380". These tubes were as follows:

(1)	X22-Y90	(4)	X25-Y87
(2)	X21-Y3	(5)	X26-Y90
(3)	X4-Y36		

Du Pont Inspection Department requested that the above five tubes be cut out and replaced because of bad finished and inside diameters exceeding Design's top limit specification of 4.380". These tubes were cut out and replaced by New York Ship. In doing so, tube welding caused the following large tubes to go out-of-round as indicated:

Serial No. 60

New York Shipbuilding Corp.
Camden 4, New Jersey
August 12, 1952

PROJECT 8980 - SAVANNAH RIVER PLANT

"R" Unit Plenum Chamber -
Honing Operation

This view shows the honing of the top land of the plenum tubes. The equipment used is a Portable Sunnen Hone attachment and rig.

All tubes are being honed to an inside diameter between 4.385" and 4.390". After the top land of all tubes have been honed to correct diameters, the plenum chamber is turned over and honing of all tubes (bottom land) is done from the bottom side of the unit.

See Serial Number 58.

SERGIO

EXHIBIT #13

PRELIMINARY FREON TEST AFTER REPLACING 18 DEFECTIVE TUBES

TUBES ADJACENT TO REPLACED TUBES
Bore Measurements

Tube No. X - Y	Top Land Min.	Top Land Max.	Bottom Land Min.	Bottom Land Max.	Remarks
2-36	4.375"	4.387"	4.379"	4.385"	
3-33	4.372"	4.384"	4.370"	4.387"	Adjacent Tubes
5-33	4.375"	4.382"	4.374"	4.385"	" "
6-36	4.375"	4.385"	4.379"	4.388"	
5-39	4.372"	4.384"	4.368"	4.384"	
3-39	4.375"	4.384"	4.372"	4.386"	
4-36	4.382"	4.382"	4.3785	4.3785	Replaced Tube
4-30	4.377"	4.382"	4.376"	4.382"	
6-30	4.383"	4.384"	4.377"	4.380"	
7-33	4.375"	4.380"	4.374"	4.380"	Adjacent Tube
8-36	4.375"	4.378"	4.377"	4.379"	Adjacent tubes
7-39	3.377"	4.382"	4.376"	4.382"	
6-42	4.377"	4.379"	4.377"	4.379"	
4-42	4.376"	4.379"	4.375"	4.383"	
2-42	4.380"	4.382"	4.378"	4.382"	
21-87	4.375"	4.386"	4.375"	4.387"	
18-87	4.378"	4.386"	4.375"	4.384"	Adjacent Tube
21-81	4.377"	4.383"	4.377"	4.383"	
21-3	4.383"	4.383"	4.380"	4.380"	Replaced Tube
23-3	4.374"	4.380"	4.375"	4.381"	
22-6	4.375"	4.385"	4.376"	4.385"	
20-6	4.372"	4.386"	4.371"	4.385"	
18-6	4.377"	4.381"	4.377"	4.379"	Adjacent Tubes
19-9	4.378"	4.380"	4.376"	4.382"	Adjacent tube
21-9	4.376"	4.384"	4.375"	4.383"	
23-9	4.377"	4.381"	4.377"	4.382"	
24-6	4.374"	4.382"	4.373"	4.385"	
25-3	4.380"	4.384"	4.375"	4.383"	
29-3	4.375"	4.381"	4.375"	4.387"	
27-93	4.372"	4.387"	4.379"	4.393"	
25-93	4.372"	4.384"	4.373"	4.381"	
23-93	4.379"	4.381"	4.376"	4.383"	Adjacent Tubes
21-93	4.373"	4.387"	4.375"	4.387"	Adjacent Tubes
18-90	4.377"	4.382"	4.377"	4.382"	
20-90	4.372"	4.387"	4.373"	4.388"	
22-90	4.380"	4.380"	4.379"	4.379"	Replaced Tube
24-90	4.385"	4.371"	4.369"	4.389"	
26-90	4.379"	4.379"	4.379"	4.379 "	Replaced Tube
28-90	4.373"	4.385"	4.371"	4.388"	Adjacent Tubes
30-90	4.379"	4.382"	4.376"	4.381"	
25-87	4.381"	4.381"	4.380"	4.380"	Replaced Tube
26-84	4.373"	4.388"	4.373"	4.388"	
24-84	4.380"	4.387"	4.372"	4.389"	
29-87	4.376"	4.382"	4.376"	4.382"	Adjacent Tubes
27-81	4.377"	4.382"	4.377"	4.382"	
25-81	4.377"	4.384"	4.376"	4.384"	
23-81	4.377"	4.382"	4.376"	4.382"	Adjacent Tubes
22-84	4.377"	4.382"	4.375"	4.385"	Adjacent Tubes
23-87	4.382"	4.386"	4.378"	4.384"	

As the above data indicates, tubes adjacent to replaced tubes went out-of-round as much as the original replaced tubes (five) due to welding. These results were sent to Design for their comments. At the latter's request, a meeting was held between du Pont Material and Equipment Section, Construction (NYS) and Design Division to discuss the tube distortion resulting from replacement of tubes in the "R" plenum chamber subsequent to final boring.

The following is a resume of that meeting:

Five large tubes and ten rod tubes of the "R" plenum were replaced during the period of July 15-20, 1952. Bore measurements in surrounding tubes revealed the following facts. Twenty-one tubes immediately adjacent to the large replacement tubes were out-of-round from 0.002" to 0.015" i.e., the major diameter exceeded minor diameter by this amount. Twenty-three other tubes in the same vicinity were out-of-round 0.001" to 0.008". Twenty-seven tubes adjacent to replaced rod tubes were out-of-round 0.007" to 0.017". Out-of-roundness was that measured in the top "land" of the plenum tubes. Distortion in the bottom "land" was comparable. In practically every case, the major axes was oriented in the direction of the replaced tube, indicating that the distortion was a direct result of the replacement weld.

Further discussion brought out these points on the history of tube replacement:

a. The technique of tube replacement was tried on a special weldment at New York Ship but no bore measurements on adjacent tubes could be recalled.

b. No plenum tube was replaced after final boring in the NYX unit.

c. No top tube sheet tubes were replaced on either the "R" or NYX units.

d. Sixteen (16) tubes (welded tubes) had been replace on the "R" bottom tube sheet, but no measurements were made on surrounding tubes specifically for the purpose of detecting out-of-roundness.

e. Three tubes of the "R" plenum were replaced at an earlier date because of severe damage to these tubes during line boring. Distortion from these cases were not detected at that time, but at least eight tubes adjacent to the three early replacements were out-of-round by amounts ranging from 0.003" to 0.015". This distortion was the principle reason for making 3 of the 5 recent replacements.

After considerable discussion it was concluded that the only safe and reasonably sure method of "reclaiming" the "R" plenum involves honing all large tubes to a larger bore. The larger bore dimension was not specified (in this meeting), but it was agreed that Design would advise Construction at New York Ship upon receipt of results of honing three representative out-of-round tubes.

At a later date the results of honing three tubes were sent to Design. Taking into consideration other factors along with the analyzed tube honing results, it was requested by Design that all large tube bores be enlarged by honing between 4.385" and 4.390".

After honing all large tubes to the new dimension, the top and bottom land of all plenum tube bores were measured with a standard dial indicator bore gage and found to be within the required tolerance. All bore finishes were checked with a profilometer and all were 63 RMS or less and accepted.

At this time it was requested by the Inspection Department that the plenum chamber be subjected to another preliminary hydrostatic test. New York Ship complied with the request and set up the plenum chamber for hydrostatic testing. The unit was prepared for testing in an identical manner described in 132-5 of this manual. After the unit was filled with deionized water, the pressure was raised to 375 lb./sq. in. and held for three hours. All welding was then visually inspected for leakage. However, during the course of inspection, it was discovered that water was seeping from two garlock gaskets used in the sealing off of tube ends. In addition to this, approximately 1/8" of greasy grit covered all welds. Working under these adverse conditions, the assembly was completely inspected and no leaks found.

After all fabrication work and repairs had been made on the plenum chamber, it was set on top of the top tube sheet for functional gaging. The large tubes were gaged with a 4.375" O.D. cylindrical shaped functional gage and rod tubes with a 1.182" O.D. functional gage of similar design. The full length of the rod tube functional gage entered all rod tubes. (In both cases, the functional gages were lowered into the tube bore by gravity.) The full length of the large tube functional gage entered all large tubes except the following:

(1) X3-Y63	(7) X41-Y87
(2) X19-Y81	(8) X28-Y90
(3) X30-Y84	(9) X30-Y90
(4) X13-Y87	(10) X23-Y93
(5) X15-Y87	(11) X27-Y93
(6) X27-Y87	(12) X29-Y93

In order to permit the full length of the functional gage to enter the above tubes, it was necessary to hone the corresponding top tube sheet tubes to the following dimensions: three tubes, X30-Y84, X15-Y87, and X23-Y93, were honed to a maximum I.D. of 4.410" for a distance of 15" from the top end of the tube. The remainder of the tube length was honed to an I.D. of 4.400".

The plenum and top tube sheet assemblies were then re-assembled again, and these twelve tubes were checked with the functional gage and its full length successfully entered. Other tubes picked at random were also gaged at this time and found satisfactory.

Note: Permission to increase the bore size of the twelve top tube sheet tubes was granted to the Inspection Department by the du Pont Design Division.

Next, it was decided by the Inspection Department that a preliminary freon test would be performed on the plenum to determine if any leakage resulted from the replacing and welding of eight (8) non-bearing tubes and

ten (10) rod tubes discussed in preceeding paragraphs. This was done and the results are indicated in Exhibit #13. (For detail procedure on how a freon test is performed, see section #11 of this manual.)

(6) Summary of Orientation Measurements on "R" Plenum Relative to "R" Top Tube Sheet

Orientation readings were taken at various times throughout the fabrication of "R" unit to determine: (1) if any shrinkage resulted from line boring of large tubes, (2)rotational movement of plenum due to welding of indexing grooves (3) other repair work done on plenum chamber as a result of line boring. These readings were taken by means of a micrometer adapted to a Vee block shown in Sketch #34.

Readings on the "R" plenum chamber relative to the "R" top tube sheet were taken at the following time:

1. Before removal of plenum from line boring operation for replacing first five defective tubes.

2. After replacement of plenum on top tube sheet after replacing first five defective tubes.

3. Before removal of plenum after re-boring the first five (5) replaced tubes.

4. After replacement of plenum after replacing first defective rod tubes.

5. Before removal of plenum after re-boring rod tubes that were replaced.

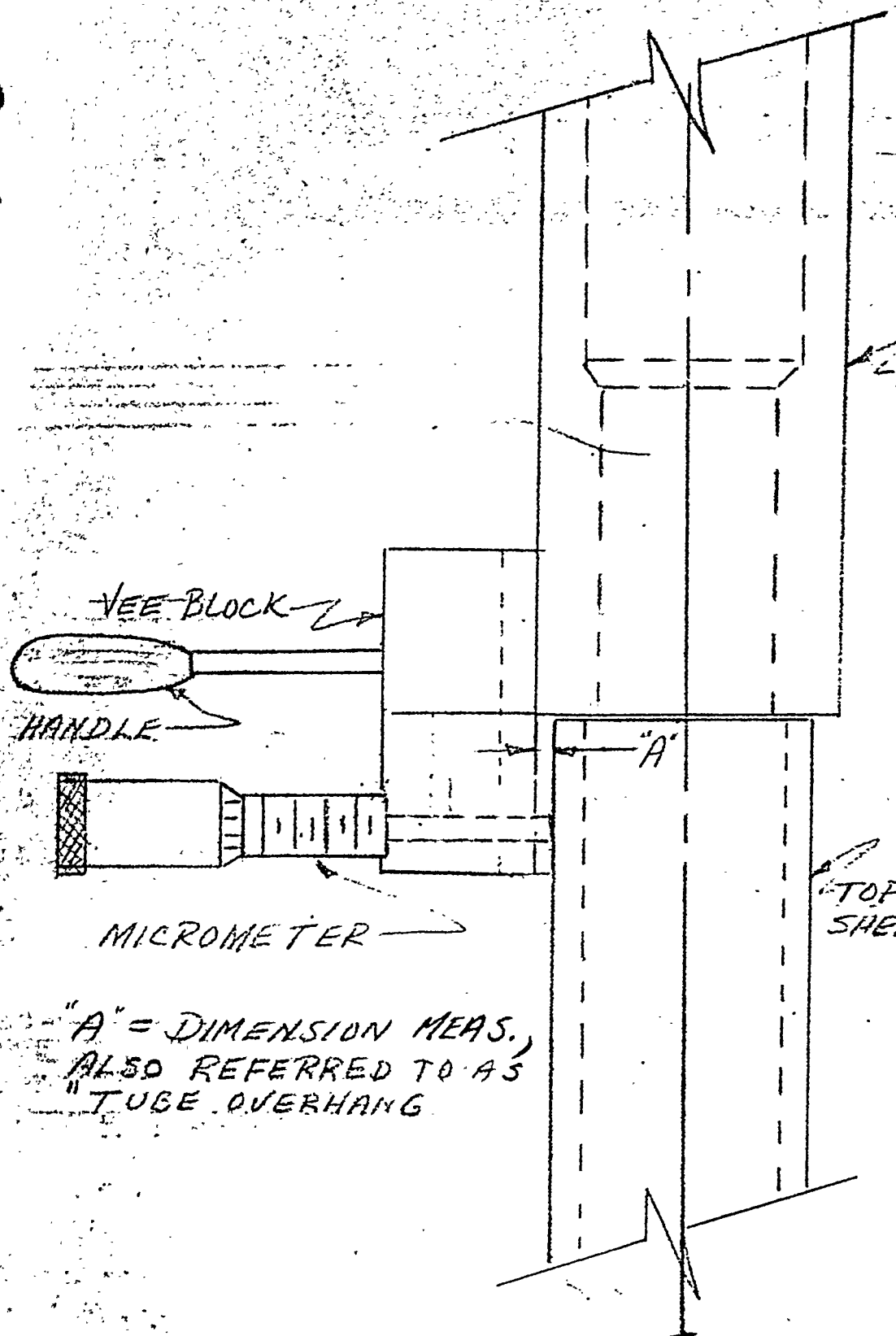
6. After replacement of plenum after another rod tube was replaced.

Data for the above is tabulated as follows:

	Tube Number		Measurements	
	X2 axis X1-Y45	Y2 axis X27-Y93	X1 axis X55-Y51	Y1 axis X29-Y3
1	0.658"	0.653"	0.678"	0.659"
2	0.660"	0.656"	0.679"	0.647"
3	0.659"	0.657"	0.681"	0.648"
4	0.661"	0.665"	0.685"	0.652"
5	0.660"	0.665"	0.685"	0.653"
6	0.658"	0.665"	0.685"	0.652"

Interpretation of Results:

Results are interpreted keeping one thing in mind, namely; readings taken at tube overhang at the extremities of the X and Y axis (as shown in Sketch #34) must all approach a nominal



"A" = DIMENSION MEAS., ALSO REFERRED TO AS "TUBE OVERHANG

SKETCH # 34

ENGINEERING SKETCH SHEET E. I. DU PONT DE NEMOURS & CO.	PROJ. No.	SIGNATURE:
PROJ. TITLE		DATE
SUBJECT:		No. E-42465

E. I. DU PONT DE NEMOURS & CO., INC. Report Number 165-R

[redacted] nuction Division

CC: C. E. Buckley, F.P.M.
R. K. Mason, F.P.M.-SRP-3
H. L. Bunker-J.G.Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
A. H. Hughes
R. H. Potts (4)
C. W. Dunn - File

August 6, 1952
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

This material contains information affecting the national defense of the United States within the meaning of the espionage laws, Title 18, U.S.C., Secs. 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

TO C. J. VEITH - M & E FILE

FROM D.M.Leland, H.E.Dahlke, O.R.Frandsen DATE July 24, 1952

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Plenum Chamber EQ.FC.NO. 155-R

DRAWING NOS. W-130910 JOB RATING

[redacted] New York Shipbuilding Corporation LOCATION Camden, N.J.

Scope: Detection of leaks, if any, in tube sheet assembly by means of Freon test after the following tubes had been re-placed.

Non-Bearing Tubes

[illegible]-21, Y- 3	X-25, Y-87	
[illegible]-23, Y- 3	X-22, Y-90	
[illegible]- 4, Y-36	X-24, Y-90	
[illegible]-28, Y-36	X-26, Y-90	

Rod Tubes

X-30, Y-16	X-48, Y-64	
X-49, Y-41	X-34, Y-64	
X-45, Y-49	X-32, Y-68	
X-40, Y-52	X-18, Y-68	
X-16, Y-58	X-25, Y-89	

Procedure:

After all openings were made airtight, ten (10) lbs. of freon (by weight) was introduced into unit, and pressure was raised to 55 psi. with air. Using a General Electric Type "H" Leak Detectors, all re-placed tubes and all tubes adjacent to the re-placed tubes were checked at the welds between tubes and tube sheet plates.

Results:

No leaks were detected.

[redacted]

reading to a degree. In other words, this "nominal reading" is approached by noting the difference in readings between all four measurements taken. When the smallest differential exists between the four readings, this is the optimum condition possible for aligning the plenum chamber over the top tube sheet.

NOTE: In all cases a centering mandrel is inserted into plenum center tube (X28-Y48) and locked with about one foot of the mandrel protruding through the bottom end of the tube. The centralizing or centering mandrel is guided into the top tube sheet center tube (X28-Y48) during the initial placing of the plenum on the top tube sheet. Then the mandrel is used as a pivot for rotating the plenum to its best position as explained above.

(7) Inspections Performed After Chamfering Large Tubes

After line boring all large tubes, the top ends were chamfered 5/32" x 10° using a special teflon piloted fly cutter. After chamfering all large tube ends to dimensions shown in Dwg. 2-1, section 16A-(2)b of this manual, all chamfers were checked using a 10° beveled gage which was a prototype of the required chamfer dimensions. Also, a visual check was made for evidence of tool "chatter" and burrs. No discrepancies were found and the job was approved.

When chamfering of large tube ends on the top side was completed, inspected and accepted, the plenum chamber was turned bottom side up and a 1/8" x 45° chamfer was machined into the bottom ends of all large tubes. Tube chamfers were checked using a 45° beveled gage which was a prototype of the required chamfer dimensions. Also, a visual inspection was made for evidence of tool "chatter" and burrs. No discrepancies were found and the job was accepted.

B. "P" Unit

(1) Preliminary Set-up

a. Leveling Top Tube Sheet Assembly

Before aligning the plenum chamber on the top tube sheet, the latter was set and leveled on special foundations. This unit was leveled in the X and Y direction using the Wild N111 Precision Level and target within 0.011". After this, the plenum chamber was aligned over the top tube sheet. Next, a straight edge was layed along the tubes in row X28 and checked for levelness using a spirit level and then along row Y48 and repeated. The unit was found to be level within 0.003" in both directions and accepted.

b. Installation of Centering Plugs in Top Ends of Rod Tubes.

Centering plugs were inserted in top tube sheet rod tubes to be later used as centering points from which rod tube base plates were set. These plugs were inserted before aligning the plenum chamber on the top tube sheet. See Section 15-A-1b of this manual for procedure.

c. Centering of Plenum Chamber Over the Top Tube Sheet

It was necessary to place the six indexing grooves (before welding) on the top tube sheet in the best condition to mate the six indexing tongues welded on the plenum. The six indexing tongues were all ready positioned and welded on the bottom of the plenum chamber at this point. The next problem was to get the best alignment of the plenum tubes over the top tube sheet tubes and weld on indexing grooves to the top tube sheet. When this best condition was established (the plenum was guided onto the top of the top tube sheet with the aid of a centralizing mandrel as explained in Part 6 of this section), readings were then taken with a depth gage at tube overhang points at the extremities of the X and Y axes. Section 15A-(6) of this manual explains where and how these readings were taken. The indexing grooves on T.T.S. were then tack welded on three sides; overhang readings re-taken to determine if any movement due to tacking took place, and then fully welded on the three sides. After welding on the indexing grooves was completed and checked out satisfactory, the two units were bolted down for line boring. Acceptable readings for the initial line boring set-up were: X_1=0.667"; X_2=0.652"; Y_1=0.712"; Y_2=0.706". (Note; The indexing devices on the top tube sheet were on the fourth side (next to tubes) when the units were separated as described on (2)-b of this section).

d. Inspection for Correct Seating of Units

Bearing surfaces between the bottom ends of the plenum tube and top ends of the top tube sheet tubes were checked for mating conditions. See Section 15A-1d of this manual for procedure.

e. Chip Stoppers

Inspection of chip stoppers was performed in a similar manner as described in Section 15A-(1)e of this manual.

(2) Inspections Performed During Line Boring Operations

a. Verticality of Plenum Tubes After First Cut (4.250")

The Inspection Department began a spot check of the verticalities of the large tubes on each shift after the first rough cut to insure an acceptable verticality. Tube

verticality readings were taken using a specially designed verticality gage described in Part III, II-L. Before the rough cut was begun, periodic checks were made of the boring bar to make sure that the bar was perpendicular to the base plate. This was done using a "Bullseye" level mounted on a "Vee" block. Also, at this time a visual inspection was made to evaluate the finish of the bored tube and a visual check made of wooden chip stoppers for possible damage or displacement.

The rough cut (4.250") dia. was completed and then all rod tubes were faced off to correct height referencing from tops of large tubes. For a resume of this inspection, see Section 16B-17 of this manual.

b. Welding of Centering Devices (Continuation of 1c above)

Next, the plenum chamber was removed from the line boring set-up to finish weld the fourth side (next to tube pattern) of the six indexing grooves. Welding could not be done on the fourth side while the units were in an operating position due to the inaccessability of the fillet weld joint. This was necessary since any additional welding on the indexing devices (after finish line boring) subjects them to either a rotational or radial movement (due to shrinkage from welding), and hence was not desirable as this movement destroys the functional gaging characteristics of both large and small tubes. After centering grooves were completely welded, the plenum chamber was again positioned on the top tube sheet and final tube overhang measurements taken and compared with initial readings. Results of readings were as follows: X_1-0.683"; X_2-0.644; Y_1-0.707"; Y_2-0.701". These readings indicated the unit did not move any appreciable amount, and they were, therefore, considered acceptable.

During the time the plenum was removed, an attempt was made to remove all burrs at bottom of large tubes caused by the rough cut. Inspection of this proved satisfactory.

c. Line Boring of Rod Tubes

[1.] List of Inspections Performed on Rod Tubes After Boring and Before Honing

(a) Bore readings in top land (X & Y directions).

(b) Bottom bore checked with "GO-NOGO" plug gage (1.3075" - 1.3175").

(c) Verticality readings by verticality gage in readings of .001" per foot.

(d) Functional gaging with 62½" long round bar with two diameters. First 9-3/4" of bar had a diameter of 1.484" and remainder, a diameter of 1.271 inches.

(c) Depth of counter-bore.

(f) Estimated finish in RMS by "feel" and comparing with G.E. standardized RMS finished.

[2.] Results

The line boring of the rod tubes began; however, an inspection of the first few tubes revealed that the counter-bore was finished to a depth of 9 7/8" to the top of the counter-bore instead of to the bottom of the counter-bore. Design gave permission to finish the tubes to this depth since several tubes had already been drilled to this depth. (See Sketch #34-A) The verticalities of three of the six rod tubes finished showed an inclination far beyond drawing tolerance. Due to the fact it was not possible to rectify the situation and because the tubes functional gaged, line boring continued. A record was kept of all discrepancies so that they might be corrected, if possible, by honing at a later date.

[3.] Stenciling Tube Numbers on Tube Ends

While the line boring of rod tubes progressed, inspectors stenciled the tube coordinates on the top of each large tube for ready identification. For history of tube stenciling, see Section 14B-9 of this manual.

[4.] Inspections During and After Honing

The following list of inspections were performed on rod tubes:

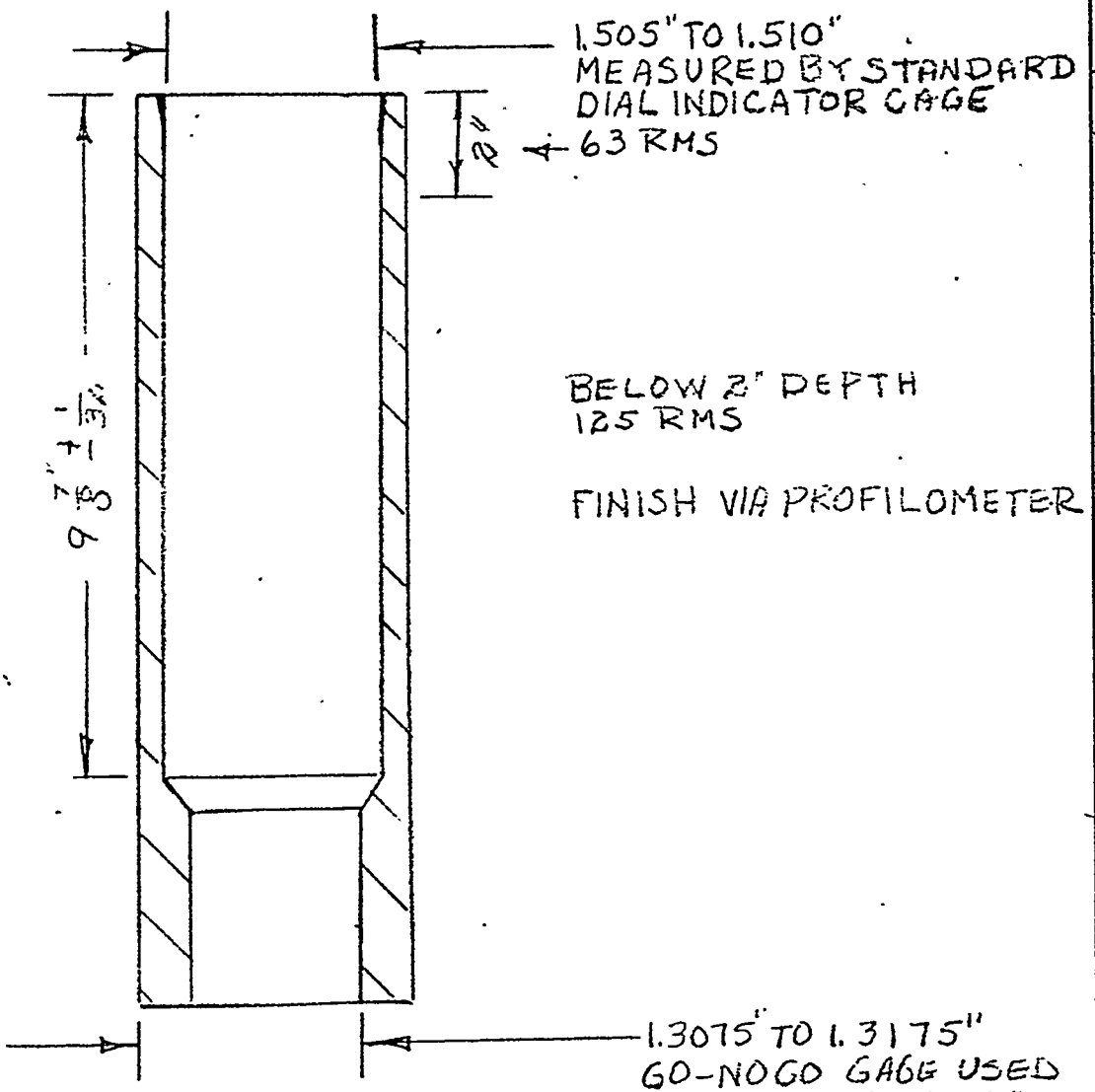
(a) Bore size in top 2" portion of tube bore using standard dial indicator bore gages and appropriate size ring gages both in the X and Y directions.

(b) Finish of tubes in RMS (profilometer readings), placing particular emphasis on O-ring seating areas. See Sketch #34-A.

(c) Visual inspection for evidence of scratches, gouges, and other mechanical defects in rod tube bores, placing particular emphasis on the top 2" portion of a rod tube.

(d) Final functional gaging with a 62½" round bar with two diameters. The top 9 7/8" of the gage has a diameter of 1.484", and the remaining portion a diameter of 1.271 inches.

SKETCH SHOWING ROD TUBE FINISH MEASUREMENTS & MEASURING DEVICES



SKETCH #34-A

ENGINEERING SKETCH SHEET E. I. DU PONT DE NEMOURS & CO.	PROJ. NO.	SIGNATURE:
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SUBJECT:		No.

(e) Verticality of tubes using a specially designed verticality gage which indicates the inclination with the vertical in 0.001"/ft. Uses of this gage is discussed in Part III, II-L.

(f) Bottom bore check from bottom side of unit using a 1.503" diameter plug gage.

(g) Checked bevel in top unit of rod tubes using a 10° beveled plug gage.

A resume of the above listed inspections and results were as follows: Immediately after line boring all rod tubes, each bore was honed to increase the diameter between 1.505" to 1.510" to enable all tubes to properly functional gage and in addition, to get a required finish of 63 RMS or better in the top 2" bore of the tube. The finish of many tubes below the 2" depth was above the 125 RMS requirement. (See Dwg. 2-2, Section 7A-2a of this manual for rod tube specifications) In lieu of this finish, it was decided that all tubes would be smoothed with emory discs (cloverleafing).

The tubes repaired in this manner were inspected and found satisfactory. Also, a re-check on bore diameter of those tubes repaired indicated no appreciable change in the bore diameter.

Tubes X33-Y17 and X26-Y52 had a top bore depth of 9-13/16" and X19-Y59 a depth of 9-61/64". These discrepancies were acceptable per Design. All other tube counter-bore lengths were checked with a special depth gage and found within tolerance.

Visual examination of all tubes revealed that tubes X15-Y53, X4-Y58, X13-Y71, X29-Y25 and X32-Y40 had scratches in the bore. It was decided that the scratches would not interfere with the seating of O-rings and were accepted on this basis. The finish (75 RMS) of the top 2" bore of tube X34-Y92 was also accepted.

Twelve rod tubes would not functional gage after honing. The bottom bores of these tubes were opened up beyond tolerance. The measurements for all tubes whose bore diameter exceeded 1.3175" were accepted. In addition, several tube counter-bores had a diameter in excess of drawing dimension 1.510". However, after repairing, these tubes functional gaged and were accepted.

Later, nine tubes (X43-Y11, X48-Y64, X17-Y77, X34-Y92, X39-Y89, X36-Y36, X30-Y44, X38-Y28 and X27-Y29)

and would not functional gage properly after honing and opening the bottom of the rod tube bore. A further attempt was made to seat the functional gage by honing corresponding top tube sheet tubes. Finally, through the combined efforts of honing in the plenum and in the top tube sheet tubes on areas where bluing compound dyed the bore from functional gaging, all tubes were made to functional gage properly. (Note: To determine where interference was located in a rod tube bore, the 1.484" rod tube functional gage was painted with a blue dying compound; then inserted into the rod tube and again removed. Visual examination of the bore indicates where the interference was located by the presence of bluing compound. This area was cloverleafed (emory disc) or honed until the functional gage passed freely.)

After beveling or chamfering the top edge of all rod tubes to dimensions shown in Dwg. 2-2, Section 7A-(2) of this manual, a 10° prototype plug gage was used to gage the depth of the finished machined bevels. All inspections proved satisfactory.

During line boring, the base plates moved while drilling rod tube X34-Y64. The plenum was removed from the top tube sheet and this tube removed. (At this time, the top tube sheet rod tubes were opened up to 0.010" oversize in the top land for those tubes that would not functional gage, as discussed in the above paragraph.)

The plenum was returned to the line boring position to line bore the replaced rod tube. After this, nine rod tubes again would not functional gage. The tube bores were enlarged in the plenum and top tube sheet to the maximum diameters acceptable to Design until all rod tubes functional gages.

For final results of rod tube line boring, see Exhibit #13-A. For rod tube line boring procedure, see Section 15A-(4) of this manual.

d. Second Cut on Large Tubes

The second cut on the large tubes was the semi-finish boring to a 4.340" diameter. The base plate set by New York Ship line boring crews operated on the principle that the base plate would best be set in that position directly over the mid-point of the top tube sheet tubes. Inspection surmised that it would be advantageous first to check all base plates previously set by New York Ship with the electronic gage. The feeling prevailed that an excessive number of tubes

EXHIBIT #13-A

RESULTS OF ROD TUBE LENS BORING OPERATION

RESULTS OF ROD TUBE LINE-BORING OPERATION — DATE COMPLETED: 2-4-53

P UNIT

IDENTIFICATION OF TUBES			BORE MEASUREMENTS					VERTICALITY							FUNCTIONAL GAGE			DEPTH OF TOP BORE	FINISHES TOP BORE		BORES AFTER HONING		
TOP NUM.		NEW YORK SHIP NO.	TOP BORE		REMARKS	BOTTOM BORE PLUG GAGE		REMARKS	DIRECTION				AVERAGE		REMARKS	GO	NO GO	REMARKS		BEFORE HONING	AFTER HONING			REMARKS Rms Below 2"
X	Y		1.5021	1.5055		1.3075	1.3175		N	E	S	W	N-S	E-W										
32	50		1.499			GO	NO GO		-5	+12	+7	-10	6N	11W					9 13/16	0-63	30	1.507	1.497	90
48	50		1.504			GO	NO GO		+5	+3	+1	+3	2E	0					9 7/8	63-125	30	1.510	1.510	100-300
15	49		1.501			GO	NO GO		-5	+1	+2	-4	3½N	3½W					9 7/8	0-63	40	1.508	1.498	480
29	50		1.501			GO	NO GO		-10	+10	+9	+14	9½N	12E					9 59/64	0-63	40	1.508	1.498	120
21	49		1.504			GO	NO GO		-7	+16	+29	-35	18N	19½W					9 57/64	0-63	50	1.516	1.506	90-100
20	50		1.499			GO	NO GO		-3	+9	+2	-9	6½N	6W					9 53/64	0-63	50	1.509	1.509	50-250
17	49		1.5001			GO	NO GO		+9	+8	-18	-2	13½S	3E					9 7/8	125-UP	20	1.507	1.507	250
8	52		1.500			GO	NO GO		-14	+22	+18	-15	2½N	18½W					9 7/8	0-63	30	1.506	1.506	80
15	53		1.501			GO	NO GO		+2	+10	-1	-13	7½S	11½W					9 57/64	63-125	50	1.510	1.510	50-250
26	52		1.498			GO	NO GO		+15	+2	-7	+4	11S	1E					9 13/16	0-63	30	1.507	1.507	50-250
29	53		1.500			GO	GO	.1315 .1318	+17	-1	-13	+5	15S	3E					9 55/64	0-63	40	1.508	1.508	50
10	52		1.500			GO	NO GO		+2	+1	0	-2	1S	1½W					9 53/64	63-125	35	1.506	1.506	100-250
12	53		1.500			GO	NO GO		+20	+2	-7	+7	13½S	2½E					9 57/64	63-125	50	1.506	1.506	35
19	55		1.502			GO	NO GO		-3	-3	+9	+1	5½N	7E					9 59/64	0-63	50	1.509	1.508	50-250
8	56		1.501			GO	NO GO		+1	-5	-15	-10	8S	9½W					9 7/8	0-63	30	1.508	1.508	50-250
5	55		1.501			GO	NO GO		-12	-9	+17	+15	14½S	11W					9 59/64	125-UP	50	1.509	1.509	50-250
14	56		1.500			GO	GO	.1316 .1315	+22	+2	+19	-7	18N	9½W					9 7/8	0-63	40	1.507	1.507	250
21	55		1.501			GO	GO	.1312 .1316	-70	+10	+96	+17	22½N	3½E					9 59/64	0-63	50	1.507	1.507	90
10	56		1.498			GO	NO GO		+3	+29	+9	-18	½N	20W					9 7/8	0-63	65	1.507	1.507	65
7	55		1.501			GO	NO GO		+4	+8	-11	-19	7½S	15½W					9 57/64	0-63	70	1.507	1.507	
3	58		1.500			GO	NO GO		-3	+3	-2	-9	½N	6W					9 53/64	0-63	25	1.508	1.508	50-250
14	58		1.500			GO	GO	.1316 .1318	+11	-12	-14	+10	9½S	11E		NO GO	GO AFTER HONING		9 57/64	125-UP	60	1.508	1.508	100-300
4	59		1.502			GO	NO GO		+2	+12	+12	-7	0	9½W					9 7/8	0-63	30	1.510	1.510	70-250
9	59		1.501			GO	NO GO		-5	-2	+8	+3	6½N	2½E					9 59/64	0-63	40	1.512	1.512	90
0	58		1.500			GO	NO GO		+9	+3	+3	+8	3S	2½E					9 7/8	63-125	50	1.508	1.508	50-350
3	59		1.502			GO	GO	.1314 .1316	+0	+2	0	+3	2S	½E					9 57/64	63-125	48	1.508	1.507	90-125
4	58		1.503			GO	NO GO		+10	+8	+1	+3	5½S	2½E					9 7/8	125-UP	50	1.508	1.508	125-250
7	59		1.5025			GO	NO GO		+2	+10	+5	-4	1½N	7W					9 7/8	0-63	50	1.506	1.507	50-250
2	62		1.5015			GO	NO GO		-7	-11	+10	+12	8½N	11½E					9 7/8	0-63	60	1.509	1.509	60-400
9	61		1.503			GO	NO GO		+2	-7	-8	+6	4½S	7E					9 59/64	0-63	20	1.506	1.506	90-90
9	62		1.500			GO	NO GO		-10	-18	+15	+20	21½N	4½E					9 7/8	0-63	60	1.507	1.507	90-130
5	61		1.501			GO	NO GO		+5	-20	-6	+20	8½S	20E		NO GO	GO AFTER HONING		9 57/64	63-125	48	1.507	1.507	90-300
4	62		1.502			GO	NO GO		+2	+7	+1	-13	1½S	16½W					9 57/64	125-UP	60	1.509	1.509	300-300
	61		1.499			GO	NO GO		-8	+2	+8	-1	8N	1½W					9 7/8	0-63	20	1.508	1.508	70-150
	65		1.504			GO	NO GO		-12	+5	+8	-2	8N	3½W					9 7/8	63-125	20	1.508	1.508	50-150
0	64		1.501			GO	NO GO		-2	-2	-8	-7	0	7½E					9 7/8	0-63	30	1.505	1.505	90-250
5			1.505		replaced	GO	NO GO		+1	-2	+1	-1	0	1½E					9 55/64	63-125	30	1.509	1.509	100-300
4			1.500			GO	NO GO		+8	+3	+3	+6	2½S	1E					9 7/8	0-63	55	1.506	1.507	
7	65		1.501			GO	NO GO		+4	+10	+2	-5	1S	7½W					9 7/8	0-63	40	1.506	1.506	50
8	64		1.504			GO	GO	.1321 .1317	-6	-6	+6	+11	9½S	8½E		NO GO	GO AFTER HONING		9 7/8	63-125	45	1.510	1.510	1.515
1	68		1.507			GO	NO GO		+2	+2	-8	-14	8S	8½W					9 7/8	63-125	65	1.510	1.510	100
6	68		N-4995			GO	NO GO		+10	-4	-10	+4	10S	4E					9 59/64	63-125	35	1.509	1.509	50-150
3	67		1.499			GO	NO GO		+15	-2	-12	+3	13½S	2½E					9 57/64	63-125	65	1.505	1.505	50-150
2	68		1.5035			GO	NO GO		+2	+2	-1	-1	1½S	½W		NO GO	GO AFTER HONING		9 7/8	0-63	46	1.507	1.507	250
9	67		1.501			GO	NO GO		+11	+6	-12	-2	11½S	3½W					9 7/8	0-63	30	1.505	1.505	150
3	66		1.499			GO	NO GO		-16	+18	-7	-2	11N	2½E					9 7/8	0-63	40	1.505	1.505	90
5	67		1.505			GO	NO GO		-11	0	+7	-4	9N	2W					9 7/8	0-63	55	1.513	1.507	250
	68		1.500			GO	NO GO		+5	-16	0	+18	21½S	11½E		NO GO	GO AFTER HONING		9 7/8	0-63	60	1.508	1.508	150-250
5	71		1.501			GO	NO GO		+6	+12	+1	+19	3S	15½W					9 59/64	63-125	35	1.508	1.508	50-150
4	70		1.500			GO	NO GO		+6	+20	+6	0	5N	10W					9 57/64	0-63	40	1.509	1.510	100-300
7	71		1.504			GO	NO GO		+15	-2	-15	0	18S	1E					9 55/64	0-63	30	1.506	1.506	100-400
1	70		1.502			GO	GO	.4317 .4324	+26	+8	-20	-2	23S	5W					9 3/8	0-63	60	1.507	1.507	70-200
	71		1.501			GO	NO GO		+9	+3	-3	+2	6S	1½W					9 7/8	63-125	20	1.507	1.507	171
2	74		1.501			GO	GO	.1315 .1315	+1	-1	-11	+1	6S	6E					9 7/8	0-63	30	1.508	1.508	50-250
1	74		1.501			GO	NO GO		-25	-15	+25	+10	25N	12½E		NO GO	GO AFTER HONING		9 57/64	63-125	57	1.505	1.505	100
	78		1.501			GO	NO GO		-19	+6	+17	-2	15½S	4½W					9 55/64	0-63	60	1.510	1.509	60-250
	74		1.503			GO	NO GO		0	0	0	-5	0	5½W					9 57/64	0-63	60	1.510	1.510	60-400
	75		1.503			GO	NO GO		-1	-2	+21	+1	1N	11½E					9 59/64	0-63	50	1.508	1.508	60-130
	74		1.5011			GO	NO GO		+2	+8	+18	+7	6N	1½W					9 59/64	0-63	40	1.507	1.507	50-150
	76		1.5005			GO	NO GO		-7	-12	-4	+12	8½S	11E					9 7/8	0-63	50	1.506	1.506	300-300
	77		1.501			GO	GO	.1316 .1317	-5	+23	-7	-28	7N	18W					9 7/8	0-63	50	1.507	1.507	50-250
	76		1.503			GO	NO GO		+8	-30	+37	+48	27½N	24½E		NO GO	GO AFTER HONING		9 57/64	63-125	60	1.512	1.512	100-125
	77		1.501			GO	NO GO		+8	-7	+8	-15	4N	8½W					9 7/8	63-125	50	1.506	1.506	300-300
	74		1.4995			GO	NO GO		+2	0	+7	+8	5N	4E					9 59/64	63-125	50	1.508	1.508	90-250
	79		1.501			GO	NO GO		-28	+22	+15	-18	20N	20W					9 7/8	125-UP	50	1.508	1.508	250
	79		1.504			GO	NO GO		-4	+9	+18	-2	8½N	9½W					9 7/8	0-63	30	1.508	1.508	250
	80		1.5005			GO	NO GO		-1	-8	-5	0	4S	1½E					9 59/64	0-63	60	1.508	1.508	60-400
	79		1.501			GO	GO	.1317 .1312	+6	+1	-12	-10	9S	9½W					9 57/64	0-63	40	1.508	1.508	110-230
	80		1.498			GO	NO GO		-18	+11	+18	-6	6½N	8½W		NO GO	GO AFTER HONING		9 57/64	63-125	55	1.510	1.510	300-300
	83		1.501			GO	NO GO		-5	+5	-2	-18	7½N	7½W					9 7/8	0-63	40	1.506	1.506	250-150
	82		1.501			GO	NO GO		-22	-5	+23	+6	25½N	5½E					9 7/8	125-UP	60	1.507	1.507	150-300
	83		1.502			GO	NO GO		+10	+2	-10	-4	10S	5W					9 7/8	63-125	90	1.506	1.506	40-150
	86		1.503			GO	NO GO		-2	-2	+3	+2	2½S	2E					9 7/8	0-63	60	1.507	1.507	50-400
	86		1.504			GO	NO GO		-12	+8	+12	-12	12N	10W					9 7/8	125-UP	55	1.509	1.509	300-300 Rms
	85		1.5005			GO	NO GO		-6	-4	+1	+6	5½N	5E					9 59/64	63-125	35	1.507	1.507	100-150
			1.4997			GO	NO GO		-11	-8	+7	+4	9N	5½E					9 57/64	0-63	50	1.506	1.506	100-250
			1.4996			GO	NO GO		+3	+6	-3	+7	8S	4½E					9 7/8	0-63	40	1.506	1.506	50-150 Rms
	97		1.502			GO	GO	.1317 .1317	-25	+11	-22	-2	22½S	11½W		NO GO	GO AFTER HONING		9 7/8	0-63	45	1.506	1.506	50-150
	98		1.501			GO	GO	.1317 .1319	+5	-9	+3	+8	0	9E		NO GO	GO AFTER HONING		9 59/64	63-125	50	1.511	1.511	150
	98		1.503			GO	NO GO		+13	0	+16	+3	11½N	8½E		NO GO	GO AFTER HONING		9 57/64	63-125	50	1.511	1.512	60-75
	95		1.505			GO	NO GO		-9	-15	+15	+19	12N	17E					9 55/64	0-63	40	1.505	1.505	
	95		1.500			GO	NO GO		-1	+10	+18	+1	9½N	14½E					9 53/64	0-63	40	1.508	1.508	90
									-5	-6	+7	+10	6N	8E					9 59/64	0-63	40	1.505	1.505	150

RESULTS OF ROD TUBE LINE-BORING OPERATIONS — DATE COMPLETED: 2-4-53

P UNIT

IFICATION TUBES		BORE MEASUREMENTS					VERTICALITY						FUNCTIONAL GAGE			DEPTH OF TOP BORE	FINISHES		BORES AFTER HONING		
TUBE UMBER	NEW YORK SHIP NO.	TOP BORE		REMARKS	BOTTOM BORE PLUG GAGE		REMARKS	DIRECTION				AVERAGE	REMARKS	GO	NO GO	REMARKS		TOP BORE BEFORE HONING	TOP BORE AFTER HONING			REMARKS
X		1.500	1.505		1.3075	1.3175		N	E	S	W	N-S E-W										
10		1.497			GO	NO GO		+5	+8	-9	-7	14S 15W		GO			9 7/8	65-125	95	1.505	1.506	100-150
16	2	1.4995			GO	NO GO		+10	+20	-8	-16	18S 36W		GO			9 27/32	0-63	50	1.508	1.508	100-150
19	5	1.500			GO	NO GO		-9	+1	+12	+7	21N 8E		GO			9 31/64	0-63	60	1.510	1.510	100-200
2	8	1.502			GO	NO GO		+14	+14	-11	-9	25S 23W		GO			9 27/32	0-63	65	1.506	1.506	100-300
0	8	1.502			GO	NO GO		+2	+15	+2	-7	0 17W		GO			9 7/8	0-63	60	1.510	1.510	150-350
4	10	1.501			GO	NO GO		+8	-8	-11	+5	9S 4E		GO			9 7/8	0-63	30	1.507	1.507	200-300
6	19	1.501			GO	NO GO		+21	+1	-20	-9	28S 5W		GO			9 25/64	0-63	65	1.509	1.509	200-400
9	11	1.501			GO	NO GO		+13	+20	+3	-9	5E 12W		GO			9 27/32	0-63	35	1.507	1.507	100-250
8	11	1.504			GO	GO	X 1.505 Y 1.319	-20	+15	+15	-11	17S 15W			NO GO	GO AFTER HONING	9 27/32	63-125	60	1.508	1.510	150-350
5	13	1.502			GO	NO GO		+12	+21	-2	-11	7S 16W		GO			9 7/8	0-63	20	1.509	1.509	90-300
4	14	1.501			GO	NO GO		-8	0	+8	+2	8N 1E		GO			9 7/8	0-63	35	1.508	1.508	100-300
1	15	1.502			GO	NO GO		-7	+18	+7	-11	7N 14E		GO			9 27/32	0-63	35	1.507	1.507	150-300
0	14	1.502			GO	NO GO		+6	-3	-3	-1	4S 1E		GO			9 25/64	0-63	30	1.508	1.508	30-600
9	17	1.499			GO	NO GO		-11	-16	+1	+11	6N 13E		GO			9 7/8	125-UP	50	1.509	1.509	200-300
0	16	1.501			GO	NO GO		-11	-11	+10	+10	10N 10E		GO			9 7/8	0-63	50	1.506	1.506	50-200
9	17	1.501			GO	NO GO		-9	-8	-6	+6	1S 7E		GO			9 13/16	0-63	65	1.510	1.510	150-350
2	17	1.498			GO	NO GO		-27	-9	+26	+12	25N 28E		GO			9 25/64	125-UP	50	1.506	1.506	60-150
2	20	1.499			GO	NO GO		-12	-3	+21	+16	16N 9E		GO			9 27/32	0-63	50	1.508	1.508	70-200
9	19	1.501			GO	NO GO		+3	-2	+5	+5	0 3E		GO			9 7/8	0-63	60	1.508	1.508	60-40 STAGE
9	20	1.501			GO	NO GO		+1	+10	+3	-6	1N 7W		GO			9 7/8	0-63	35	1.506	1.506	60-150
5	19	1.4995			GO	NO GO		+2	+4	+5	+2	9N 1W		GO			9 7/8	0-63	55	1.505	1.506	70-200
8	20	1.4992			GO	NO GO		-1	-4	+2	+6	1N 6E		GO			9 25/64	0-63	40	1.508	1.508	150
0	23	1.5005			GO	NO GO		+6	+9	-6	-8	6S 8W		GO			9 7/8	0-63	40	1.508	1.508	40-500
0	22	1.501			GO	NO GO		+3	-5	-5	+5	5S 5E		GO			9 27/32	63-125	35	1.508	1.508	200-800
5	23	1.497			GO	NO GO		-11	-11	+8	+7	9N 9E		GO			9 25/64	0-63	30	1.507	1.507	150
4	22	1.504			GO	NO GO		-6	+27	+12	-25	9S 25W		GO			9 31/64	0-63	40	1.508	1.508	50
7	23	1.501			GO	NO GO		-13	0	+16	0	14N 0		GO			9 7/8	0-63	50	1.505	1.505	150
6	23	1.499			GO	NO GO		-7	-9	+9	+6	8N 6E		GO			9 7/8	63-125	50	1.509	1.509	90-300
6	26	1.502			GO	NO GO		-8	+17	+7	-15	9N 15W		GO			9 7/8	0-63	55	1.508	1.508	100-300
3	25	1.505			GO	NO GO		+19	-6	-20	+3	14S 9E		GO			9 7/8	63-125	40	1.509	1.510	50-70
3	26	1.500			GO	NO GO		+9	+15	+2	-1	8S 8W		GO			9 25/64	0-63	50	1.505	1.505	100-300
7	25	1.501			GO	NO GO		-3	+1	-8	+10	2S 10W		GO			9 27/32	0-63	40	1.510	1.510	28-150
1	26	1.500			GO	NO GO		-12	+10	+11	-8	11N 9W		GO			9 31/64	63-125	35	1.505	1.505	50
1	25	1.509			GO	NO GO		+8	+12	-1	-4	9S 8W		GO			9 7/8	125-UP	50	1.508	1.512	20-50
1	26	1.503			GO	NO GO		+6	+3	-8	0	5S 1W		GO			9 25/64	0-63	60	1.508	1.508	60-300
1	28	1.500			GO	NO GO		+12	-2	-7	-9	9S 9W		GO			9 7/8	0-63	50	1.508	1.509	50-400
4	29	1.500			GO	NO GO		-5	0	+9	+7	6N 3E		GO			9 7/8	63-125	30	1.506	1.506	100-200
7	28	1.502			GO	NO GO		+2	+6	+1	-2	1S 4W		GO			9 25/64	0-68	50	1.508	1.505	50-120
7	29	1.505			GO	GO	X 1.364 Y 1.321	-10	+9	+15	-16	16N 9W			NO GO	GO AFTER HONING	9 7/8	125-UP	40	1.512	1.512	50-100
1		1.506			GO	GO	X 1.324 Y 1.321	+22	+26	-26	-25	24S 23W			NO GO	GO AFTER HONING	9 7/8	125-UP	45	1.508	1.510	50
1		1.500			GO	NO GO		-8	+2	+8	+1	8N 1W		GO			9 25/64	125-UP	55	1.509	1.510	150-350
1	32	1.4995			GO	NO GO		+9	+12	+18	-12	15N 12W		GO			9 31/64	0-63	55	1.505	1.505	50-200
7	31	1.502			GO	NO GO		-10	-10	0	-3	3N 5W		GO			9 7/8	0-63	65	1.506	1.506	60-150
1	32	1.500			GO	NO GO		+12	+15	-9	-12	14S 12W		GO			9 7/8	125-UP	50	1.509	1.509	150
2	32	1.500			GO	NO GO		-4	+16	+13	-5	7N 10W		GO			9 7/8	0-63	30	1.509	1.509	30-80
	31	1.4995			GO	NO GO		+6	+10	0	-8	2S 7W		GO			9 7/8	63-125	80	1.506	1.506	50
	32	1.505			GO	NO GO		+11	-22	-8	+26	9S 24E		GO			9 31/32	63-125	30	1.506	1.506	30-120
	35	1.505			GO	GO	X 1.318 Y 1.330	+4	+2	+9	+5	2N 7E		GO			9 25/64	0-63	60	1.509	1.509	60-250
	34	1.505			GO	NO GO		-6	-10	+9	+8	7N 9E		GO			9 25/64	0-68	40	1.508	1.508	100-300
	35	1.502			GO	GO	X 1.063 Y 1.025	-8	+6	+7	-8	7N 11W		GO			9 7/8	0-63	50	1.507	1.507	20-80
	34	1.504			GO	NO GO		-1	+7	+9	+2	2N 2W		GO			9 7/8	0-63	35	1.507	1.507	150
	55	1.500			GO	NO GO		+8	-2	+9	-3	5S 6W		GO			9 7/8	0-63	40	1.508	1.508	50-200
	54	1.499			GO	NO GO		+5	+5	-2	-2	2N 2W		GO			9 25/64	0-63	50	1.506	1.506	50-150
	35	1.501			GO	NO GO		-10	-6	+7	+5	8S 5E		GO			9 7/8	0-63	40	1.506	1.508	50-90
	58	1.501			GO	NO GO		-5	-5	+2	0	2N 2E		GO			9 25/64	0-63	90	1.507	1.507	70-85
	57	1.500			GO	NO GO		+2	0	+2	-2	0 1W		GO			9 31/64	125-UP	60	1.506	1.506	150-350
	58	1.503			GO	NO GO		+12	-13	+8	-7	12S 12W		GO			9 25/64	0-63	30	1.506	1.506	200
	59	1.504			GO	NO GO		+6	+10	-1	-6	9S 7E		GO			9 7/8	0-63	20	1.507	1.507	90-75
	57	1.501			GO	GO	X 1.339 Y 1.325	-8	+7	-8	+9	6N 8E		GO			9 27/32	63-125	35	1.508	1.508	100
	58	1.506			GO	NO GO		-2	+8	+8	-1	5N 9W		GO			9 25/64	63-125	60	1.508	1.508	50-200
	57	1.498			GO	NO GO		-10	-7	+14	+8	12N 7W		GO			9 27/32	0-63	50	1.506	1.506	20-40
	41	1.502			GO	NO GO		+5	+6	-2	-2	2N 2E		GO			9 27/32	63-125	50	1.508	1.508	100-300
	40	1.4991			GO	NO GO		0	-4	+3	+9	7N 5E		GO			9 25/64	63-125	60	1.507	1.507	95
	41	1.500			GO	NO GO		+8	+8	+8	+5	10N 8E		GO			9 27/32	0-63	35	1.508	1.508	200-300
	40	1.502			GO	NO GO		-3	-1	-3	-1	0 0		GO			9 7/8	0-63	35	1.508	1.509	90-120
	41	1.502			GO	NO GO		-12	-16	+7	+17	14S 15E		GO			9 7/8	63-125	40	1.508	1.508	150
	40	1.504			GO	NO GO		-13	-14	+15	-15	14N 15W		GO			9 25/64	63-125	95	1.508	1.508	150
	41	1.502			GO	NO GO		-11	-1	+20	+10	16N 15W		GO			9 31/64	0-63	55	1.507	1.507	60-250
	44	1.504			GO	NO GO		-2	-6	-9	+13	9N 12E		GO			9 7/8	0-63	35	1.506	1.508	50-200
	43	1.502			GO	NO GO		-5	0	-1	-5	2N 2W		GO			9 7/8	63-125	50	1.507	1.507	50-200
	44	1.501			GO	GO	X 1.305 Y 1.335	+2	+5	-1	-11	8S 6W		GO			9 25/64	0-63	50	1.506	1.506	70-140
	42	1.500			GO	NO GO		+25	-30	-5	-55	15S 6W			NO GO	GO AFTER HONING	9 7/8	125-UP	50	1.506	1.506	200
	44	1.498			GO	NO GO		-5	-6	-4	-2	1S 1E		GO			9 7/8	0-63	30	1.507	1.505	50-250
	43	1.500			GO	GO	X 1.313 Y 1.327	+1	+22	+2	-15	4N 18W		GO			9 7/8	125-UP	45	1.506	1.506	150-250
	44	1.5005			GO	NO GO		0	-3	+10	+15	5S 9E		GO			9 25/64	63-125	40	1.507	1.507	150-250
	46	1.501			GO	NO GO		-6	+7	+12	-2	9N 4W		GO			9 7/8	0-63	45	1.507	1.507	30-300
	47	1.501			GO	NO GO		+4	-4	-3	+2	1S 1E		GO			9 27/32	0-63	40	1.507	1.507	250
	46	1.500			GO	NO GO		+5	+30	+11	-13	6N 21W		GO			9 25/64	0-63	35	1.506	1.506	200-300
		1.500			GO	NO GO		-10	-26	-10	+10	0 17E		GO			9 31/64	0-63	30	1.508	1.508	150
		1.4991			GO	GO	X 1.335 Y 1.360	+26	-5	-22	+29	24S 7E			NO GO	GO AFTER HONING	9 25/64	0-63	40	1.508	1.508	NO
	47	1.5000			GO	NO GO		-5	+7	+8	+8	6N 6E		GO			9 7/8	0-63	60	1.506	1.506	75-150
								+13	+8	-16	-14	19S 1W										

did not functional gage on "R" unit and that improvement could be made through the use of the electronic gage on "P" unit. Therefore, a methodical check was made on every base plate set by New York Ship for the semi-finish cut of the large tubes. Base plates were moved to the desired position (concentric and level with the mid-point of the top tube sheet) when electronic gage readings showed that the readings for the mid-point were above 0.010" in either N-S or E-W directions. It was necessary to move the base plates on several hundred tubes to make the latter concentric and level with the top tube sheet mid-point. After the semi-finish cut, inspectors checked each tube bored to note condition of the bore as to whether or not it would clean up after the final finish cut. A detail discussion on this is covered in the following section. (The procedure for using the electronic gage was developed on this unit by du Pont inspectors. For a detail procedure on how to use this gage, see Part III, Section II-F.)

e. Inspections Prior to Final Cut

The procedure for moving the base plate to locate the mid-point of the top tube sheet tube did not take into account verticality of the top tube sheet tube. It was apparent that a tube far out of vertical in the top tube sheet would not allow the functional gage to seat even though the plenum tube was bored to the mid-point of the top tube sheet tube. The solution fell into the problem of tilting the base on the plenum to conform to the tilt of the top tube sheet tube.

However, at this time, it was not known whether tubes could be bored with a controlled out of vertical tilt. The first base was tilted within 0.005" to improve the situation; however, the tube did not functional gage. The next base was tilted a greater amount to insure that it was practical to tilt a base. This tube functional gaged whereas it would not have under the previous system. In addition, an inspection of the bore showed that the tube was not gouged because of out-of-verticality boring. On "L" unit, it was definitely proven that tubes could be bored in such a fashion that all tubes would functional gage, as indicated by the number (77) successfully bored using this method. See paragraph "f" below for resume covering the reasons this new phase of inspection was incorporated into the line boring of "L" unit. However, only four tubes were tilted and bored deliberately out-of-vertical in "P" in order that they might accept the functional gage. These were as follows:

X51-Y27 - Tilted 0.004 in./ft.	Final Verticality -	8S-3$\frac{1}{2}$E
X53-Y39 - Tilted 0.002 in./ft.	" "	2$\frac{1}{2}$S-1W
X52-Y30 - Tilted 0.003 in./ft.	" "	12$\frac{1}{2}$S-9$\frac{1}{2}$E
X47-Y15 - Tilted 0.002 in./ft.	" "	1N-1W

All of these tubes accepted the 4.365" functional gage successfully.

The above base plate tilting method was perfected on "P" unit and used on "L" and "C" unit line boring operations. This procedure was as follows:

1. Prior to the semi-finish cut and after New York Ship has set the base plate, the du Pont electronic gage is inserted into the tubes by the inspectors. The base has been leveled and centralized over the middle of the top tube sheet tube. This is checked with the electronic gage.

2. The centrality of the top tube sheet tube is checked at the top, middle, and bottom, in both the North-South and East-West directions. The algebraic sum of the N-S and E-W readings at the top and bottom indicates the amount and direction that the tube is out of vertical. If the algebraic sum of the centralities at the top and bottom exceeds 0.050", then there will be interference with the functional gage.

3. With the electronic gage still in the tube, the base is tilted and moved laterally until the algebraic sum of the centrality at the top and bottom is below 0.050" and the base is still centralized over the middle of the top tube sheet tube. Next, the base is checked with a spirit level, and if it is out-of-level greater than 0.010 in./ft., it is moved back to 0.010 in./ft.

4. The electronic gage is removed and the boring bar is set on the base. The floating head of the boring bar is left loose so that it will float freely and allow the bar to bore perpendicular to the base but slightly oblique to the plane of the top of the tube.

5. After the semi-finish cut is made, the base is checked again to see if the base has shifted and if so to re-set it.

6. After the finish cut is made, the verticalities, centralities, bore size, and finish of all tubes are checked and recorded. Also, the 4.365" functional gage is inserted into each tube to determine its acceptability.

f. History of Tilting Base Plates During Line Boring

During the line boring of the MXX and "R" unit, plenum chamber, many tubes would not accept the functional gage after finish boring. This was due to the fact that the corresponding tube bores in the top tube sheet were beyond drawing tolerance with respect to verticality, while the plenum chamber tubes were vertical within drawing tolerance. This condition caused interference with the functional gage preventing it from passing all of the way through both bores.

This condition was subsequently relieved by enlarging the bores of the affected top tube sheet tubes by grinding and honing. This enlarging process was limited to removing metal in the areas where the functional gage interfered. This process was time consuming and costly; therefore, it was considered unsatisfactory. The ideal situtation would be to have all tubes accept the functional gage with no interference immediately following line boring with no further work needed and all tube bores perfectly vertical.

It was evident that the limiting factor in obtaining the ideal situation was the verticality of the top tube sheet tube bores which cannot be changed after the unit has been assembled and welded together when you start out with pre-machined tubes.

There was a reasonable solution to this problem. The plenum chamber tubes can be bored out of vertical to match the top tube sheet tubes, thus allowing the functional gage to pass freely through both tubes.

During the line boring of "P" unit, it was discovered that the electronic gage indicated which top tube sheet tubes were out of vertical and how much the plenum chamber tube would have to be bored out of vertical in order to give sufficient clearance for the functional gage. It was decided at that time, with Design Division knowledge, that the plenum chamber tubes should be bored out of vertical up to a maximum of 0.010 in./ft. Those tubes were necessary to maintain clearance for the functional gage. The results of "P", and "L" units show that this method has been successful in reducing to a minimum the number of tubes that had to be enlarged.

The base tilting procedure (see paragraph "c" above) brought about considerable savings on "P" and "L" units as compared to "R". On "R" unit, after line boring and honing of all large tubes, there were twenty-nine (29) tubes that would not functional gage, seventeen (17) of these tubes accepted the gage after the plenum chamber tubes were honed to the maximum size. The remaining twelve (12) tubes required considerable grinding in the top tube sheet tubes before they would accept the gage. In addition to these twenty-nine (29) tubes, the Field reported sixty (60) tubes would not accept the gage after the unit arrived at Savannah River. "P" and "L" units had only six large tubes (at New York Ship) in each that would not accept the functional gage and these were relieved by a small amount of honing in the top tube sheet tubes. Also, the field had not reported any tubes that would not functional gage in "P" or "L" units after arrival at Savannah River Plant.

In addition to the above troubles encountered on "R" unit, eight large tubes had to be replaced, after line boring

due to poor finish, oversize bores, and inability to accept the functional gage. The cost of replacing tubes in the plenum chamber was approximately $880.00 per tube. Since no tubes were replaced in "P" and "L" units, it can be assumed that the tilting base procedure contributed to eliminating the need for removing tubes and thereby further reducing the cost of these units.

6. Inspections Performed on Finished Bored Plenum Tubes

[1] General

The inspections of the final bore will be divided into two categories, namely:

(a.) Inspections made with electronic gage.

(b.) Inspections made with other gages.

[2] Inspections Made with Electronic Gage

(a) General

Results of the final bore were obtained in a somewhat different manner than heretofore. There were two "special" bases made; each base having a different pilot diameter. (See photo serial #223 in Part III, Section F).

(b) Procedure

Using a bore gage set for 4.375" diameter, check the top land of plenum for bore size. After the bore size has checked "OK" (4.375" - 4.378" approx.), the boring fixture base plate must be removed and the bore swabbed clean until dry, including the tube in the top tube sheet.

Select the "special" base for the electronic gage which has a pilot diameter nearest (on the minus side) to that of the bore size. Position the base and lock into position by means of the locking fingers.

Level the base by means of a "precision level" as close as possible. The "precision level" should be positioned in line with the axis, first in one direction and then the other. After this step is completed, position the electronic gage and adjust the base for level by means of the "all-way" level.

Extend the plungers with the north plungers aligned in a northerly direction and continue as follows:

(c) Results

1. Centrality on bottom land of plenum chamber tube

   a. Use top-top stage of plungers with selector set on centrality.

   b. Read top left hand dial for N-S reading and bottom left hand dial for E-W reading.

   c. Record the full dial readings showing the proper plus or minus signs for each.

   Note: Centrality on the bottom land of the plenum chamber were recorded on "pp" unit only.

2. Centrality of mid-length bore of top tube sheet tube.

   a. Use center stage of plungers with selector set on centrality.

   b. Read top-center dial for N-S reading and bottom center dial for E-W reading.

   c. Record the full dial readings showing the proper plus or minus signs for each.

3. Inspections Made with Other Gages

   (a) Bore Size

      1. At 1½" below top surface of plenum chamber tube in the X and Y directions, bore sizes were measured using a standard dial indicator bore gage and ring gage. This measurement was between the O-ring areas.

      2. From one to three inches below the chamfer on the bottom land of the plenum tubes, bore sizes were again measured using the bore gage.

   (b) Verticality

      The inclination with respect to the vertical of the plenum chamber bore of each tube was measured with a verticality gage in the north, east, south, and west directions. For operation and use of this gage see Part III, Section L.

(c) Surface Finish of Bore on Plenum Tube in RMS Micro-inches

The finish of the top and bottom land of all plenum tubes was determined by using ones fingernail and comparing with roughness standards. All results were segregated into one of the following three classifications: (1) 0-63, (2) 63-125, and (3) 125-up.

(d) Functional Gaging

All large tubes were gaged using a 4.365" diameter functional gage. This functional gage was a 5 ft. 7 in. piece of aluminum tubing, the top 14" of which had a diameter of 4.365" and the remainder 4.330". This gage was inserted in the bore after the line boring operation to determine if the tube would functional gage. Prior to honing and after line boring, there were a total of twenty (20) tubes that exhibited a tight fit of the 4.365" diameter functional gage. These tubes were: X44-Y12, X47-Y27, X51-Y33, X49-Y39, X54-Y54, X49-Y21, X49-Y27, X53-Y33, X2-Y42, X54-Y36, X53-Y57, X46-Y24, X51-Y27, X52-Y36, X55-Y45, X51-Y69, X48-Y24, X49-Y33; X55-Y51, X50-Y72.

The above tubes were later honed to a maximum of 4.390" after which all accepted a 4.375" diameter functional gage properly. (See Section 168-7 of the manual for final functional gaging)

Note: (1) Plenum tubes after line boring were required to accept a 4.365" diameter functional gage Tube diameters at this time were bored between 4.375" and 4.380" in diameter.

(2) Plenum tubes after honing were required to accept a 4.375" diameter functional gage. Finish tube diameters were honed to 4.385" ± .005. In some cases tubes were honed to 4.393" before functional gage would seat properly; however, this was done only with the consent of the Design Division.

For final results of "P" unit line boring inspection, see Exhibit #13-B. This completed all inspections performed in the line boring set-up. The units were separated and further fabrication continued.

(3) Inspections After Chamfering Large Tubes

After line boring all large tubes, the top ends were chamfered 5/32" x 10° using a special tyflon piloted cutter. After chamfering all large tube ends to dimensions shown in Dwg. 2-1, Section 16A-(2)b of this manual, all chamfers were checked using a 10° beveled gage which was a prototype of the required chamfer dimensions. Also, a visual check was made for evidence of tool "chatter" and burrs. No discrepancies were found and the job was approved.

When chamfering of large tube ends on the top side was completed, inspected and accepted, the plenum chamber was turned bottom side up an a 1/8" x 45° chamfer was machined into the bottom ends of all large tubes. Tube chamfers were checked using a 45° beveled gage which was a prototype of the required chamfer dimensions. Also, a visual inspection was made for evidence of tool "chatter" and burrs. No discrepancies were found and the job was accepted.

C. "L" Unit

(1) Preliminary Set-up

a. Leveling Top Tube Sheet Assembly

This unit was leveled and accepted in a similar manner described in section 15B-(1)a of this manual.

b. Installation of Centering Plugs in Top Ends of Rod Tubes

Inspection of centering plugs was performed in a similar manner as described in Section 15A-(1)b of this manual.

c. Chip Stoppers

Inspection of chip stoppers was performed in a similar manner as described in section 15A-(1)c of this manual.

d. Pre-determining Whether Tubes Will Give Trouble During Line Boring.

The pre-determined knowledge of what tubes will not properly seat the functional gage after line boring is an invaluable asset.

From the experience gained by du Pont Inspectors on the line boring of "R" and "P" units, a method by which one can calculate whether or not tubes will cause trouble thereby

EXHIBIT #13-B

RESULTS OF "P" UNIT LINE BORING OPERATION

RESULTS OF LINE BORING

P UNIT

BASIC BORE 4.375 — BASIC BORE 4.385

TUBE NOS X	Y	NVS	BORE MEAS. BEFORE HONING T.L.	B.L.	VERTICALITY N	E	S	W	AVERAGE N-S	E-W	CENTRALITY B.L. PLENUM N	E	S	W	AVERAGE N-S	E-W	CENTER TUBE SHEET N	E	S	W	AVERAGE N-S	E-W	FUNCTIONAL GAGE GO	NO GO	FINISH BEFORE HONING 0-63	63-125	125-UP	AFTER HONING BORE MEAS. T.L.	B.L.	FINISH-RMS T.L.	B.L.	REMARKS
21	3		+2	+3	-12	-9	-9	-12	1½N	1½W					-7	+12					+23	+21	GO		✓			8	+3	45	40	
23	3		+4	+3	-21	-15	-13	-18	4N	1½W					-3	+3					-4	-1	GO		✓			0	+1	50	35	
25	3		+3	+3	-11	-11	-9	-10	1N	½W					+3	-5					+17	-14	GO		✓			+3	+1	40	35	
27	3		+3	+3	-7	-5	-5	-6	1N	½W					-2	0					+1	+12	GO		✓			+2	+1	40	35	
29	3		+4	+4	-18	-12	-16	-23	1N	5½W					-2	+6					+12	-11	GO		✓			0	+1	60	35	
31	3		+4	+4	-12	-10	-10	-12	1N	1W					+3	-2					+10	-1	GO			✓		+3	+1	35	35	
33	3		+3	+3	-7	-1	-2	-7	2½N	3W					+1	+1					+8	-8	GO			✓		+2	+3	45	35	
35	3		+5	+5	-11	-7	-2	-6	4½N	½E					-6	+3					0	-2	GO		✓			0	8	40	40	
16	6		+2	+2	-11	-10	-10	-11	½N	½W					-6	+9					+2	+13	GO		✓			+1	+2	30	30	
18	6		+4	+3	-7	-7	-7	-7	0	0					+1	-6					+1	+3	GO		✓			+1	+1	40	35	
20	6		+1	+1	-5	-6	-5	-4	0	1E					-6	+3					+2	+12	GO			✓		+2	+1	50	40	
22	6		+5	+5	-5	-5	-4	-5	½S	0					0	-5					-10	-12	GO		✓			0	0	40	35	
24	6		+1	+1	-10	-8	-6	-5	2N	1½E					-1	-6					-11	-15	GO		✓			0	+1	35	35	
26	6		+2	+2	-4	-5	-7	-5	1½S	0					-3	+5					-6	+16	GO			✓		+3	+2	30	35	
28	6		+4	+2	-4	0	-8	-10	2S	5W					+1	+15					+6	+5	GO		✓			+4	+4	55	20	
30	6		+2	+1	-9	-10	-7	-9	1N	3E					-7	-3					-27	+32	GO			✓		+5	+1	35	25	
32	6		+4	+4	-7	-3	-6	-10	½N	3½W					-2	+18					-7	+19	GO		✓			+2	0	45	35	
34	6		+3	+3	-9	-9	-5	-6	2S	1½E					-4	-6					-8	-6	GO		✓			+2	+2	45	35	
36	6		+1	+2	-11	-15	-10	-11	½N	2E					-3	-1					-10	+19	GO		✓			+3	8	35	30	
38	6		+2	+2	-4	-5	-6	-2	1S	1½E					+5	-5					-11	-6	GO		✓			0	8	20	45	TT3 TUBE HONED TO 4.405 TO PERMIT FUNCTIONAL GAGING.
40	6		+1	+1	-6	-5	-6	-7	0	1W					+5	-3					-5	-8	GO			✓		+3	0	20	45	
13	9		+2	+2	-4	-9	-8	-6	2S	1½E					+9	-12					-14	-24	GO		✓			0	+1	35	30	
15	9		+3	+3	-7	-8	-5	-4	1N	2E					-3	-7					-15	-7	GO			✓		+1	+1	40	30	
17	9		+2	+2	-4	-6	-7	-7	1½S	½W					+8	-9					-15	+5	GO		✓			8	+1	30	30	
19	9		+4	+4	-6	-6	-6	-6	0	0					0	-4					-3	-7	GO		✓			+2	+2	30	30	
21	9		+1	+1	-9	-7	-5	-5	2N	1E					-12	-4					-11	+2	GO			✓		+1	+1	30	30	
23	9		+2	+1	-6	-10	-4	-1	1N	4½E					-7	-10					-15	+7	GO		✓			+2	+1	45	35	
25	9		+2	+2	-13	-8	-10	-16	1½N	4W					-2	+11					+17	-6	GO			✓		+2	+1	50	35	
27	9		+4	+3	-7	-7	-6	-8	½N	½W					+2	-2					-8	-6	GO		✓			+2	+1	35	25	
29	9		+2	+2	-2	-3	-3	-3	½S	0					+5	0					-6	-11	GO		✓			+4	+1	30	30	
31	9		+2	+2	-10	-10	-9	-11	½N	½W					+5	-5					+9	-6	GO		✓			+9	+1	40	25	
33	9		+5	+4	-9	-4	-7	-7	1½S	1½W					+7	+3					-11	0	GO		✓			+1	+2	35	25	
35	9		+1	+1	-7	-2	-5	-11	1N	4½W					+3	+8					-17	-5	GO		✓			+3	+3	40	35	
37	9		+2	+2	+1	0	-2	-1	1½S	½W					+5	+8					-6	+11	GO		✓			+1	8	30	30	
39	9		+2	+1	-8	-5	-4	-5	2N	0					-5	+2					-3	-7	GO			✓		+3	8	20	35	
41	9		+1	+1	-10	+10	-2	0		1½W					+7	+4					+11	-2	GO			✓		+1	0	25	35	
43	9		+1	+1	0	-2	-1	-1	1½S	½E					+1	-8					+7	-12	GO			✓		+2	+2	25	30	
12	12		+2	+1	-3	-6	-7	-2	2S	2E					+4	-10					+2	+2	GO		✓			+2	+2	35	30	
14	12		+1	+1	-6	-4	-3	-4	1½N	0					-2	-1					+3	0	GO		✓			+2	+1	50	30	
16	12		8	8	-2	+3	-3	0	½S	1½E					+9	-6					-6	-13	GO		✓			+1	0	50	35	
			+2	+2																								+1	+1	40	30	

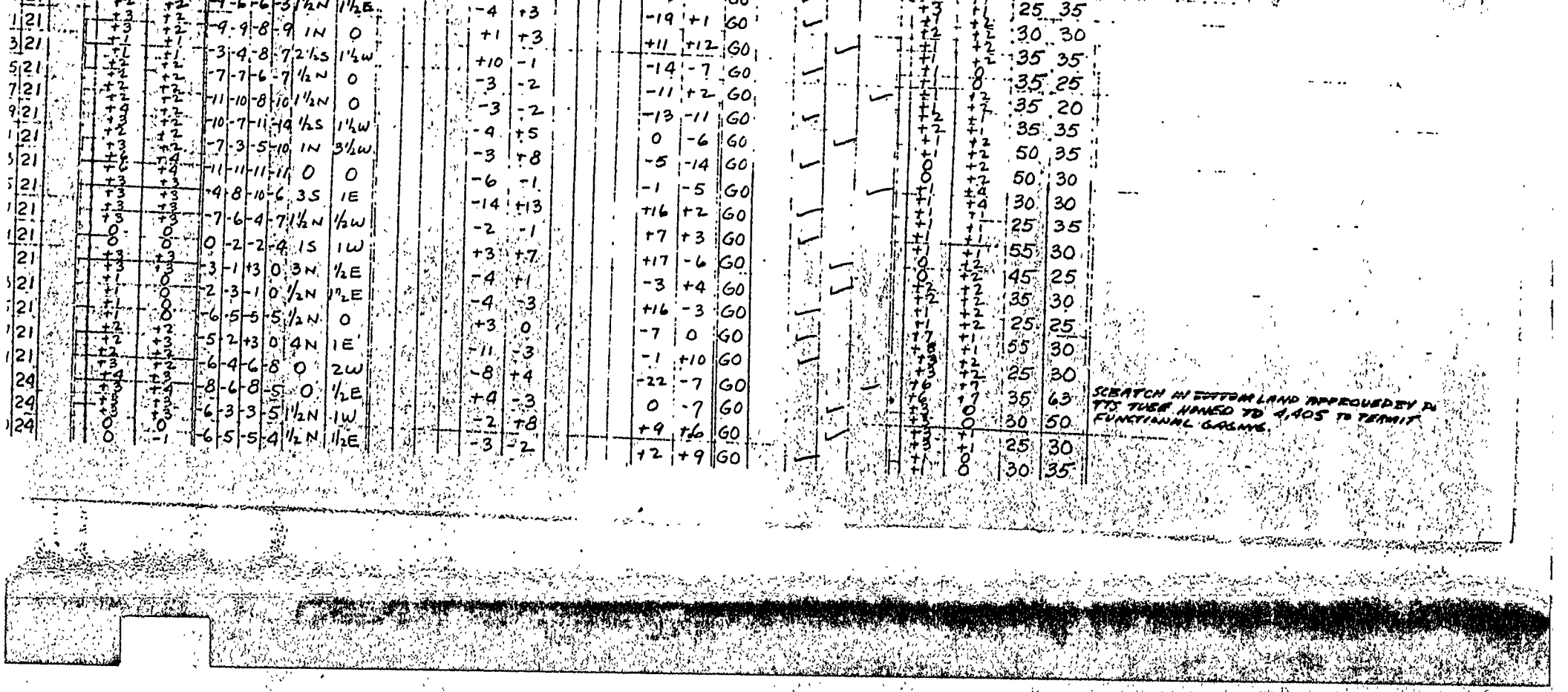
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RESULTS OF LINE BORING

P UNIT

BASIC BORE 4.375 — BASIC BORE 4.385

TUBE NOS X	TUBE NOS V	TUBE NOS NV5	BORE MEAS. BEFORE HONING X T.L.	X B.L.	Y T.L.	Y B.L.	VERTICALITY N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY PLENUM N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY CENTER TUBE SHEET N	E	S	W	AVERAGE N-S	AVERAGE E-W	FUNCTIONAL GAGE GO	NO GO	FINISH BEFORE HONING 0-63	63-125	125-up	AFTER HONING BORE MEAS. X T.L.	X B.L.	Y T.L.	Y B.L.	FINISH - RMS T.L.	B.L.	REMARKS
21	15		+3	+3	+3	+3	-6	-8	-8	-5	1S	1½E					-3	-1					-1	+7	GO					+2	+1	+1	+1	40	35	THIS TUBE LEAKED AT WELD DURING FREON TEST & WAS SHRINK WELDED
23	15		+4	+4	+4	+4	-9	-9	-13	-13	2S	2W					+5	+6					+10	-5	GO					+2	+2	+3	+2	60	35	
25	15		+2	+2	+2	+2	-7	-7	-8	-8½	S	½W					-2	-1					+12	-7	GO					+3	+2	+2	+2	40	35	
27	15		8	8	0	0	-8	-6	-5	-9	1½N	1½W					+1	-1					+9	-8	GO					+1	+2	+2	+2	40	30	
29	15		+4	+3	+3	+3	-6	-6	-9	-8	1½S	1W					+5	0					+5	-6	GO					8	+2	+3	+3	45	25	
31	15		+1	0	+1	0	-7	-6	-6	-7½	N	½W					-4	+5					-8	+13	GO					+2	+4	+2	+4	25	25	
33	15		+4	+2	+2	+2	-4	-5	-5	-4	½S	½E					-1	-1					-8	+5	GO					+2	+1	+2	+1	30	30	
35	15		+2	+2	+2	+2	-5	-5	-9	-9	2S	2W					-1	+8					-5	-6	GO					+2	+1	+1	+1	50	20	
37	15		+2	+3	+3	+3	-6	-7	-8	-7	1S	0					+1	0					-5	+2	GO					+1	+1	+1	+1	50	20	
39	15		+1	+1	+1	+1	-5	-5	-7	-7	1S	1W					+2	+2					-8	-5	GO					8	+1	+1	+1	50	25	
41	15		+1	+1	+1	+1	0	-2	-1	-1	1½S	½E					-2	-2					+12	+7	GO					+1	+2	+2	+2	30	30	
43	15		0	0	0	0	-1	-1	-1	-1	0	0					-5	+2					-12	+3	GO					+1	+2	+1	+2	30	35	
45	15		-1	8	-1	8	-3	0	0	0	1½N	0					-2	+4					+4	+17	GO					+3	+4	+3	+3	30	30	
47	15		+2	+1	+2	+2	-1	0	+1	-2	1N	1W					-2	+10					+10	+26	GO					+4	+3	+4	+3	25	30	
8	18		+3	+2	+3	+2	-4	-4	-9	-6	2½S	1W					+8	-5					-3	-12	GO					+2	+1	+2	+1	25	30	
10	18		+2	+2	+2	+2	+2	+2	+2	+2	0	0					+12	+3					+1	+4	GO					+1	+2	+2	+2	25	40	
12	18		+3	+3	+2	+2	-4	-7	-8	-8	2S	½W					+5	+4					-2	-4	GO					+1	8	+1	8	20	40	
14	18		+2	+2	+1	+2	-3	-8	-6	-3	1½S	2½E					+5	-12					0	-5	GO					+4	+1	+4	+1	35	35	
16	18		+3	+4	+4	+4	-12	-8	-5	-10	3½N	1W					-10	-4					+2	-2	GO					0	+2	0	+2	40	45	
18	18		+1	+1	+1	+1	-1	-4	-5	-1	2S	1½E					+6	-9					0	-7	GO					+2	+2	+1	+2	30	30	
20	18		+2	+2	+2	+2	-8	-9	-10	-10	1S	½W					+6	0					-8	-8	GO					+1	+3	+1	+3	20	30	
22	18		+3	+3	+3	+3	-10	-11	-11	-12	1½S	1½W					+5	+8					+24	-8	GO					+2	+2	+2	+2	30	25	
24	18		+3	+4	+4	+4	-8	-8	-5	-5	1½N	1½E					-2	-8					-7	-2	GO					+3	+1	+2	+1	40	30	
26	18		+2	+2	+2	+2	-12	-13	-7	-6	2½N	3½E					-1	-14					+16	-3	GO					+2	+1	+1	+1	50	35	
28	18		+1	+1	+1	+1	-7	-6	-6	-8	½N	1W					-5	+6					-3	-6	GO					8	+1	+2	+1	45	30	
30	18		+1	+1	+1	+1	-8	-6	-3	-5	2½N	½E					-10	-1					+4	-3	GO					+2	+3	+2	+2	55	30	
32	18		+3	+3	+3	+3	-18	-15	-14	-19	2N	2W					-8	-7					-1	-4	GO					+1	+2	+1	0	30	30	
34	18		+3	+2	+3	+2	-13	-10	-10	-12	1½N	1W					-10	+5					-7	-2	GO					+3	+5	+3	+5	25	25	
36	18		+3	+3	+3	+3	-10	-10	-10	-9	0	½E					-4	-1					-14	-17	GO					0	+2	0	+2	40	30	
38	18		+4	0	+3	0	0	+1	-2	-3	1S	2W					+2	+2					+5	0	GO					0	+2	0	+2	50	30	
10	18		+3	+2	+3	+2	-12	-8	-11	-12	½N	2W					-5	+5					+6	0	GO					8	+2	8	+2	30	25	
12	18		+2	+2	+2	+2	0	-2	-2	-2	1S	2E					-3	+1					-10	-1	GO					+2	+2	+2	+2	25	25	
14	18		8	8	8	8	-1	-1	-1	-2	0	½W					-3	0					-16	+1	GO					+2	+2	+2	+2	40	25	
16	18		+1	0	+1	0	0	+1	+2	0	1S	½E					+4	-1					-20	+6	GO					+1	+3	+1	+3	35	35	
18	18		0	0	0	0	0	+3	+1	-2	½N	2½W					-1	+10					-8	+3	GO					+3	0	+3	0	25	30	
7	21		+3	+2	+2	+2	-4	-6	-6	-9	1S	1E					+8	-2					+3	-10	GO					+3	+1	+3	+1	30	50	
9	21		+3	+1	+3	+1	-5	-5	-7	-7	1S	1W					+5	+7					+1	+2	GO					+5	+1	+5	+1	25	25	
11	21		0	0	0	0	0	+1	-2	0	1S	½W					0	-3					+13	0	GO					+2	+1	+2	+1	30	35	
13	21		0	0	0	0	+2	-2	-4	-1	3S	½E					+10	-4					+11	-4	GO					+4	8	+4	8	25	40	
5	21		+3	+3	+3	+3	-7	-3	-6	-10	½N	3½W					-7	+9					0	+11	GO					+2	+1	+2	+1			
7	21		+3	+2																																	


SCRATCH IN BOTTOM LAND APPROXIMATELY 1/8 TUBE HONED TO 4.405 TO PERMIT FUNCTIONAL GAGING.

RESULTS OF LINE BORING

P UNIT

BASIC BORE 4.375 — BASIC BORE 4.385

TUBE NOS X	TUBE NOS Y	TUBE NOS NVS	BORE MEAS. BEFORE HONING T.L.	BORE MEAS. BEFORE HONING B.L.	VERTICALITY N	E	S	W	AVERAGE N-S	AVERAGE E-W	PLENUM N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTER TUBE SHEET N	E	S	W	AVERAGE N-S	AVERAGE E-W	FUNCTIONAL GAGE GO NO GO	FINISH BEFORE HONING 0-43 63-125 125-UP	AFTER HONING BORE MEAS. T.L.	AFTER HONING BORE MEAS. B.L.	FINISH-RMS T.L.	FINISH-RMS B.L.	REMARKS
12	24		+3	+2	-4	-1	-7	-5	1½S	2W					+3	-5					-5	-7	GO		+3	0	30	40	
			+3	+2																					+2	0			
14	24		+2	+1	-4	-6	-8	-6	2S	0					+8	-1					+2	-1	GO		+2	27	25	35	
			+2	+1																					+3	+1			
16	24		+3	+3	-7	-8	-8	-7	½S	½E					+1	0					+6	+1	GO		+3	+2	30	38	
			+3	+3																					+3	+2			
18	24		+3	+3	-2	-7	-9	-3	3½S	2E					+13	-8					-12	-13	GO		+1	+2	25	30	
			+3	+3																					0	+2			
20	24		8	8	0	0	-1	-2	½S	1W					+4	+4					+13	-6	GO		+2	+3	20	25	
			8	8																					+2	+3			
22	24		+3	+3	-7	-8	-10	-8	1½S	0					+5	-3					+2	+3	GO		+4	+1	25	25	
			+4	+3																					+4	+1			
24	24		+3	+2	-11	-9	-11	-13	0	2S					+1	+3					+5	-14	GO		+3	+2	30	25	
			+3	+3																					+3	+2			
26	24		+5	+4	-14	-14	-16	-15	1½N	2E					+1	-11					0	-8	GO		+1	+1	25	25	
			+5	+4																					0	+1			
28	24		+3	+3	-5	-1	-9	-11	2S	5W					-2	+9					+22	-6	GO		+1	+4	35	30	
			+3	+3																					+1	+4			
30	24		+3	+2	-5	-5	-8	-8	1½S	1½W					+1	+2					+12	-2	GO		+1	+1	35	35	
			+3	+2																					+3	+1			
32	24		+3	+3	-3	-6	-9	-7	3S	½W					+6	-4					-20	-21	GO		+3	+1	25	35	
			+3	+3																					+1	+2			
34	24		+3	+3	-8	-6	-7	-7	½N	½W					-9	-2					-6	-6	GO		+1	+2	20	30	
			+3	+3																					+1	+2			
36	24		+2	+2	-5	-5	-9	-9	2S	2W					-3	-3					-4	-8	GO		+1	0	30	20	
			+2	+2																					+2	+2			
38	24		+4	+4	-5	-1	-10	-4	2½N	1½W					-11	+7					+19	+4	GO		+2	+2	35	25	
			+4	+4																					+2	+2			
40	24		-1	+1	-3	0	+1	-4	2N	2W					-9	+6					-6	-9	GO		+1	+3	25	40	
			0	-2																					+1	+2			
42	24		+2	+2	-7	-3	-5	-8	1N	2½W					-8	+8					+6	+3	GO		+1	+2	30	35	
			+2	+2																					+1	+1			
44	24		+3	+2	-4	+1	-3	-6	½N	3½W					-1	+13					-5	-14	GO		+1	+1	30	30	
			+3	+2																					+1	+1			
46	24		+2	+1	-7	-9	-6	-7	½N	1E					-8	+6					-12	+1	GO AFTER HONING		+6	+5	25	50	HONE IN TTS TOP X 4.406 Y 4.406
			+2	+1																					+6	+5			
48	24		+3	+2	-2	-5	0	+2	1N	3½E					-11	-7					-8	+6	GO AFTER HONING		+6	+5	30	30	HONE IN TTS TOP X 4.391 BOTTOM X 4.387 Y 4.390 Y 4.384
			+3	+2																					+6	+5			
50	24		+4	+4	+4	+4	0	+2	2S	1W					+7	+5					+32	-7	GO		+5	+2	40	35	HONE IN TTS TOP X 4.405 Y 4.405
			+4	+4																					+5	+2			
5	27		+3	+2	-3	-6	-6	-6	1½S	0					+5	-2					-5	+2	GO		+3	0	30	45	
			+3	+2																					+3	+1			
7	27		+1	+1	-3	-5	+1	+2	2N	3½E					-5	-16					-6	-11	GO		+4	+1	30	20	
			+1	+1																					+2	+1			
9	27		0	0	-19	-24	-24	-20	2½S	2E					+6	-7					-7	-10	GO		+2	+1	35	45	
			0	0																					+2	+1			
11	27		+4	+3	-4	-5	-6	-5	1S	0					+3	+1					-1	-2	GO		+2	+1	30	30	
			+4	+3																					+2	+1			
13	27		+1	+1	-5	-5	-9	-9	2S	2W					+5	+5					0	-8	GO		+2	+3	25	25	
			+1	+1																					+2	+3			
15	27		+1	+1	-3	-1	+1	-4	2N	1½W					-5	+5					+19	-9	GO		+2	0	30	35	
			+1	+1																					+2	0			
17	27		+2	+2	0	-1	-3	-2	1½S	½W					+4	0					+17	0	GO		0	+1	45	35	
			+2	+2																					0	+1			
19	27		+3	+3	-6	-7	-7	-7	½S	0					-2	-8					-5	-10	GO		+3	+1	20	45	
			+3	+3																					+3	+2			
21	27		+3	+3	-6	-7	-7	-7	½S	0					+5	-8					-6	-13	GO		+2	+3	25	25	
			+3	+3																					+2	+3			
23	27		+2	+1	-5	-6	-6	-7	½S	½W					0	-3					-5	-11	GO		+1	+2	25	30	
			+2	+1																					+1	+2			
25	27		+3	+3	-11	-11	-18	-10	½N	½E					+3	-3					+12	-12	GO		+4	+1	30	25	
			+3	+3																					+4	+1			
27	27		+2	+2	-7	-8	-8	-8	½S	0					-1	-3					+1	+1	GO		+1	+3	55	30	
			+2	+2																					+1	+3			
29	27		+4	+3	-6	-6	-6	-5	0	½E					-1	0					-4	-2	GO		+2	+1	40	30	
			+4	+4																					+2	+1			
31	27		+1	0	-7	-5	-5	-7	1N	1W					-9	-2					-7	-9	GO		+2	+1	40	30	
			+1	0																					+2	+1			
33	27		0	0	-2	-2	-2	-2	0	0					-3	+1					-9	-3	GO		+2	+2	35	35	
			0	0																					+2	+2			
35	27		+3	+3	-11	-7	-10	-14	½N	3½W					-4	+14					+8	+2	GO		+2	+2	30	30	
			+4	+3																					+2	+2			
37	27		+2	+2	-4	-6	-8	-6	2S	0					+3	-3					-1	-3	GO		+1	+1	30	30	
			+2	+2																					+1	+1			
39	27		0	+1	-1	-3	-2	0	½S	1½E					-5	-3					0	-1	GO		+3	+1	20	30	
			0	+1																					+2	+1			
41	27		+2	+2	-5	-6	-9	-8	2S	1W					+3	+1					-13	-22	GO		0	+1	35	35	

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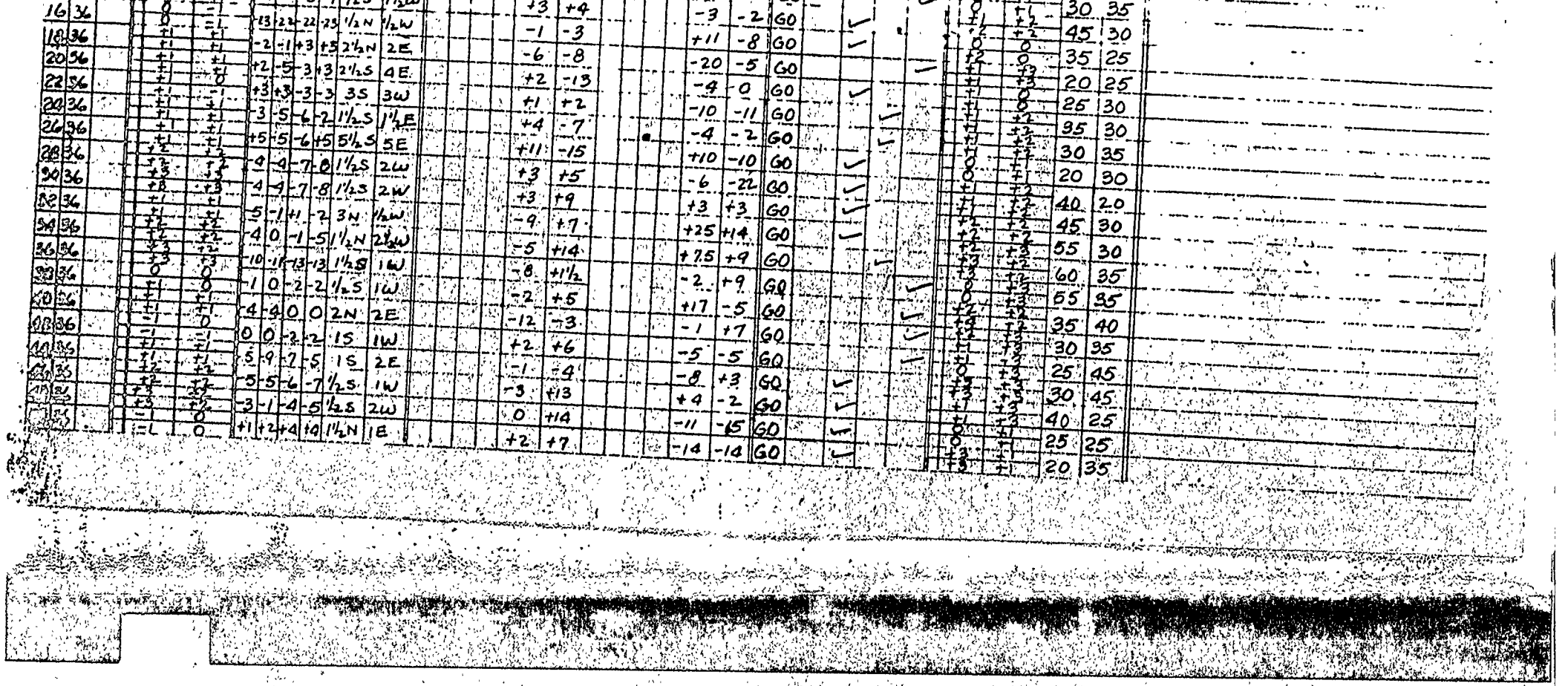
RESULTS OF LINE BORING

P UNIT

BASIC BORE 4.375

BASIC BORE 4.385

TUBE NOS X	TUBE NOS Y	NVS	BORE MEAS. BEFORE HONING T.L.	BORE MEAS. BEFORE HONING B.L.	VERTICALITY N	VERTICALITY E	VERTICALITY S	VERTICALITY W	VERTICALITY AVERAGE N-S	VERTICALITY AVERAGE E-W	CENTRALITY B.L. PLENUM N	CENTRALITY B.L. PLENUM E	CENTRALITY B.L. PLENUM S	CENTRALITY B.L. PLENUM W	CENTRALITY B.L. PLENUM AVERAGE N-S	CENTRALITY B.L. PLENUM AVERAGE E-W	CENTRALITY CENTER TUBE SHEET N	CENTRALITY CENTER TUBE SHEET E	CENTRALITY CENTER TUBE SHEET S	CENTRALITY CENTER TUBE SHEET W	CENTRALITY CENTER TUBE SHEET AVERAGE N-S	CENTRALITY CENTER TUBE SHEET AVERAGE E-W	FUNCTIONAL GAGE GO	FUNCTIONAL GAGE NO GO	FINISH BEFORE HONING 0-63	FINISH BEFORE HONING 63-125	FINISH BEFORE HONING 125-UP	AFTER HONING BORE MEAS. T.L.	AFTER HONING BORE MEAS. B.L.	AFTER HONING FINISH-RMS T.L.	AFTER HONING FINISH-RMS B.L.	REMARKS
36	30		X +1	+1	-22	-25	-26	-22	2S	1½E					+1	-3					0	+1	GO					X +2	+2			
38	30		Y +1	+1																								Y +2	+2	45	30	
40	30		+4	+4	-5	-6	-5	-6	0	0					+2	+2					-19	+4	GO					+5	+2	25	30	
42	30		+2	+2	-2	0	0	-1	1N	½W					-5	0					+17	-9	GO					+2	+2	35	25	
44	30		+1	+1	-21	-22	-24	-25	1½S	1½W					+4	+8					+4	-2	GO					+1	+2	25	30	
46	30		+3	+2	-2	-8	-8	-4	3S	1E					+7	+1					-8	-23	GO					+1	+1	30	30	
48	30		+9	+9	-6	-4	-7	-10	½S	3W					-3	+12					+7	-18	GO					+2	+1	40	35	
50	30		+3	+3	-3	-5	-7	-5	2S	0					-2	-1					-14	-6	GO					+2	+2	35	30	HONE IN TTS TOP X 4.395 Y 4.387
52	30		0	+1	-1	0	0	-2	½N	1W					-2	+5					-14	+7	GO					+2	+3	30	35	HONE IN TTS TOP X 4.402 Y 4.393
3	33		+3	+3	+11	-11	-14	+8	12½S	9½E					+33	-25					+45	-55	GO					+3	+1	40	35	TTS TUBE HONED TO 2.405 TO PERMIT FUNCTIONAL GAGING
5	33		+3	+2	-7	-5	-9	-6	1½N	½W					-2	-1					+10	-5	GO					+4	0	80	40	
7	33		0	0	+1	+1	+1	0	0	½W					-3	-1					-9	-1	GO					+5	0	40	30	
9	33		+1	+1	-5	-5	-7	-7	1S	1W					-1	+2					+2	-3	GO					+3	+1	45	30	
11	35		+2	+2	-2	-3	-1	0	½N	1½E					-7	-6					-3	+1	GO					+3	+1	35	30	
15	33		+3	+2	-5	-5	-5	-6	0	½W					+1	+1					-2	-4	GO					+2	+3	35	30	
15	35		+2	+2	0	-1	-3	-3	1½S	1W					+2	+3					+16	-2	GO					+2	+2	25	20	
17	33		+2	+2	+18	+18	+18	+18	0	0					+2	-7					+17	-4	GO					+2	+1	30	25	
19	33		+2	+1	-8	-6	-4	-5	2N	1½E					-6	-5					-18	-3	GO					+1	+1	30	35	
21	33		+1	0	-6	-7	-8	-8	1S	½W					+4	-4					-15	-6	GO					+2	+1	30	30	
23	33		+1	+1	-6	-7	-9	-7	1½S	0					+1	-1					-3	-8	GO					0	0	35	35	
25	33		+1	+1	-2	-1	-1	-2	½N	½W					-4	+1					-1	-6	GO					+1	+2	40	25	
27	33		+2	+2	-5	-6	-5	-5	0	½E					-3	-3					-6	-5	GO					+1	+1	35	20	
29	33		0	0	0	-1	-1	-1	1½S	0					+1	-3					+1	-9	GO					0	+3	30	35	
31	33		+1	0	+1	+4	+1	-2	0	3W					-4	+9					+11	+6	GO					0	+3	40	35	
33	33		+3	+2	-7	-6	-6	-8	1½N	1W					-8	+4					-9	-2	GO					0	+2	30	35	
35	33		+2	+1	-4	-8	-8	-5	2S	1½E					+1	-10					-13	-12	GO					+1	+1	25	30	
37	33		+1	+1	-4	-5	-8	-8	2S	1½W					0	+3					-17	-5	GO					+4	+1	50	30	
39	33		+1	0	-4	-5	-8	-9	2S	2W					+3	+1					-4	-14	GO					+2	+2	45	30	
41	33		+1	+1	+1	0	+1	-2	0	1W					-5	+2					-18	-4	GO					+1	+1	35	25	
43	33		+3	+3	-7	-8	-5	-5	1N	1½E					-2	-6					+5	+2	GO					+2	+1	30	35	
45	33		+2	+1	0	+1	+1	-1	½N	1W					-1	+7					+10	+1	GO					+2	+2	25	30	
47	33		0	+1	+2	0	-2	-2	2S	1W					+5	+4					-1	+1	GO					+1	+2	35	45	
49	33		+3	+2	-5	-5	-5	-5	0	0					-5	-6					+8	-14	GO					0	+2	35	35	
51	33		+4	+3	-6	-4	-4	-6	1N	1W					-11	+3					-16	-8	GO					+1	+2	30	35	TTS X 4.403 SNUG FG, HONE IN TTS Y 4.403
53	33		0	+1	+1	0	-2	-2	1½S	1W					+4	-1					-9	-10	GO AFTER HONING					+6	+5	20	20	HONE TTS X 4.398 Y 4.385 TOP BOTTOM X 4.397 Y 4.392
2	36		+1	+2	-7	-10	-10	-8	1½S	1E					+15	-1					-12	-3	GO AFTER HONING					+5	+5	35	40	HONE TTS X 4.400 Y 4.399 BOTTOM X 4.395 Y 4.396
4	36		+4	+3	-2	-1	-7	-8	2½S	3½W					+3	+10					+12	-2	GO					+1	+1	30	30	
6	36		+2	+2	-4	-1	+1	-2	2½N	½W					0	+1					+27	-1	GO					+4	0	30	30	
8	36		-1	-1	-5	-6	-8	-8	1½S	1W					+7	+4					-13	-3	GO					+2	+2	25	35	
10	36		+1	+1	-2	-2	0	0	1N	1E					0	-6					+11	-8	GO					+3	+3	40	30	
12	36		+4	+4	-9	-13	-10	-6	1½S	3½E					+1	-14					-8	-15	GO					+1	+1			
			0	0	0	-2	-3	-2	1½S	0																						



RESULTS OF LINE BORING

P UNIT

BASIC BORE 4.375 — BASIC BORE 4.385

TUBE NOS X	TUBE NOS Y	NVS	BORE MEAS. BEFORE HONING T.L.	BORE MEAS. BEFORE HONING B.L.	VERTICALITY N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY PLENUM B.L. N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY CENTER TUBE SHEET N	E	S	W	AVERAGE N-S	AVERAGE E-W	FUNCTIONAL GAGE GO	NO GO	FINISH BEFORE HONING 0-63	63-125	125-UP	AFTER HONING BORE MEAS. T.L.	B.L.	FINISH - RMS T.L.	B.L.
52	36		X +2 Y +2	+2 +2	0	-1	-1	0	1/2S	1/2E					0	-2					-3	+11	GO AFTER HONING					X +6 Y +4	+2 +2	20	35
54	36		+2	+2	0	-1	0	+1	0	1E					-1	+6					-8	+16	GO AFTER HONING					+5	+2	40	25
3	39		0	0	-4	-3	-4	-6	0	1 1/2W					-3	+5					+4	+10	GO					+3	0	30	25
5	39		+3	+3	-3	-7	-8	-9	2 1/2S	1 1/2E					+11	-6					-6	-6	GO					+1	+1	25	45
7	39		+1	+1	-2	-3	0	+3	1N	3E					0	-13					-8	-10	GO					+3	+1	20	35
9	39		+1	+1	-5	-6	-9	-6	2S	0					+6	-3					-9	-4	GO					+1	+3	25	30
11	39		+2	+2	-10	-11	-11	-11	1/2S	0					0	-1					0	-14	GO					+1	0	35	25
13	39		+1	+1	-4	-7	-8	-7	2S	0					+5	-3					-21	-19	GO					+1	+1	35	25
15	39		+2	+2	-8	-8	-8	-9	0	1/2W					-5	+7					-10	+14	GO					+1	0	35	25
17	39		0	0	-7	-8	-6	-6	1/2N	1E					-3	-5					-3	-9	GO					+2	+3	30	35
19	39		+2	+2	-1	-4	-1	+2	0	3E					-3	-10					-5	+10	GO					+2	+1	30	30
21	39		+1	+1	+3	+2	-1	0	2S	1W					+7	-5					-12	-5	GO					+1	+2	30	30
23	39		+1	+1	-6	-10	-7	-8	1/2S	1E					-1	-17					-9	-14	GO					+2	+2	30	30
25	39		+2	+2	-4	+1	+2	-2	3N	1 1/2W					-7	+5					-7	+1	GO					+1	+3	35	25
27	39		+3	+3	-5	-7	-7	-7	1S	0					+1	-5					-8	-6	GO					+2	+1	30	25
29	39		+3	+3	-4	-6	-7	-5	1 1/2S	1/2E					0	-3					-3	-21	GO					+1	0	40	30
31	39		+1	+1	-5	-7	-7	-7	1S	0					-2	-1					-22	-9	GO					0	+3	45	30
33	39		+2	+2	-8	-8	-8	-7	0	1/2E					-2	-4					-6	-8	GO					+1	+3	50	45
35	39		+1	+1	-7	-3	-2	-5	2 1/2N	1W					-7	-1					+1	0	GO					+2	+1	30	30
37	39		+2	+2	-5	-5	-8	-10	1 1/2S	2 1/2W					0	+7					+10	-9	GO					+2	+3	50	35
39	39		+4	+4	-5	-7	-6	-7	1/2S	0					-3	+13					+4	+1	GO					+2	+2	55	30
41	39		+1	+1	-7	-8	-8	-6	1/2S	1E					-1	-6					-1	+5	GO					+2	+2	30	40
43	39		+3	+3	-5	-7	-6	-6	1/2S	1/2E					-1	+3					+6	+17	GO					+2	+1	30	30
45	39		-1	-1	-5	-6	-7	-6	1S	0					+3	+2					-13	+12	GO					+2	+3	30	50
47	39		+6	+4	-10	-11	-11	-9	1S	2E					-1	+4					+12	+6	GO					+1	+3	25	25
49	39		+2	+1	-7	-8	-6	-4	1/2N	2E					0	+4					+16	+14	GO AFTER HONING					+6	+5	50	35
51	39		+1	+1	0	-2	-2	0	1S	1E					0	+7					-22	+12	GO					+2	+2	25	30
53	39		+1	+1	+2	0	-3	-2	2 1/2S	1W					+6	+10					+6	0	GO					+2	+3	30	35
2	42		+3	+3	-12	-8	-10	-12	1N	2W					-6	+6					+10	-7	GO					+3	+3	25	35
4	42		+2	+1	+2	-2	-2	-5	2S	1 1/2W					+10	-2					-10	+2 1/2	GO					+5	+1	30	50
6	42		0	0	-3	-5	+1	+2	2N	3 1/2E					-5	-12					-6	+7	GO					5	0	50	30
8	42		+1	+1	-2	-5	-4	0	1S	2 1/2E					+3	-12					0	+1	GO					+2	0	55	35
10	42		0	0	-2	-3	+1	-2	1 1/2N	1/2E					-5	-12					+18	-7	GO					+2	+2	60	30
12	42		+2	+1	-4	-3	-1	+1	1 1/2N	2E					+11	+8					-7	-10	GO					+2	0	40	30
14	42		0	0	-2	-5	-4	-2	1S	1/2E					+2	-9					-13	-3	GO					0	0	55	20
16	42		+4	+4	-17	-15	-17	-19	0	2W					-2	+7					+3	+2	GO					+1	+3	20	35
18	42		+5	+3	-2	-1	+1	0	1 1/2N	1/2E					-3	-3					-2	-1	GO					+1	+2	25	30
20	42		0	0	0	-2	-2	+1	1S	1 1/2E					0	-6					-11	-3	GO					+2	+3	30	30
22	42		+1	+1	-7	-7	-6	-6	1/2N	1/2E					+6	-1					-6	-8	GO					+1	+2	45	35
24	42		+3	+3	-3	-8	-10	-7	3 1/2S	1/2E					+7	0					-1	-10	GO					+1	+1	30	25

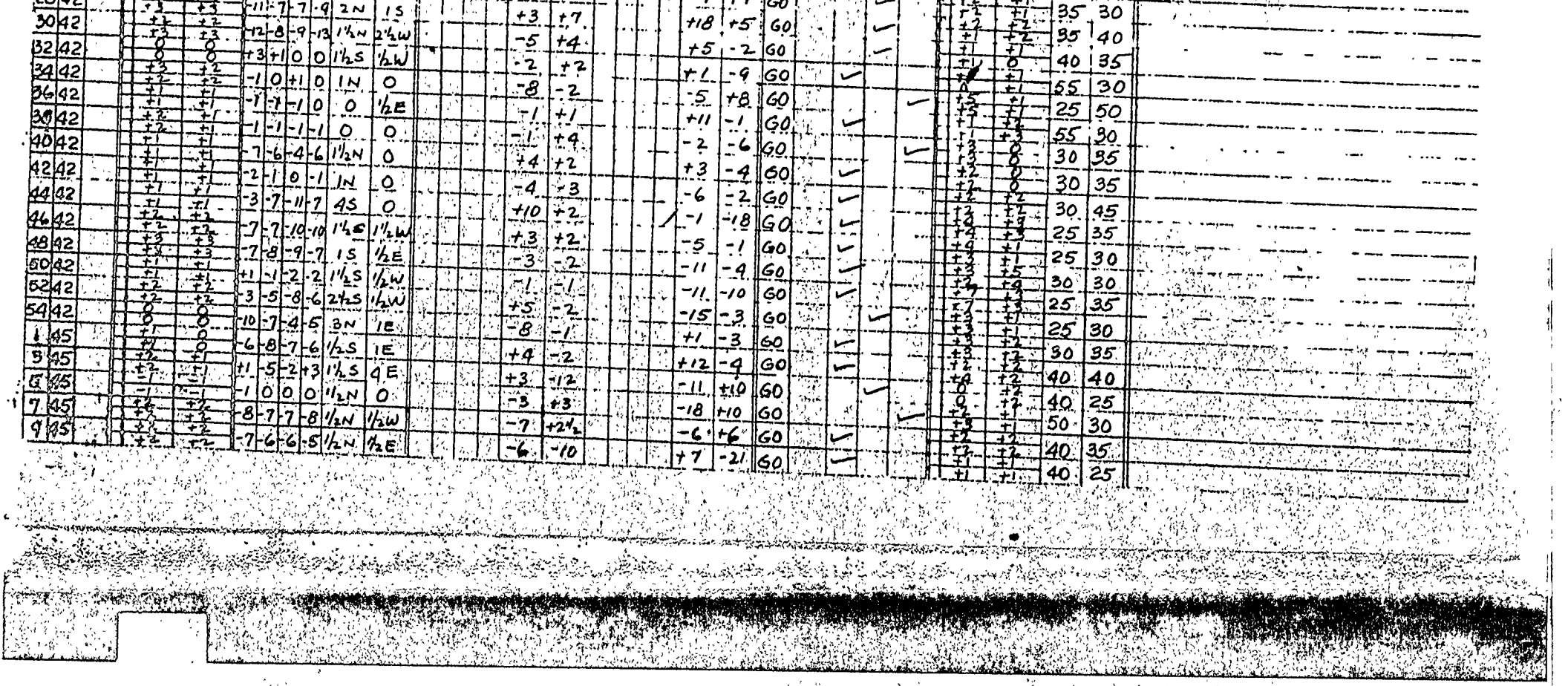
REMARKS

GO AFTER HONE IN TTS. SPINE WELDING ON PLENUM TUBE.

	X	Y	
	4.391	92	TOP
	93	93	1 3/4" DOWN
	97	98	BOTTOM

HONE TTS TOP X 4.385 Y 4.391 BOTTOM X 4.381 Y 4.382

TTS TUBE HONED TO 4.403 TO PERMIT FUNCTIONAL GAGING.
SNUG-GO AFTER HONING

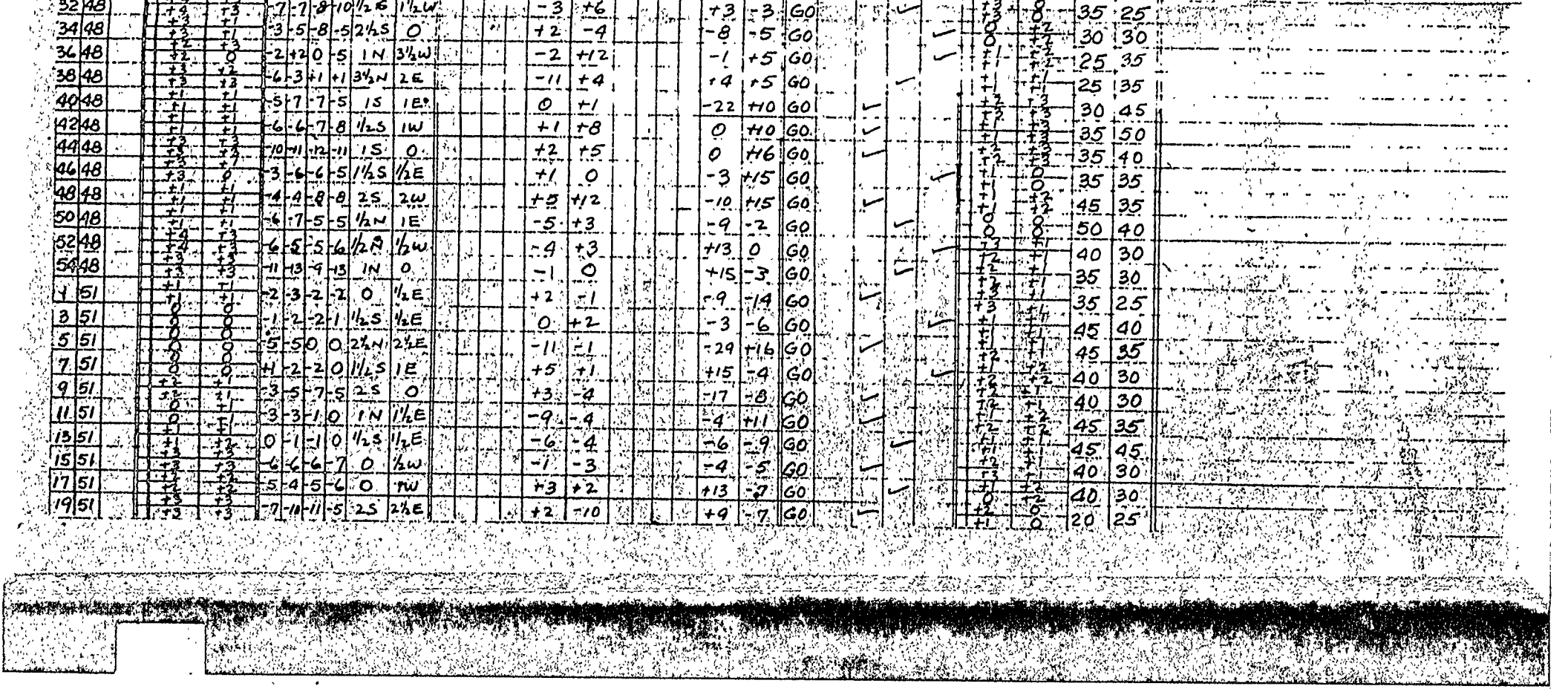


RESULTS OF LINE BORING

P UNIT

BASIC BORE 4.375 — BASIC BORE 4.385

TUBE NOS X	TUBE NOS Y	NVS	BORE MEAS. BEFORE HONING T.L.	BORE MEAS. BEFORE HONING B.L.	VERTICALITY N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY PLENUM N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY CENTER TUBE SHEET N	E	S	W	AVERAGE N-S	AVERAGE E-W	FUNCTIONAL GAGE GO	FUNCTIONAL GAGE NO GO	FINISH BEFORE HONING 0-63	63-125	125-UP	AFTER HONING BORE MEAS. T.L.	AFTER HONING BORE MEAS. B.L.	AFTER HONING FINISH-RMS T.L.	AFTER HONING FINISH-RMS B.L.	REMARKS
11	45		0	-1	-8	-7	-5	-5	1½N	1E					-3	-5					-4	-6	GO		✓			X 0	+1	60	25	
13	45		+1	+1	-9	-7	-6	-9	1½N	1W					-2	+1					+5	+5	GO		✓			Y +1	+1			
15	45		0	0	-1	-1	0	+1	½N	1E					-3	-8					-8	+4	GO		✓			0	+3	40	40	
17	45		+2	+1	-5	-6	-6	-7	1½S	½W					+2	-1					-2	-6	GO			✓		+2	+8			
19	45		+2	+2	-9	-10	-9	-9	0	1½E					-4	+4					+17	+6	GO			✓		+3	+1	30	35	
21	45		-1	-1	+1	+1	0	-1	½S	1W					-1	+2					-7	0	GO		✓			+3	0			
23	45		+4	+4	-14	-19	-20	-18	3S	½E					+1	-4					0	-17	GO		✓			+2	+1	20	30	
25	45		+3	+2	-6	-8	-2	-5	2N	1½E					+3	-13					-4	-10	GO			✓		+2	+1	20	30	
27	45		0	-1	+1	-1	-3	-4	2S	2½W					+7	+5					+9	-12	GO		✓			+3	+1	20	35	
29	45		+1	+1	-5	-4	-2	-2	1½N	1E					-5	-3					-9	-8	GO			✓		+3	+1	20	30	
31	45		+3	+3	-2	-2	-1	-2	½N	0					-8	+1					+6	+9	GO			✓		+2	+2	20	30	
33	45		+2	+2	0	0	0	-1	0	½W					-5	+5					+8	-8	GO			✓		+2	+2	20	30	
35	45		+2	+2	-7	-8	-6	-6	½N	1E					-3	+2					+6	-4	GO		✓			+1	+2	40	30	
37	45		+2	+2	-2	-1	0	0	1N	½E					-1	+6					+8	+6	GO			✓		+2	+2	45	35	
39	45		+1	+1	+10	+11	+10	+10	0	½W					0	-1					+5	-2	GO		✓			+3	+2	40	35	
41	45		+1	+1	-7	-5	-7	-8	0	1½W					-1	+5					-9	-2	GO			✓		+4	0	45	50	
43	45		+2	+1	-9	-11	-12	-9	1½S	1E					+3	0					-9	-11	GO			✓		+3	+2	30	30	
45	45		+3	+3	-5	-5	-5	-5	0	0					+1	+2					+9	0	GO			✓		+3	+2	30	30	
47	45		+2	+2	-7	-6	-4	-6	1½N	0					-7	+8					+4	-1	GO			✓		+1	+2	35	30	
49	45		+1	+1	-8	-8	-8	-8	0	0					-1	+4					-4	-12	GO			✓		+2	+1	30	35	HONE IN TTS TDP X 4.410 Y 4.410
51	45		+2	+2	-3	-4	-4	-5	½S	½W					+5	+10					-9	-6	GO			✓		+1	+1	35	30	
53	45		+1	0	-4	-4	-5	-5	½S	½W					-2	+6					-7	+8	GO			✓		+2	+1	55	30	
55	45		+2	+2	-4	-6	-6	-7	1S	½W					-3	+2					-5	-4	GO			✓		+5	+5	50	30	SNUG — GO AFTER HONE
2	48		+2	+2	-5	-7	-7	-6	1S	½E					+2	-4					-1	-14	GO			✓		+1	+1	35	25	
4	48		0	0	+1	+1	-4	-3	2½S	2W					+2	+8					+13	-4	GO			✓		0	+1	45	25	
6	48		+2	+1	+2	-4	-4	+3	3S	3½E					+7	-8					-3	-12	GO			✓		+1	+2	30	25	
8	48		+3	+2	-10	-8	-11	-15	½S	3½W					+6	+13					+9	-5	GO			✓		+1	+2	50	30	
10	48		0	+1	0	-5	+1	+2	½N	3½E					+1	-13					-2	+4	GO			✓		+2	+1	60	30	
12	48		0	0	0	0	0	-1	0	½W					-2	0					+8	+4	GO			✓		0	+4	30	30	
14	48		0	-1	-7	-10	-6	-4	½N	3E					-2	-10					-13	+2	GO			✓		+2	+1	40	25	
16	48		+2	+2	-2	0	0	-2	1N	1W					+2	0					-2	+13	GO			✓		+2	+4	25	30	
18	48		0	0	-1	-2	-3	-3	1S	½W					+4	+1					+1	-7	GO			✓		+3	+2	30	35	
20	48		+2	+2	-5	-8	-9	-6	2S	1E					+5	-9					+3	-5	GO			✓		+2	+1	20	30	
22	48		0	0	-3	-10	-2	-2	1½N	½W					-3	0					+8	-8	GO			✓		+4	+1	25	25	
24	48		+1	+1	-4	-4	-5	-4	1½S	0					+3	-4					-4	-10	GO			✓		+4	+2	30	30	
26	48		+1	0	-1	-3	-2	0	½S	1½E					0	-5					+4	+3	GO			✓		+3	+2	30	20	
28	48		+3	+2	-3	-1	+1	-1	2N	0					-6	-2					-4	-2	GO			✓		+2	+1	30	25	



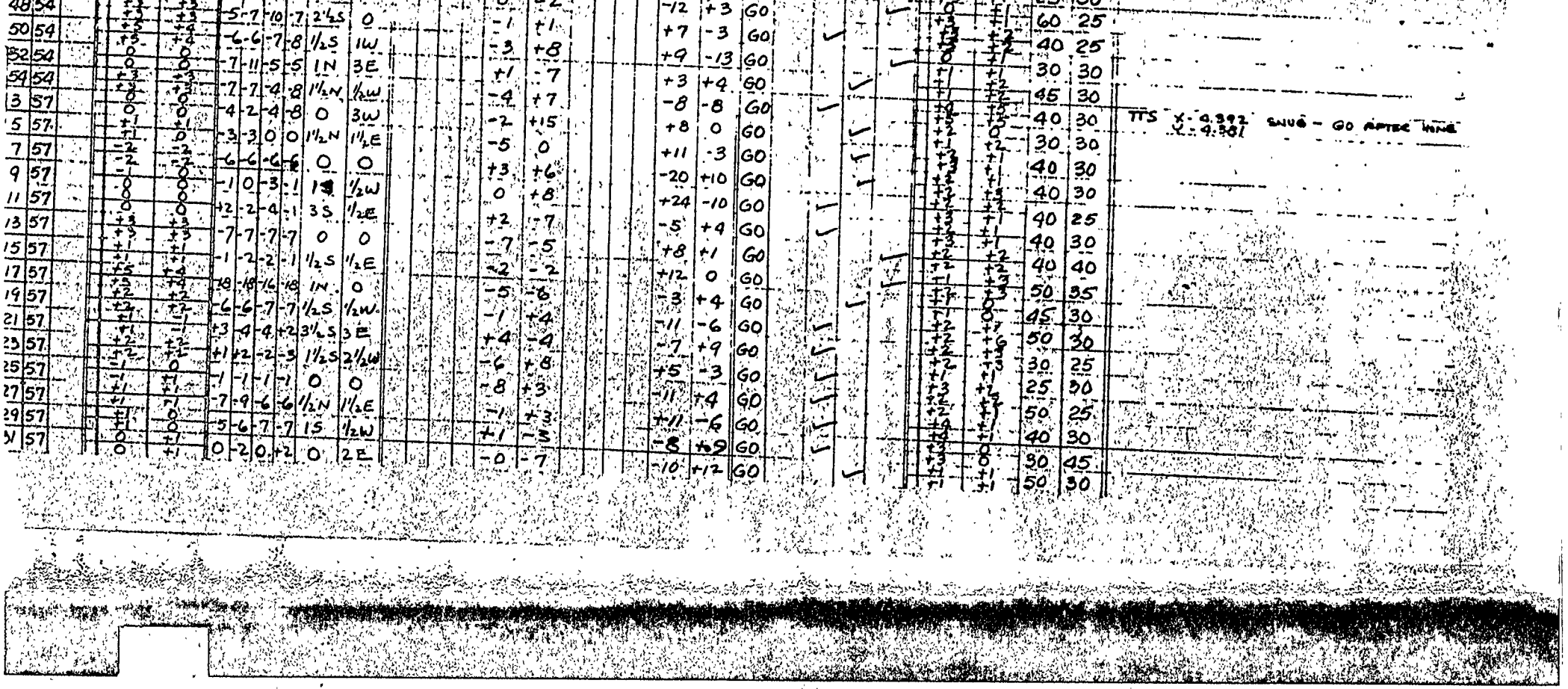
13.37

RESULTS OF LINE BORING

P UNIT

BASIC BORE 4.375

TUBE NOS X	TUBE NOS Y	TUBE NOS NVS	BORE MEAS. BEFORE HONING T.L. X	T.L. Y	B.L. X	B.L. Y	VERTICALITY N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY B.L. N	E	S	W	PLENUM AVERAGE N-S	PLENUM AVERAGE E-W	CENTRALITY CENTER TUBE SHEET N	E	S	W	AVERAGE N-S	AVERAGE E-W	FUNCTIONAL GAGE GO	NO GO	FINISH BEFORE HONING 0-63	63-125	125 UP	BASIC BORE 4.385 AFTER HONING BORE MEAS. T.L. X	T.L. Y	B.L. X	B.L. Y	FINISH - RMS T.L.	B.L.	REMARKS
21	51		+3	+3	+3	+3	-4	+2	+5	-4	4½N	3W					-9	+5					+3	-10	GO					+2	+3			30	25	
23	51		+1		0		-3	0	0	-3	1½N	1½W					-1	+3					+8	+4	GO					+1	+1			50	35	
25	51		+3		+3		-18	-18	-11	-10	1½S	0					+4	-5					-1	-5	GO					+3	+1			30	35	
27	51		+1		+1		-2	0	+1	-2	1½N	1W					-2	+1					+3	+3	GO					+3	0			30	30	
29	51		0		-1		0	0	0	0	0	0					-3	-2					-7	-9	GO					+1	+2			45	35	
31	51		+3		+2		-4	-4	-8	-7	2S	1½W					+9	-4					-7	-10	GO					0	+2			40	40	
33	51		+1		+1		-4	-5	-6	-7	1S	1W					+5	-3					+1	-6	GO					+1	+2			20	25	
35	51		0		0		-3	+1	+2	-2	2½N	1½W					-5	-7					+12	+3	GO					+3	0			30	30	
37	51		+1		0		+3	0	-1	-1	2S	½W					+3	+3					-4	-11	GO					+2	+1			35	35	
39	51		+2		+2		-3	-1	-2	-6	½N	2½W					-6	+11					-2	-5	GO					+3	+1			25	30	
41	51		+2		+2		-5	-6	-5	-4	0	1E					-1	+2					+7	-7	GO					+3	+1			25	30	
43	51		+2		+2		-4	-4	-4	-4	0	0					-3	-3					+15	-13	GO					+1	+2			30	35	
45	51		+1		0		-7	-7	-6	-6	½N	1½E					0	-3					-1	-13	GO					0	+2			30	35	
47	51		+3		+3		-9	-9	-15	-13	2S	2W					+7	+19					+2	+10	GO					+2	+2			30	30	
49	51		+3		+2		-10	-10	-10	-10	0	0					-3	+8					+11	-1	GO					+1	+2			35	30	
51	51		+1		+1		+2	+1	0	0	IN	½E					+1	+7					-1	+8	GO					0				40	30	
53	51		+1		+1		-23	-22	-21	-22	1N	0					-1	+7					+15	+2	GO					+3	+1			45	30	
55	51		+1		+1		-4	-8	-10	-5	3S	1½E					+7	-3					-3	-9	GO					+5	+5			40	21	SNUG - GO AFTER HONE
2	54		0		0		-2	-6	-4	-1	1S	2½E					0	-6					-1½	-5	GO					+1	+5			50	35	
4	54		+1		-1		-2	-1	-1	0	1½N	½E					-8	+6					+7	+10	GO					+2	+2			45	30	
6	54		0		-1		0	-4	-2	+1	1S	2½E					0	-1					-1	+9	GO					+5	+2			50	35	THIS TUBE LEAKED AT WELD DURING AIRGON TEST # WAS SHRINK WELDED.
8	54		+2		+1		-8	-9	-5	-4	1½N	2½E					-8	-2					-17	+11	GO					+1	+1			40	30	
10	54		+3		+2		-7	-9	-8	-5	1½S	2E					-6	-7					-15	-2	GO					+2	+1			40	25	
12	54		0		0		-9	-8	-10	-12	½S	2W					-9	+4					-2	-9	GO					+2	+3			40	45	
14	54		+2		+2		-11	-12	-10	-9	1N	1½E					-10	-5					+12	+2	GO					0	+2			40	35	
16	54		+2		+2		-3	-4	-6	-5	1½S	½W					+1	-2					-5	-4	GO					0	+2			40	25	
18	54		+4		+3		-11	-11	-10	-8	1½N	1½E					-8	+8					+2	-4	GO					0	0			45	20	
20	54		+2		+2		-4	-7	-9	-5	2½S	1E					0	-4					-18	0	GO					0	+2			30	35	
22	54		+1		8		-7	-6	-8	-7	1½S	½W					-1	+2					-12	+1	GO					+2	+1			25	35	
24	54		0		-1		0	+1	0	-1	0	1W					+5	-15					-15	-15	GO					+3	+1			30	30	
26	54		+1		+1		+2	+2	-3	-3	2½S	2½W					-2	+1					-9	-5	GO					+1	+2			40	30	
28	54		+2		+2		0	0	0	0	0	0					-8	+2					-5	+7	GO					+2	+2			35	30	
30	54		8		-1		-5	-7	-8	-6	1½S	½E					+1	-1					-21	0	GO					+3	+3			25	35	
32	54		±1		±1		+18	+17	+18	+18	0	1½E					-7	+8					+8	-2	GO					0	+1			20	20	
34	54		+3		+3		-11	-9	-9	-11	1N	1W					-5	+6					+13	+9	GO					+2	+1			40	35	
36	54		+1		+1		-8	+1	+5	-4	6½N	2½W					-17	+7					+3	+7	GO					+1	+1			35	35	
38	54		+1		+1		-1	-1	-1	-1	0	0					-4	+1					-12	-1	GO					+2	+2			40	30	
40	54		+1		+1		-4	-6	-8	-7	2S	½W					+1	-1					-7	-3	GO					+1	+2			40	30	
42	54		+4		+3		-5	-5	-10	-11	2½S	3W					+2	+5					+1	-9	GO											
44	54		+1		+1		-6	-8	-7	-4	1½S	2E					+1																			



TTS X - 0.392 SNUG - GO AFTER NINE
Y - 9.581

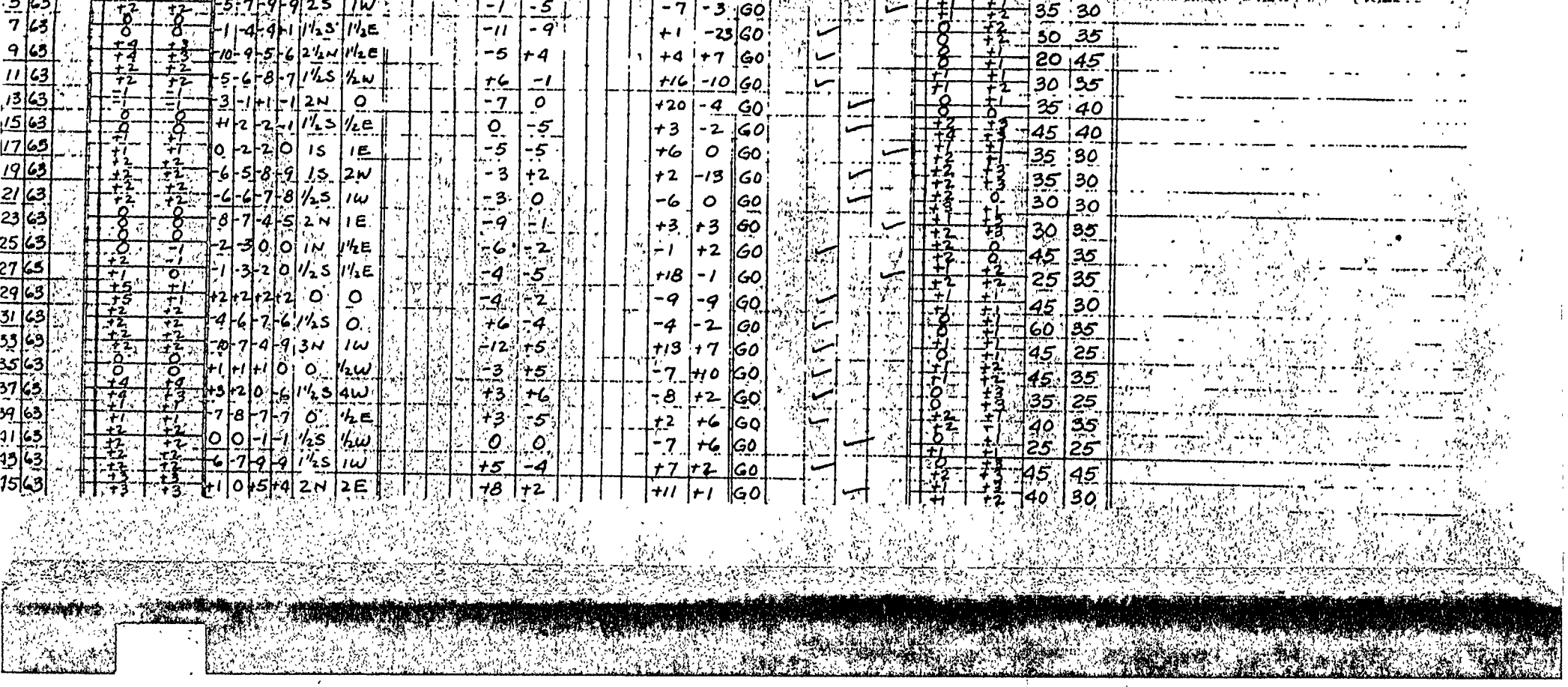
13B8

RESULTS OF LINE BORING

P UNIT

BASIC BORE 4.375" — BASIC BORE 4.385"

TUBE NOS X	TUBE NOS Y	TUBE NOS NVS	BORE MEAS. BEFORE HONING T.L.	BORE MEAS. BEFORE HONING B.L.	VERTICALITY N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY PLENUM B. N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY CENTER TUBE SHEET N	E	S	W	AVERAGE N-S	AVERAGE E-W	FUNCTIONAL GAGE GO	NO GO	FINISH BEFORE HONING 0-63	63-125	125-UP	AFTER HONING BORE MEAS. T.L.	AFTER HONING BORE MEAS. B.L.	AFTER HONING FINISH-RMS T.L.	AFTER HONING FINISH-RMS B.L.	REMARKS
33	57		X +2 Y +2	+1 0	-3	+3	-2	-4	1/2N	3 1/2W					-4	+10					-8	-3	GO					X 0 Y +3	+2 +2	20	35	
35	57		+1	+1	-10	-10	-11	-11	1/2S	1/2W					-4	-3					-10	-13	GO					0	0	35	35	
37	57		+1	0	-2	-6	-8	-8	3S	1W					+3	0					-9	-3	GO					+1	0	35	35	
39	57		0	0	-5	-7	-10	-7	2 1/2S	0					+5	-3					0	-24	GO					0	+2	35	35	
41	57		0	0	-2	-2	-1	-1	1/2N	1/2E					-1	+1					+27	-9	GO					0	0	40	35	
43	57		0	0	-22	-26	-24	-21	2S	2 1/2E					+5	-12					+2	-15	GO					+1	+4	30	30	
45	57		+2	+2	-7	-6	-6	-8	1/2N	1W					-3	+1					-6	+6	GO					+2	+3	40	30	
47	57		+1	+1	-5	-8	-8	-6	1 1/2S	1E					-1	-5					-11	+2	GO					0	+2	40	35	
49	57		+1	+1	-7	-5	-3	-4	2N	1/2E					-6	-3					0	+4	GO					+1	0	50	35	
51	57		+3	+3	-8	-7	-9	-5	1/2S	1E					+8	-4					-7	-2	GO					+2	+2	60	35	
53	57		-1	-1	-6	-6	-6	-6	0	0					0	-2					-8	+6	GO AFTER HONING					+3	+1	35	40	
2	60		0	0	-8	-7	-7	-8	1/2N	1/2W					-4	+8					-9	+25	GO					+4	+1	40	30	HONE IN TO TOP X 4.384 Y 4.384 Bottom X 4.386 Y 4.385
4	60		0	0	-5	-5	+1	0	3N	2 1/2E					-6	-1					+26	-1	GO					+5	+2	40	30	
6	60		+6	+6	-10	-10	-9	-10	1N	0					-4	-2					+23	-2	GO					0	+2	50	35	
8	60		+3	+2	-5	-4	-5	-4	0	0					+2	0					+3	-6	GO					+1	+3	40	30	
10	60		+3	+3	-11	-12	-11	-8	0	2E					+7	-6					+3	0	GO					+1	+2	30	30	
12	60		+1	+1	-3	-9	-9	-5	3S	2E					+2	-10					-9	-10	GO					+1	+2	60	30	
14	60		+3	+2	-8	-11	-10	-7	1S	2E					+4	-10					+3	-12	GO					+1	+2	45	30	
16	60		+3	+3	-5	-6	-9	-8	2S	1W					+2	+1					-5	-1	GO					+2	+3	55	30	
18	60		+1	+1	-10	-8	-4	-6	3N	1E					-18	-3					-4	-4	GO					+2	+1	60	35	
20	60		+3	+3	-2	-2	0	0	1N	1E					-9	-2					+2	0	GO					0	+1	45	30	
22	60		+2	+2	-1	-1	-1	-1	0	0					-9	+2					-6	+1	GO					+2	+2	45	30	
24	60		+2	+2	-11	-9	-8	-7	1 1/2N	1E					-15	-3					+5	+16	GO					+1	+2	45	30	
26	60		+4	+4	-7	-6	-5	-5	1N	1/2E					+2	-5					-8	-1	GO					+2	+1	30	25	
28	60		+3	+1	-2	0	0	+2	1N	1E					-7	+2					-10	-6	GO					+3	+1	30	35	
30	60		+2	+1	-6	-6	-4	-5	1N	1/2E					-9	-4					-11	-12	GO					+3	0	30	25	
32	60		+2	+2	-11	-10	-9	-9	1N	1/2E					-5	-1					-9	-6	GO					+2	+1	40	35	
34	60		+3	+2	-5	-5	-7	-8	2S	1 1/2W					+2	-3					-15	-15	GO					+1	+1	50	25	
36	60		+1	+1	-6	0	+1	-5	3 1/2N	2 1/2W					-9	+10					+15	-8	GO					+1	+1	45	35	
38	60		+3	+3	0	0	0	0	0	0					+1	-3					-9	-4	GO					0	0	30	30	
40	60		+3	+3	-10	-9	-9	-9	1/2N	0					-3	+1					+4	+3	GO					+2	+1	40	30	
42	60		+3	+2	-9	-12	-13	-10	2S	1E					+3	-6					+6	-60	GO					+1	+1	40	25	
44	60		+2	+2	-10	-11	-11	-10	1/2S	1/2E					+1	+1					+10	+2	GO					+2	+2	35	30	
46	60		+1	+2	-5	-7	-10	-10	2 1/2S	1 1/2E					+5	+5					-7	-4	GO					+3	+3	30	35	
48	60		+1	+1	-7	-6	-5	-5	0	1/2E					-3	-4					+2	-1	GO					+2	+1	35	25	
50	60		+3	+3	-12	-13	-8	-14	4N	1/2W					-7	+4					+10	-9	GO					+2	+1	25	25	
52	60		0	-1	0	-1	-2	-2	1S	1/2W					+5	+4					0	-6	GO					+4	+1	30	35	
54	60		+1	+1	-4	-3	-8	-8	2S	2 1/2W					+6	+10					-6	+10	GO					+3	+2	30	40	
			+2	+1																								0	+2	30	35	
																												+1	+1	30	35	



13B.9

RESULTS OF LINE BORING

P UNIT

BASIC BORE 4.375 — BASIC BORE 4.385

TUBE NOS X	TUBE NOS Y	NVS	BORE MEAS. BEFORE HONING T.L.	BORE MEAS. BEFORE HONING B.L.	VERTICALITY N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY B.L. PLENUM N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY CENTER TUBE SHEET N	E	S	W	AVERAGE N-S	AVERAGE E-W	FUNCTIONAL GAGE GO AND GO	FINISH BEFORE HONING 0-63	63-125	125-UP	AFTER HONING BORE MEAS. T.L.	BORE MEAS. B.L.	FINISH-RMS T.L.	FINISH-RMS B.L.	REMARKS
47	63		+1	0	-4	-2	+2	-1	3N	½E					-3	-1					+22	0	GO		✓		X +1	+2	50	25	
49	63		+4	+2	-11	-9	-10	-13	½N	2W					0	0					+10	-15	GO		✓		Y +1	+1	60	40	
51	63		+3	+3	0	0	-3	-2	1½S	1W					+5	-3					+8	-15	GO		✓		+1	+2	35	25	
53	63		+2	+2	-6	-10	-7	-3	½S	3½E					+5	-11					-18	+18	GO		✓		+1	+2	40	40	T3 TUBE HONED TO 4.405 TO PERMIT FUNCTIONAL GAGING.
4	66		+2	+2	-9	-6	-6	-7	1½N	½W					-2	+10					+6	+10	GO	✓			0	+1	30	30	
6	66		+2	+2	-1	-4	-2	+1	½S	2½E					-5	+1					+9	0	GO	✓			+1	+2	30	35	
8	66		+3	+2	-12	-10	-11	-11	½N	½W					-4	+6					+20	-6	GO	✓			+2	+2	30	35	
10	66		+3	+3	-10	-11	-11	-9	½S	1E					+2	-1					+23	+6	GO	✓			+2	0	25	35	
12	66		+1	+1	-1	-1	0	-1	½N	0					-5	0					+13	-10	GO	✓			0	0	30	35	
14	66		+2	+2	+2	+4	0	-2	1S	3W					-1	+5					-14	-11	GO	✓			+1	0	30	25	
16	66		+2	+2	-10	-9	-11	-12	½S	1½W					-1	-9					+7	-4	GO	✓			0	+1	45	30	
18	66		0	0	-2	-4	-2	-1	0	1½E					-8	-6					-9	+16	GO	✓			+2	+2	45	30	
20	66		+3	+3	-10	-10	-10	-10	0	0					-1	+9					+22	+4	GO	✓			+3	+1	35	25	
22	66		+3	+2	+1	0	-3	-3	2S	1½W					+2	+6					+4	-7	GO		✓		+3	+1	30	25	
24	66		+1	+1	-6	-8	-7	-5	½S	1½E					-3	+1					-6	-1	GO	✓			+1	+2	50	35	
26	66		+3	+3	+1	-2	-3	-1	2S	½E					+2	-1					-16	+1	GO	✓			+1	+2	45	25	
28	66		+1	0	-24	-22	-22	-21	1N	½E					-1	+2					+4	+5	GO	✓			+1	+3	35	20	
30	66		+3	+2	-9	-9	-10	-11	½S	1W					-2	+4					-7	-2	GO	✓			+1	+2	45	30	
32	66		0	-1	0	-1	-2	-1	1S	0					+1	+2					+8	-6	GO	✓			+1	+1	50	35	
34	66		+4	+2	+1	0	-1	-1	1S	½W					0	0					-1	+7	GO	✓			0	+2	40	40	
36	66		+3	+4	+3	0	-3	-1	3S	½W					+2	+7					-10	-4	GO	✓			+2	+2	30	35	
38	66		+1	+1	-1	-1	-1	-1	0	0					-3	+4					+7	-1	GO		✓		+2	+2	35	35	
40	66		+3	+3	-5	-5	-7	-7	1S	1W					+5	+5					-8	+3	GO		✓		0	+3	30	30	
42	66		+1	+4	+2	-2	-3	+1	2½S	1½E					+5	-4					-2	-8	GO		✓		+1	+3	45	35	
44	66		+2	+2	+3	0	-1	+1	2S	½E					+4	+6					-16	+1	GO	✓			+3	+2	40	35	
46	66		-3	-3	-2	-5	-8	-6	3N	½W					+5	+4					-6	+5	GO		✓		+1	+2	45	40	
48	66		+5	0	0	0	0	-1	0	½W					-5	0					+4	+2	GO			✓	+1	+1	50	25	
50	66		0	0	-2	-2	+1	-1	1½N	½E					-8	+3					-8	+12	GO	✓			+2	+3	40	30	
52	66		+1	+1	-8	-5	-5	-8	1½N	1½W					-9	+2					-4	+8	GO	✓			+1	+1	40	25	
5	69		+3	+2	-6	-6	-7	-8	½S	1W					+1	+5					-19	-3	GO	✓			0	+2	30	30	
7	69		+2	+2	-1	-2	-4	-3	1½S	½W					0	+11					0	-6	GO		✓		+2	+1	30	35	
9	69		+3	+2	-8	-8	-9	-10	½S	1W					+2	+8					-1	+4	GO	✓			+1	+2	30	35	
11	69		+2	+2	-5	-10	-8	-5	1½S	2½E					0	-5					-11	-3	GO	✓			+2	+2	30	30	
13	69		0	-1	-10	-10	-7	-6	1½N	2E					-2	-2					0	+15	GO		✓		0	+2	25	20	
15	69		+1	+3	-9	-9	-13	-11	4S	2W					-1	+4					+5	-7	GO	✓			+2	+1	35	25	
17	69		+1	+1	0	0	0	0	0	0					-1	-1					+7	-2	GO	✓			+2	+1	25	30	
19	69		+1	+1	-1	+1	0	-2	½N	1½W					-8	+7					+4	-5	GO	✓			+2	+3	30	30	
21	69		+3	+3	-9	-12	-12	-11	1½S	½E					-6	+2					-4	+8	GO	✓			+2	+2	30	40	

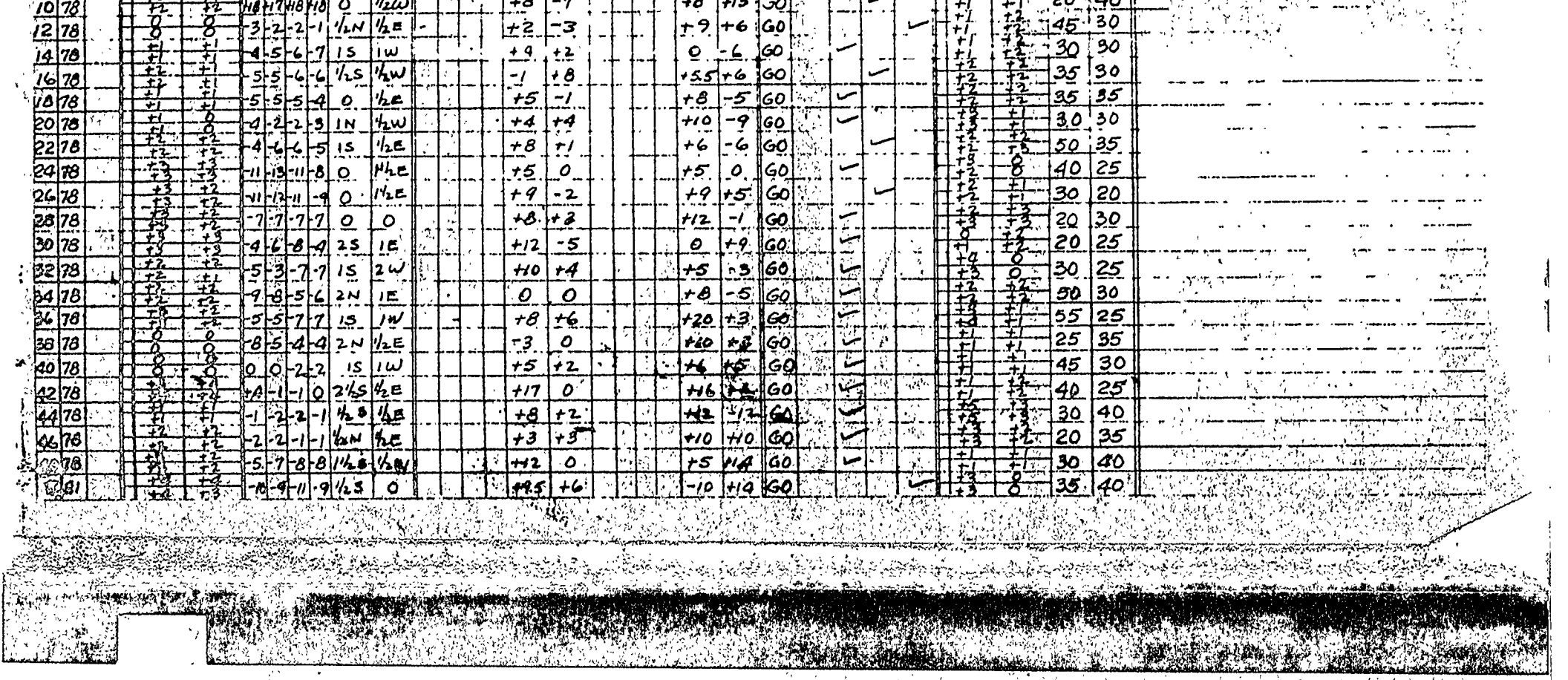
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RESULTS OF LINE BORING

P UNIT

BASIC BORE 4.375 — BASIC BORE 4.385

TUBE NOS X	Y	NVS	BORE MEAS. BEFORE HONING T.L.	B.L.	VERTICALITY N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY PLENUM B.L. N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY CENTER TUBE SHEET N	E	S	W	AVERAGE N-S	AVERAGE E-W	FUNCTIONAL GAGE GO AND GO	FINISH BEFORE HONING 0-63	63-125	125-UP	AFTER HONING BORE MEAS. T.L.	B.L.	FINISH-RMS T.L.	B.L.	REMARKS
20	72		X +3 Y +3	+2 +2	-6	-6	-6	-6	0	0					-8	-5					-16	-1	GO				X +3 Y +3	+1 +2	30	25	
22	72		+2	+2	-11	-7	-9	-7	3½N	0					-12	0					-9	+8	GO				+3	+2	25	35	
24	72		+2	+2	+3	-1	0	+3	1½S	2E					0	-2					-3	-5	GO				+3	+1	40	30	
26	72		+3	+2	-9	-6	-8	-6	2S	0					0	-9					-8	0	GO				+3	+1	35	35	
28	72		0	0	-3	-8	-9	-9	3S	2E					+3	-3					-11	+5	GO				+3	+1	30	25	
30	72		+1	+1	-18	-18	-18	-17	0	½W					-2	-9					+2	+1	GO				+3	0	25	25	
32	72		+2	+2	-5	-5	-7	-7	1N	1W					-6	-2					-27	0	GO				0	+2	45	30	
34	72		+1	+1	-2	-7	-9	-5	3½S	1E					+5	-1					-18	0	GO				+2	+4	30	35	
36	72		+1	+1	0	0	0	-2	0	1W	+2	+6½			-2	+6	+3	+6½			+2	+6	GO				+2	0	30	35	
38	72		0	0	+1	+1	0	0	½S	½W					+1	+6					+3	+2	GO				+1	+2	30	35	
40	72		+5	0	+1	-1	-1	+1	1S	1E					0	-5					+9	+4	GO				+1	+1	30	35	
42	72		0	0	-1	+1	+1	-2	1N	1½W					-3	+9					+1	+1	GO				+1	+2	25	40	
44	72		+3	+3	+3	-1	-2	+1	2½S	1E					+1	-2					-18	+4	GO				0	+2	50	40	
46	72		+2	+1	0	-2	-2	-2	1S	0					+2	-2					+5	+8	GO				+2	+2	35	30	
48	72		+1	+1	-5	-5	-5	-5	0	0					0	-2					-4	+13	GO				+4	+3	25	40	
50	72		+2	+2	-7	-7	-7	-6	0	½E					-4	-3					-4	+10	GO				+8	+7	35	60	TTS BORES X 4.390 SNUG - GO Y 4.380 AFTER HONE
7	75		+5	+5	-5	-5	-5	-4	0	½E					+5	+4					+14	-1	GO				8	+1	35	30	
9	75		+3	+2	-7	-7	-7	-7	0	0					0	-6					+5	-14	GO				+1	0	40	30	
11	75		+5	+2	-5	-10	-6	-2	1S	4E					+35	-11.5					-8.5	-10	GO				+2	+1	25	30	
13	75		+3	+3	-12	-11	-9	-9	1½N	1E					-3	+1					+29	+9	GO				8	+2	35	35	
15	75		+3	+3	-10	-12	-12	-8	1S	2E					+6	-7					+7	+4	GO				+2	+1	25	30	
17	75		+2	+2	-6	-6	-7	-7	½N	½W					-2	-1					-18	0	GO				+1	+1	25	35	
19	75		+2	+2	+2	+4	+4	+2	1N	1W					-4	-5					+2	-13	GO				+2	+2	30	35	
21	75		+4	+2	-8	-14	-13	-7	2½S	7E					+5	+1					-1	+10	GO				+4	+1	30	30	
23	75		+3	+3	-4	-5	-6	-6	1S	½W					-1	+2					-8	+1	GO				+3	+2	35	35	
25	75		+2	+2	-10	-10	-8	-8	1N	1E					-4	+3					+18	+6	GO				+2	+1	30	25	
27	75		+3	+3	-5	-3	-9	-10	2S	3½W					+2	+13					-1	-5	GO				+2	+1	30	20	
29	75		0	0	-5	-4	-5	-6	0	1W					-5	+7					-11	+1	GO				+3	0	20	20	
31	75		+1	0	-8	-7	-6	-6	1N	½E					-7	-1					+1	0	GO				+4	+2	25	35	
33	75		+3	+2	-3	-7	-7	-4	2S	1½E					+3	-3					-14	+6	GO				+3	+2	25	30	
35	75		+2	+2	-3	-2	-1	-1	1N	½E					-2	+3					+18	+6	GO				+2	+2	45	30	
37	75		0	0	-1	+1	+2	0	1½N	½W					-5	0					-1	+7	GO				+1	+1	30	30	
39	75		0	+1	0	0	0	0	0	0					-2	0					+3	-7	GO				+1	+2	30	35	
41	75		0	0	-24	-20	-22	-24	1N	3W					-3	+9					+2	-8	GO				+1	+2	35	30	
43	75		+3	+2	-1	-2	-1	0	0	1E					-4	-5					+15	-9	GO				+2	+4	30	35	
45	75		+1	+1	0	0	-1	-1	½S	½W					+1	+9					-8	+8	GO				0	+2	30	35	
47	75		0	-1	0	-1	-2	0	1S	½E					0	-2					+8	-1	GO				+2	+1	35	35	
49	75		+1	+1	-7	-10	-8	-4	½S	3E					-4	+17					+9	+20	GO				+3	+2	30	35	



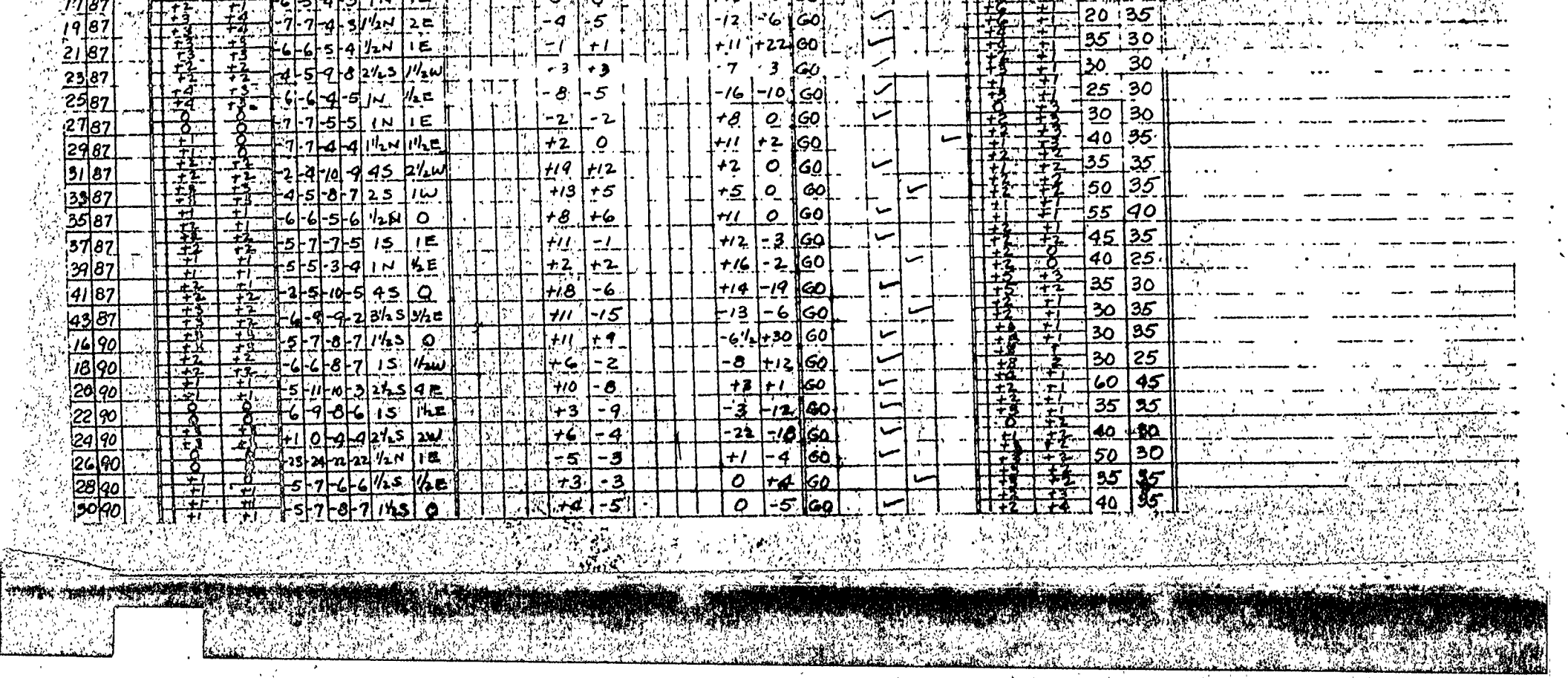
13.B.11

RESULTS OF LINE BORING

P UNIT

BASIC BORE 4.375 — BASIC BORE 4.385

TUBE NOS X	TUBE NOS Y	TUBE NOS NVS	BORE MEAS. BEFORE HONING T.L.	BORE MEAS. BEFORE HONING B.L.	VERTICALITY N	VERTICALITY E	VERTICALITY S	VERTICALITY W	VERTICALITY AVERAGE N-S	VERTICALITY AVERAGE E-W	CENTRALITY PLENUM N	CENTRALITY PLENUM E	CENTRALITY PLENUM S	CENTRALITY PLENUM W	CENTRALITY PLENUM AVERAGE N-S	CENTRALITY PLENUM AVERAGE E-W	CENTRALITY CENTER TUBE SHEET N	CENTRALITY CENTER TUBE SHEET E	CENTRALITY CENTER TUBE SHEET S	CENTRALITY CENTER TUBE SHEET W	CENTRALITY CENTER TUBE SHEET AVERAGE N-S	CENTRALITY CENTER TUBE SHEET AVERAGE E-W	FUNCTIONAL GAGE GO	FUNCTIONAL GAGE NO GO	FINISH BEFORE HONING 0-63	FINISH BEFORE HONING 63-125	FINISH BEFORE HONING 125-UP	AFTER HONING BORE MEAS. T.L.	AFTER HONING BORE MEAS. B.L.	AFTER HONING FINISH - RMS T.L.	AFTER HONING FINISH - RMS B.L.	REMARKS
11	81		X +1	+1	-3	-8	-8	-3	2½S	2½E					+6	-9					-13	-16	GO				✓	X +2	+1	30	30	
13	81		Y +1	+1	-8	-3	+1	-4	4½N	½W					-12	+8					+11	-5	GO				✓	Y +2	+1	20	30	
15	81		+2	+2	+1	+2	+2	+3	½N	½E					-2	-4					+13	-16	GO				✓	+2	+1	35	35	
17	81		+2	+2	-9	-9	-7	-7	1½S	1½W					+5	-2					-11	-10	GO				✓	+1	+2	40	40	
19	81		+3	+2	-7	-7	-6	-6	½N	½E					+7	+2					+24	+10	GO				✓	+3	+2	30	35	
21	81		+2	+3	-7	-8	-8	-7	½S	½E					+5	+6					+12	0	GO				✓	+3	+1	60	35	+
23	81		+2	+2	-7	-7	-6	-6	½N	½E					+3	0					+11	-12	GO				✓	+2	+1	40	35	
25	81		+2	+2	-6	-9	-7	-9	½S	2½E					+7	-8					-2	+4	GO				✓	+1	0	40	35	
27	81		0	-1	-6	-6	-6	-7	0	½E					+2	0					+17	-1	GO				✓	+1	0	30	35	
29	81		+1	+1	+6	+6	+6	+7	2N	2W					-2	+7					+19	-9	GO				✓	+4	0	30	30	
31	81		0	0	-3	+1	+1	-3	½N	1E					+2	+4					+4	+5	GO				✓	+5	+1	30	35	
33	81		+3	+2	-9	-9	-8	-7	4S	½W					+15	+2					-5	-8	GO				✓	+3	+2	45	35	
35	81		+2	+2	-3	-7	-11	-8	1N	½W					+5	+1					+13	0	GO				✓	0	+1	45	35	
37	81		+1	0	-6	-4	-4	-5	0	0					+3	-1					+3	+7	GO				✓	+1	+1	40	25	
39	81		+2	+2	-9	-9	-9	-9	½S	½W					+12	+5					+16	-4	GO				✓	+3	0	45	35	
41	81		+2	+2	+18	+18	+17	+17	1½N	0					+4	+7					+25	+15	GO				✓	+3	+3	40	30	
43	81		+1	+1	-4	-1	-1	-1	1S	1E					+8	0					+20	-6	GO				✓	+1	+2	30	25	
45	81		0	0	0	-2	-2	0	½S	½E					+3	+19					+26	-3	GO				✓	+3	0	25	25	
47	81		+3	+2	-6	-7	-7	-6	6½S	1½W					+18	+1					+5	+1	GO				✓	+2	+3	35	35	
12	84		+1	+1	0	-5	-13	-8	1½S	7½E					+3	-28					-14	-10	GO				✓	+1	+2	40	40	
14	84		+1	+1	-5	-14	-8	+1	2S	1W					+10	+1					+9	-11	GO				✓	+4	+1	45	30	
16	84		+1	+1	-4	-5	-8	-7	1S	½E					+4	+1					+17	-6.5	GO				✓	+2	+1	40	35	
18	84		+1	+1	-5	-6	-7	-5	1S	½E					+4	-5					-2	-6	GO				✓	+5	+2	30	30	
20	84		+3	+3	-4	-5	-5	-3	1½S	1E					-2	0					+6	-8	GO				✓	+3	+3	30	30	
22	84		0	0	0	+1	+1	0	½N	½W					+3	+3					+9	-6	GO				✓	+3	+1	25	35	
24	84		+2	+2	-4	-5	-4	-5	0	0					+11	+7					-6	-6	GO				✓	+5	0	25	40	
26	84		+2	+2	-2	-5	-9	-7	3½S	1W					+10	-7					-8	+3	GO				✓	+4	0	30	30	
28	84		+4	+3	-4	-9	-6	0	1S	4½E					+3	+1					+8	+1	GO				✓	+3	0	50	30	
30	84		+1	+1	-7	-6	-5	-5	1N	½E					+4	-1					+11	-8	GO				✓	+2	+2	35	30	
32	84		0	0	+36	+37	+38	+38	1N	½E					+11	+6					+10	-6	GO				✓	0	+1	35	35	
34	84		+3	+3	-10	-9	-12	-10	1S	½W					+15	+17					+38	-5	GO				✓	+2	+4	30	35	
36	84		+2	+2	-9	-2	-9	-10	2½S	4W					+6	+4					+10	-5	GO				✓	+3	+3	30	35	
38	84		+2	+2	+2	+5	+2	+3	0	1W					+11	-13					+2	+16	GO				✓	+2	+2	40	35	
40	84		+4	+4	-4	-11	-7	0	1½S	5½E					+17	-3					0	+6	GO				✓	+2	+2	50	40	
42	84		+3	+3	-2	-3	-5	0	1½S	1½E					+7	-1					+10	-7	GO				✓	0	+1	35	30	
44	84		0	0	-7	-7	-7	-7	0	0					+9	+4					+9	+4	GO				✓	+1	+1	30	25	
13	87		+1	+1	-6	-6	-8	-8	1S	1W					+4	-1					-12	+14	GO				✓	+2	+2	40	35	
			0	0	-5	-7	-10	-5	2½S	1E					+12	+7					-8	-5	GO				✓	+2	+2	40	30	
			+1	+1																								+5	+3	40	30	
																												+2	0	20	30	



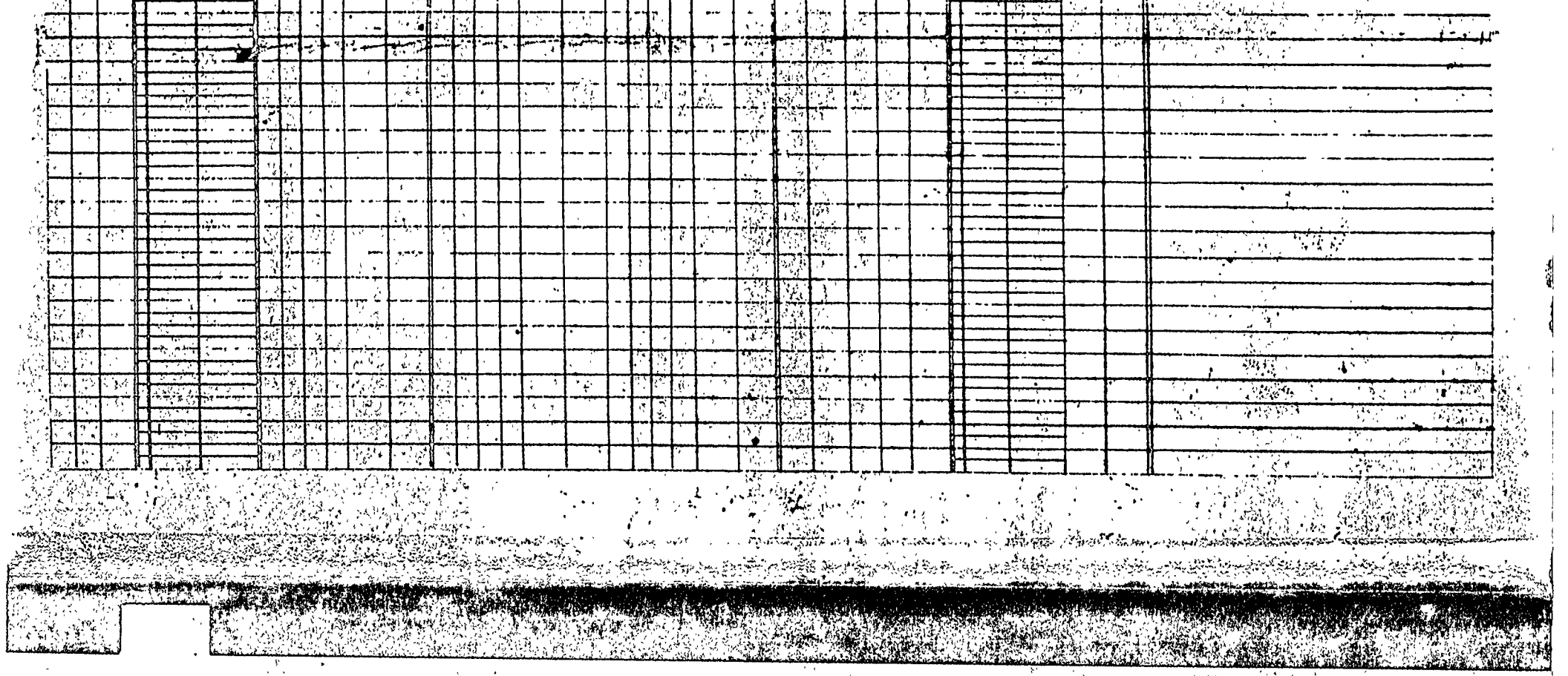
13.B.12

RESULTS OF LINE BORING

P UNIT

BASIC BORE 4.375 — BASIC BORE 4.385.

TUBE NOS X	TUBE NOS Y	TUBE NOS NVS	BORE MEAS. BEFORE HONING T.L.	BORE MEAS. BEFORE HONING B.L.	VERTICALITY N	VERTICALITY E	VERTICALITY S	VERTICALITY W	VERTICALITY AVERAGE N-S	VERTICALITY AVERAGE E-W	CENTRALITY B.L. PLENUM N	CENTRALITY B.L. PLENUM E	CENTRALITY B.L. PLENUM S	CENTRALITY B.L. PLENUM W	CENTRALITY B.L. PLENUM AVERAGE N-S	CENTRALITY B.L. PLENUM AVERAGE E-W	CENTRALITY CENTER TUBE SHEET N	CENTRALITY CENTER TUBE SHEET E	CENTRALITY CENTER TUBE SHEET S	CENTRALITY CENTER TUBE SHEET W	CENTRALITY CENTER TUBE SHEET AVERAGE N-S	CENTRALITY CENTER TUBE SHEET AVERAGE E-W	FUNCTIONAL GAGE 40 NO GO	FINISH BEFORE HONING 0-63	FINISH BEFORE HONING 63-125	FINISH BEFORE HONING 125-UP	AFTER HONING BORE MEAS. T.L.	AFTER HONING BORE MEAS. B.L.	AFTER HONING FINISH-RMS T.L.	AFTER HONING FINISH-RMS B.L.	REMARKS
32	90		+1	+1	-5	-5	-5	-9	0	2S					+1	0					+3	-13	GO	✓			+2	+2	30	35	
34	90		+3	+2	-5	-3	-8	-8	1½S	2½W					+10	+3					+1	-3	GO			✓	+3	+1	55	35	
36	90		+1	+1	-7	-5	-7	-8	0	1½W					+8	-1					+13	-6	GO	✓			+3	+2	55	35	
38	90		+3	+2	-4	-7	-9	-6	2½S	½E					+10	-3					+2	+1	GO	✓			+2	+2	50	25	
40	90		+3	+3	-8	-12	-12	-9	2S	1½E					+3	-6					+5	-10	GO	✓			+3	+1	25	25	
21	95		+3	+2	-7	-9	-5	-3	1N	3E					-2	-5					+11	+1	GO	✓			+4	8	30	20	
23	95		+3	+2	-5	-10	-6	-9	½S	3E					0	+7					-9	+31	GO	✓			+1	+3	40	25	
25	93		+5	+4	-5	-7	-4	-2	½N	2½E					0	-10					-4	-3	GO	✓			+1	+1	50	30	
27	95		+1	+1	-11	-11	-10	-10	½N	1E					+1	-1.5					+15	+1	GO		✓		+2	+3	30	30	
29	93		+2	+2	-6	-6	-6	-6	0	0					+2	+4					-13	-9	GO	✓			+2	+1	35	40	
31	93		+2	+2	-7	-7	-7	-7	0	0					+3	+3					+15	-10	GO	✓			+2	+2	45	40	
33	95		+2	+2	-9	-11	-11	-9	1S	1E					0	0					+15	-8	GO	✓			+3	+2	40	45	
35	93		+2	+2	-7	-10	-8	-3	½S	3½E					+9	-13					-1	+5	GO	✓			+2	+1	50	25	



preventing the functional gage from seating properly was developed. Essentially, the problem resolved itself into one simple question. Will the functional gage seat properly in a tube after it was line bored, or will interference in the top tube sheet result? Knowing the answer to this question prior to start-up of line boring, much time and money would have been saved on previous units.

On "L" unit a method by which one can predict what tubes will give trouble during line boring was used. This method can best be explained by the following mathematical calculations on which pre-determined knowledge of functional gaging characteristics were based: First, the assumption is made that all plenum tubes are bored vertical. Based on this assumption the mathematical calculations to follow prove that when verticality of a top tube sheet tube exceeds 0.013 in./ft., interference will result when attempting to properly seat the functional gage.

Given: 4.390" I.D. of top tube sheet tube.

4.340" O.D. of that part of functional gage suspended in top tube sheet tube (See sketch #34-A1.

46.875" Finish end to end length of top tube sheet tube.

0.050" Maximum amount of clearance between functional gage and I.D. of top tube sheet and still allow functional gage to seat properly. See sketch #34-A1.

12" Length of the leveling arm on top of top tube sheet verticality gage. Gage reads verticality in inches/foot.

To Find: The amount (in inches/foot) the top tube sheet verticality gage can read and still pass a 4.365"-4.340" diameter functional gage through plenum and top tube sheet tubes.

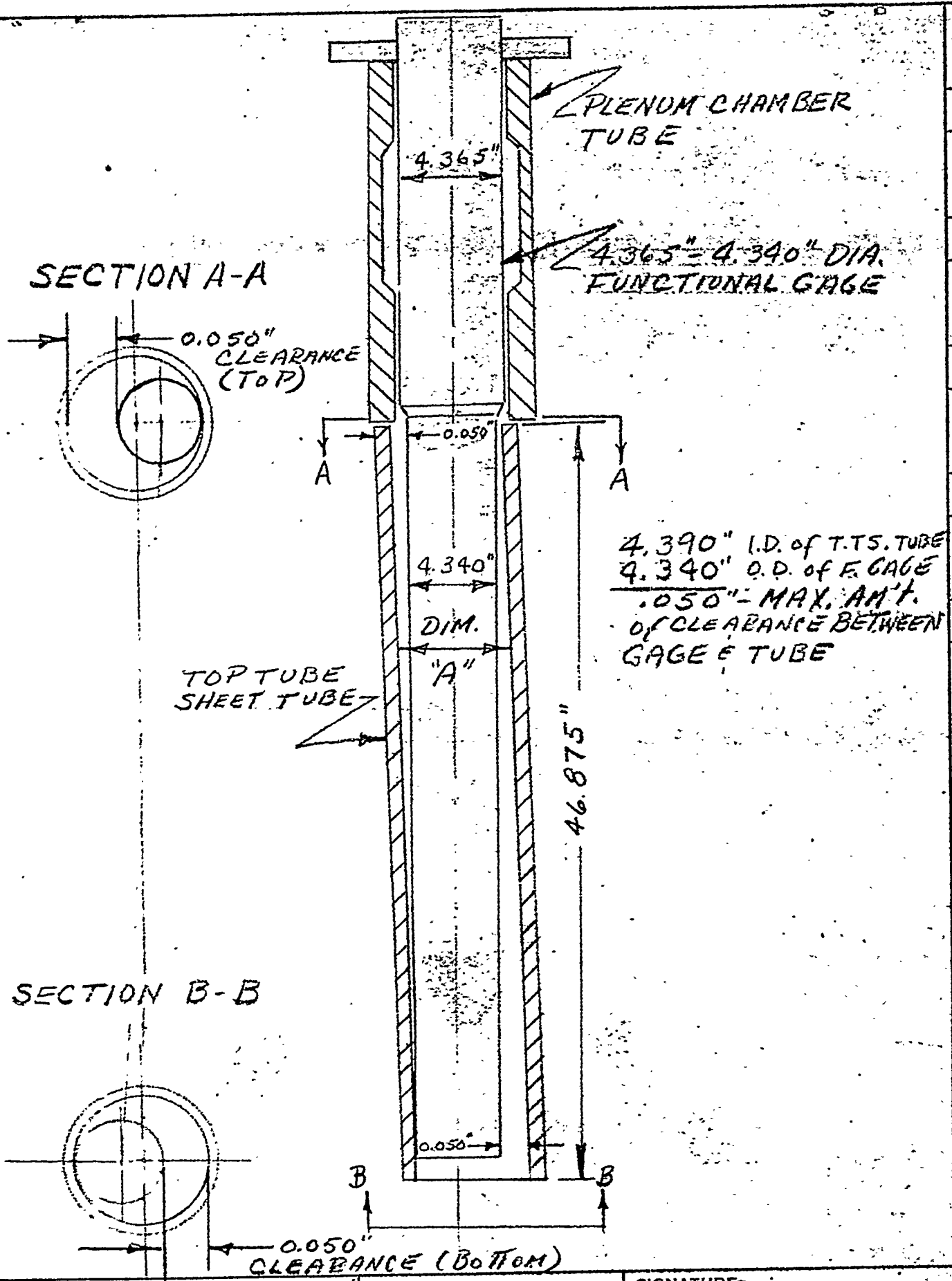
Calculations: Let X = amount the top tube sheet verticality gage can read and still pass functional gage.

Then, by proportion (refer to sketch #34-A the verticality in inches/foot is thus determined, 46.875" : .050" :: 12" : X

$$46.875\,X = (12)(.050)$$

$$X = \frac{.600}{46.875}$$

$$X = \underline{0.013 \text{ inches/foot}}$$



K J H G F E D C B A

ENGINEERING SKETCH SHEET
E. I. DU PONT DE NEMOURS & CO.

PROJ. No.

SIGNATURE

PROJ. TITLE

SKETCH #34-A1

DATE

SUBJECT:

No. E-42432

Thus, the 0.013"/ft. calculated is the maximum amount that the top tube sheet verticality gage can read and still pass without inferference in the top tube sheet tube the 4.365" - 4.340" diameter functional gage. However, if this verticality is exceeded, interference will result in the top tube sheet.

Verticality readings were taken on all tubes in the "L" top tube sheet. After it was leveled and prior to the alignment of the plenum chamber. Results were analyzed, based on the above calculations, and data given to New York Ship for guidance during the line boring operation

e. Centering of Plenum Chamber Over Top Tube Sheet and Welding of Indexing Grooves

Six centering grooves or indexing devices were roughly positioned approximately 60° apart on the top side of the top tube sheet. The corresponding six indexing tongues (spaced 60° apart) that fit into the centering grooves were all ready positioned and welded to the bottom side of the plenum chamber, inspected and found satisfactory. Consequently, when the plenum chamber was placed on the top tube sheet and aligned, the indexing tongues on the plenum automatically positioned the indexing grooves (located on the top tube sheet) for welding. Before welding the centering grooves to the top tube sheet, it was necessary to check tube overhang at the extremities of the X and Y axes to determine if the unit tube patterns were properly mated. Section 15A-(6) of this manual explains where and how these measurements were taken, and also how these measurements were interpretated. With the plenum chamber properly oriented with respect to the top tube sheet, three sides on each of the six indexing grooves were tack welded. Tube overhang measurements were re-taken and compared with initial measurements. No appreciable movement of the units was evident. Next, the three sides of the indexing grooves were fully welded using hand operated aircomatic automatic welding machines. After welding three sides of the six indexing grooves, tube overhang measurements were again taken and compared with the initial and second set of readings. Again, no appreciable movement of the units was evident; then, the plenum chamber was removed from the top tube sheet and the fourth side of each indexing groove was welded. Removing unit was necessary since welding of the fourth side was impossible with the unit in an operating position. Before replacing the plenum chamber, all welding joining the indexing grooves to the top tube sheet was ground smooth and then inspected for cracks, pin holes, and other mechanical defects. Necessary repairs were made, re-inspected and welding accepted. The plenum was placed back on the top tube sheet and positioned with the aid of the indexing tongue and grooves on the plenum chamber and top tube sheet, respectively. Final tube overhang measurements were taken

and compared with previous data. Final analysis of these readings revealed that no appreciable movement occurred.

In addition to the above, bearing surfaces between the bottom ends of plenum tubes and top ends of top tube sheet tubes were checked for mating conditions using feeler gages. For pictorial illustration of this inspection, see Part II-11B, photo serial #202. Also, the clearance between mating ports of the centering devices welded to the plenum chamber and top tube sheet was checked. This was done to determine whether or not the tongues (welded to P.C.) were binding or "riding" on corresponding groove faces (welded to T.T.S.). This final check revealed that no binding or "riding" was present and the units were considered satisfactory for line boring to proceed.

(2) Inspections Performed During Line Boring Operation

a. Verticality of rough bored large tubes, deburring and rod tube facing.

The Inspection Department began a spot check of the verticalities of the large tubes on each shift after the first rough cut to insure an acceptable verticality. Tube verticality readings were taken using a specially designed verticality gage described in Part III, II-L. Before the rough cut was begun, periodic checks were made of the boring bar to make sure that the bar was set perpendicular to the base plate. This was done using a "bulls eye" level mounted on a "Vee" block. Also, at this time a visual inspection was made to evaluate the finish of the bored tube, and in addition, a visual check was made of wooden chip stoppers for possible damage or displacement.

After the rough cut on large tubes was completed, the plenum chamber was removed and placed on a platen with the bottom side up for deburring of tube ends. All tube ends were deburred on the bottom side and then visually inspected by the du Pont Inspection Department. The deburring job was approved and the plenum was returned to the line boring operation, aligned, and measurements taken again at tube overhang check points. This was necessary to ascertain whether or not the plenum chamber was oriented to its original position prior to removing from the boring set-up. Measurements were satisfactory and the facing and line boring of rod tubes commenced.

First, all rod tubes were faced off to the correct height referencing from tops of large tubes using a 2 1/8" diameter milling cutter. After facing the top ends of large tubes to the top ends of rod tubes was measured using a combination square graduated in 1/64". Drawing dimensions stated this distance to be 1.800" ± .062". Also,

a visual inspection was made to insure that the seating area (2 1/8" spot face) was clear of all overhanging rod tube fillet welding that might interfere with the operation of the plenum chamber at a later date. All spot facing found unsatisfactory was marked for repairs. Repairs were made, visually re-inspected and accepted. In addition, all dimensional data was analyzed and found to be within allowable tolerances and the entire job was approved.

b. Line Boring of Rod Tubes

[1.] List of Inspections Performed on Rod Tubes After Boring and Before Honing

(a) Bore readings in top land (X and Y directions)

(b) Verticality readings by verticality gage in readings of 0.001 in./ft.

(c) Functional gaging with 62 $\frac{1}{4}$" long round bar with two diameters. First 9 3/4" of bar had a diameter of 1.484", and remainder, a diameter of 1.271".

(d) Estimated finish in RMS micro-inches and comparing with G.E. Standardize RMS finishes.

(e) Checked bevel in top end of rod tubes using a 10° beveled gage which was a prototype of the beveled dimensions.

[2.] Results

Rod tube bores were finished bored straight through from 1.500" - 1.505" on this unit per Designs request. (See Dwg. 2-2 in Section 7A of this manual). All of the listed inspections in 1. above were carried out by the du Pont Inspection Department. A record was kept of all discrepancies so that they might be corrected if possible, by honing at a later date. The boring of rod tubes was approved subject to further inspection after honing.

[3.] Stenciling Tube Numbers on Tube Ends

While the line boring of rod tubes progressed, inspectors stenciled the tube coordinates on the top of each large tube and next to each rod tube to make for easy identification. For history of tube stenciling, see Section 11B-(9) of this manual.

4. Inspections During and After Honing Rod Tube Bores

The following list of inspections were performed on rod tubes:

(a) Bore sizes in top 2" portion of tube bore using standard dial indicator bore gages and appropriate size ring gages both in the X and Y direction.

(b) Finish of tubes in RMS micro-inches placing particular emphasis on "O" ring seating areas.

(c) Visual inspection for evidence of scratches, gouges, and other mechanical defects in rod tube bores, placing particular emphasis on the top 2" portion of a rod tube.

(d) Final functional gaging with a 62 ½" round bar with two diameters. The top 9 7/8" of the gage has a diameter of 1.484", and the remaining portion a diameter of 1.271 inches.

(e) Verticality of tubes using a specially designed verticality gage which indicates the inclination with the vertical in 0.001"/ft. Uses of this gage is discussed in Part III, II-L.

(f) Bottom bore check from bottom side using a 1.503" diameter plug gage.

A resume of the above listed inspections, other miscellaneous inspections, and steps taken to rectify discrepancies was as follows:

Immediately after line boring all rod tubes (1.500" - 1.503" dia.), each bore was honed to increase the diameter between 1.505" to 1.510" to enable all rod tubes to properly functional gage, and in addition, to get a required finish of 63 RMS micro-finish or better in the top 2" bore of the tube. (See dwg. 2-2, Section 7A-(2)a of this manual for rod tube specifications.) In the course of this inspection it was found that several tubes had scratches in the top 2" bore in the O-ring seating area. These tubes did not clean up after honing to the maximum bore diameter of 1.510". Design Division granted permission to hone these tubes to 1.513". (See rod tube line boring record presented herewith as Exhibit #13-C for identification of these tubes). All affected tubes were honed to this limit and re-inspected. Some tubes still had scratches below

EXHIBIT #13-C

RESULTS OF ROD TUBE LINE BORING OPERATION

ROD TUBE LINE BORING

L UNIT

TUBE NOS X	TUBE NOS Y	BASIC 1.800 LARGE TUBE TO ROD TUBE	AFTER BORING & BEFORE HONING: TOP BORE 1" DOWN X	TOP BORE 1" DOWN Y	VERTICALITY N	VERTICALITY E	VERTICALITY S	VERTICALITY W	AVERAGE N-S	AVERAGE E-W	FUNC GAGE	FINISHES RMS TOP 2"	FINISHES RMS BELOW 2"	REMARKS	AFTER HONING: TOP BORE 1" DOWN X	TOP BORE 1" DOWN Y	FINISHES RMS TOP 2"	FINISHES RMS BELOW 2"	PLUG GAGE 1.503	PLUG GAGE 1.509	FUNC GAGE	REMARKS
17	59	-31	1.501	1.501	+2	+15	+8	-5	3N	10W	GO	63-125	125	RIDGE 3" DOWN	1.511	1.512	55	85	GO	NO GO	GO	
12	62	-41	1.498	1.498	+6	+10	-5	+1	10½S	4½W	GO	0-63	250	SCRATCH 1" DOWN RIDGES IN BOTTOM	1.511	1.511	50	85	GO	NO GO	GO	
9	61	+35	1.499	1.501	-24	+26	+26	-21	25N	23½W	NO GO 3"	0-63	60		1.510	1.510	30	40	GO	NO GO	GO	
8	62	-29	1.500	1.500	0	+20	0	-10	0	15W	GO	125-UP	250	ROUGH FINISH	1.511	1.511	40	125	GO	NO GO	GO	
5	61	-33	1.500	1.501	-5	+9	+9	-2	7N	5½W	GO	0-63	125		1.507	1.507	60	40	GO	NO GO	GO	
4	62	-44	1.499	1.499	+15	+19	-4	-11	9½S	15W	GO	125-UP	350		1.507	1.507	30	120	GO	NO GO	GO	
1	61	-40	1.499	1.499	+13	+18	-9	-10	11S	14W	GO	0-63	200	SCRATCH 1" DOWN	1.513	1.513	30	110	GO	GO	GO	
9	65	-45	1.499	1.499	+5	+12	+8	+6	1½N	3W	GO	125-UP	250		1.505	1.505	15	90	GO	NO GO	GO	
0	64	-22	1.500	1.500	+8	+19	-1	-7	4½S	13W	GO	63-125	75		1.506	1.506	50	50	GO	NO GO	GO	
3	65	-34	1.498	1.499	+1	+12	+9	-4	4N	8W	GO	125-UP	70		1.507	1.508	30	30	GO	NO GO	GO	
4	64	-10	1.499	1.500	+4	+5	+5	-1	½N	3W	GO	0-63	120		1.505	1.505	40	40	GO	NO GO	GO	
7	65	-5	1.498	1.498	-8	+10	+22	+3	15N	3½W	GO	63-125	150		1.509	1.509	40	40	GO	NO GO	GO	
8	64	-38	1.499	1.499	+3	0	+5	+8	1N	4E	GO	0-63	63	REPLACED TUBE RIDGE IN O-RING AREA	1.507	1.507	20	50	GO	NO GO	GO	
11	65	-36	1.499	1.499	-2	-14	+7	+21	4½N	18E	GO	63-125	150		1.506	1.506	35	80	GO	NO GO	GO	
6	68	-16	1.497	1.497	+2	+10	+12	+4	5N	3W	GO	0-63	63	RIDGE 3" DOWN	1.512	1.512	50	85	GO	NO GO	GO	RIDGE-3" DOWN
13	67	-13	1.502	1.502	-28	+10	+35	-3	31½N	6½W	GO	0-63	63		1.508	1.508	40	85	GO	NO GO	GO	GROOVE-8" DOWN
2	68	-35	1.499	1.499	+8	+10	-6	0	12S	5W	GO	0-63	60		1.507	1.507	35	30	GO	NO GO	GO	
9	67	-28	1.502	1.503	+1	+14	+15	-5	7N	9½W	GO	63-125	125		1.506	1.506	35	30	GO	NO GO	GO	
8	68	-45	1.498	1.499	+5	-3	+7	+12	1N	7½E	GO	63-125	125		1.506	1.506	45	60	GO	NO GO	GO	
5	67	-41	1.498	1.498	+4	+4	+4	+10	0	3E	GO	0-63	40	not entirely bead blown	1.506	1.506	50	80	GO	NO GO	GO	
1	68	-23	1.500	1.499	-6	-9	+10	+15	8N	12E	GO	63-125	90		1.506	1.506	30	95	GO	NO GO	GO	
0	70	-41	1.502	1.502	-11	-19	+28	+21	19½N	20E	GO	125-UP	200		1.508	1.508	50	80	GO	NO GO	GO	GROOVE-4" DOWN
3	71	-40	1.498	1.498	+9	+12	+7	0	1S	6W	GO	0-63	60		1.506	1.506	40	30	GO	NO GO	GO	
4	70	-25	1.501	1.501	+1	+12	+9	-2	4N	7W	GO	125-UP	150		1.506	1.506	40	30	GO	NO GO	GO	
7	71	-35	1.500	1.500	0	+10	+10	-4	5N	7W	GO	0-63	63		1.510	1.510	30	80	GO	NO GO	GO	GROOVE-6½ DOWN
18	70	+24	1.500	1.498	-19	+8	+24	+2	21½N	3W	GO	0-63	50	SCRATCH 2"	1.506	1.505	40	60	GO	NO GO	GO	SCRATCH-3" FROM BOTTOM
11	71	-25	1.499	1.499	+5	0	-2	+3	9½S	1½E	GO	0-63	120		1.506	1.506	40	50	GO	NO GO	GO	
10	74	-50	1.505	1.505	-6	+11	+2	-7	4N	9W	GO	63-125	125	RIDGES 2" DOWN	1.512	1.512	40	100	GO	NO GO	GO	1.515 GROOVES-7" 18" DOWN

3	73	0	1.500	1.500	-4	+8	+10	0	7N	4W	GO	63-125	125								
2	74	-35	1.500	1.501	+3	-2	+12	+15	1½N	8½E	GO	63-125	125								
9	73	-38	1.500	1.498	-2	+9	+7	-3	4½N	6W	GO	0-63	100								
3	74	-43	1.498	1.498	-7	-3	+11	+8	9N	5½E	GO	63-125	70								
4	76	-36	1.498	1.498	-10	-4	+20	+18	15N	11E	GO	25	100								
7	77	-38	1.500	1.500	-9	+4	+23	+8	16N	2E	GO	63-125	150								
8	76	-30	1.498	1.498	+5	+6	+8	+5	2½N	½W	GO	0-63	63								
1	77	-46	1.498	1.499	+5	+11	+5	-1	0	6W	GO	63-125	125								
2	76	.00	1.504	1.504	+9	+14	+8	+4	½S	5W	GO	0-63	120	RIDGE 1" DOWN							
5	79	-19	1.501	1.502	+8	+8	+11	+8	1½N	0	GO	63-125	125-UP	RIDGE 1¼" DOWN							
7	79	+40	1.499	1.498	0	+11	+8	-4	4N	7½W	GO	0-63	70	REPLACED TUBE-NO PINK GAGE TUBE OUT MEET @ ½, 29½W							
6	80	-18	1.499	1.499	-10	+13	+17	-2	13½N	7½W	GO	63-125	70								
3	79	-20	1.500	1.499	-13	0	+16	+6	14½N	3E	GO	0-63	100								
2	80	-22	1.500	1.500	-11	-1	+13	+9	12N	5E	NO GO 8"	125-UP	250								
1	83	-15	1.500	1.500	-2	+4	+6	-2	4N	3W	GO	63-125	100								
2	82	-46	1.499	1.499	-4	-5	0	+1	2N	3E	GO	0-63	60								
5	83	+25	1.506	1.506	+6	+5	-4	-2	4½S	5½N	GO	63-125	100								
4	86	-26	1.507	1.507	-8	+14	+15	-3	11½N	8½W	GO	63-125	150								
0	86	-44	1.500	1.500	-1	-9	+4	+12	2½N	10½E	GO	63-125	125								
7	85	-14	1.505	1.504	-11	0	+19	+6	15N	3E	GO	63-125	150								
8	86	-25	1.501	1.501	-5	+4	+7	-4	6N	4W	GO	126-UP	125								
5	89	-11	1.499	1.500	+20	+20	-5	-11	2½S	15½W	GO	63-125	85								
4	89	-25	1.501	1.501	-7	+7	+15	+2	11N	2½W	GO	63-125	250								
4	92	-44	1.500	1.500	+15	+8	-5	-4	10S	6W	GO	63-125	125								
0	92	-44	1.502	1.500	-6	-17	+10	+18	8N	17½E	GO	63-125	200								
0	95	-50	1.501	1.501	-3	+8	+3	-9	3N	8½W	GO	63-125	200								
															1.505	1.505	35	30	GO	NO GO	GO	
															1.506	1.506	30	50	GO	NO GO	GO	SCRATCH BELOW 2"
															1.506	1.506	40	110	GO	NO GO	GO	
															1.506	1.506	40	120	GO	NO GO	GO	
															1.506	1.606	40	40	GO	NO GO	GO	
															1.507	1.507	40	75	GO	NO GO	GO	
															1.506	1.506	40	30	GO	NO GO	GO	
															1.507	1.508	60	85	GO	NO GO	GO	
															1.507	1.506	20	50	GO	NO GO	GO	GROOVES-4" & 7" DOWN
															1.518	1.513	45	40	GO	NO GO	GO	
															1.506	1.506	20	50	GO	NO GO	GO	
															1.505	1.505	50	120	GO	NO GO	GO	
															1.508	1.508	60	40	GO	NO GO	GO	
															1.510	1.50	30	100	GO	NO GO	SNUG	GO AFTER HONE TO 1.327 IN TTS
															1.507	1.507	50	70	GO	NO GO	GO	RIDGE - 4" DOWN
															1.509	1.509	40	90	GO	NO GO	GO	GROOVE - 8" DOWN 1.516
															1.510	1.510	40	90	GO	NO GO	GO	SCRATCHED - 24.26" DOWN
															1.510	1.510	20	40	GO	NO GO	GO	1.515 GROOVE - 6" DOWN
															1.510	1.510	60	90	GO	NO GO	GO	GROOVE - 11.26" DOWN
															1.509	1.509	50	120	GO	NO GO	GO	1.515 GROOVE - 5" DOWN
															1.507	1.507	20	100	GO	NO GO	GO	
															1.507	1.507	35	85	GO	NO GO	GO	
															1.510	1.510	25	80	GO	NO GO	GO	
															1.507	1.507	35	80	GO	NO GO	GO	
															1.508	1.508	40	80	GO	NO GO	GO	GROOVES-3" 15" DOWN
															1.507	1.507	35	75	GO	NO GO	GO	GROOVE-8" DOWN

13.C.2

ROD TUBE LINE BORING

L UNIT

TUBE NOS		AFTER BORING & BEFORE HONING												AFTER HONING							
		BASIC 1.500	TOP BORE 1" DOWN		VERTICALITY				AVERAGE		FUNC GAGE	FINISHES RMS		REMARKS	TOP BORE 1" DOWN		FINISHES RMS		PLUG GAGE		FUNC GAGE	REMARKS
X	Y	LARGE TUBE TO ROD TUBE	X	Y	N	E	S	W	N-S	E-W		TOP 2"	BELOW 2"		X	Y	TOP 2"	BELOW 2"	1.503	1.509		
54	38	+3	1.499	1.500	0	+6	+11	+4	5½N	1W	GO	63-125	85		1.506	1.506	40	45	GO	NO GO	GO	
40	38	-35	1.500	1.499	-1	+18	+7	-13	4N	13½W	NO GO 1½"	0-63	90		1.509	1.509	50	120	GO	NO GO	GO	
37	37	-30	1.499	1.500	+4	-5	+3	+12	½S	8½E	GO	125-UP	135		1.507	1.505	50	125	GO	NO GO	GO	
26	38	-51	1.505	1.505	+12	+5	+1	+7	5½S	1E	GO	63-125	125		1.507	1.507	30	100	GO	NO GO	GO	
23	37	-28	1.499	1.499	+5	+9	+6	0	½N	4½W	GO	63-125	125		1.506	1.506	40	70	GO	NO GO	GO	
12	38	-47	1.499	1.499	+15	-1	-7	+11	11S	6E	GO	0-63	100		1.507	1.507	30	90	GO	NO GO	GO	
9	37	-45	1.498	1.498	+4	-1	+2	+6	1S	3½E	GO	63-125	230		1.506	1.506	30	100	GO	NO GO	GO	
7	41	-38	1.499	1.499	+4	-11	+4	+18	0	14½E	GO	63-125	125		1.508	1.508	35	75	GO	NO GO	GO	
18	40	-44	1.499	1.499	-2	-5	+8	+9	5N	7E	GO	0-63	90		1.506	1.506	25	125	GO	NO GO	GO	
21	41	-39	1.499	1.499	+18	+9	+11	+6	3½S	1½W	GO	68-125	150		1.507	1.507	50	80	GO	NO GO	GO	
32	40	-41	1.498	1.498	+2	+8	+8	+2	3N	3W	GO	63-125	75		1.506	1.507	60	NO	GO	NO GO	GO	
35	41	-25	1.500	1.499	-3	+7	+18	+4	10½N	1½W	GO	125-UP	130		1.506	1.506	50	40	GO	NO GO	GO	
46	40	-29	1.500	1.500	+8	-10	+5	+20	1½S	15E	GO	63-125	100		1.507	1.507	45	100	GO	NO GO	GO	
49	41	-53	1.503	1.503	+10	+3	+1	+7	4½S	2E	GO	63-125	125		1.506	1.506	40	45	GO	NO GO	GO	
44	44	-38	1.498	1.498	+2	+12	+8	-5	3N	8½W	GO	63-125	90		1.507	1.507	60	80	GO	NO GO	GO	
41	43	-48	1.498	1.498	0	+8	+8	+4	4N	2W	GO	0-63	40		1.506	1.506	50	60	GO	NO GO	GO	
30	44	-30	1.500	1.500	0	+3	+4	0	2N	1½W	GO	63-125	125		1.507	1.507	40	60	GO	NO GO	GO	
27	43	-31	1.499	1.499	+5	+18	+8	-5	1½N	11½W	GO	63-125	150		1.507	1.507	60	60	GO	NO GO	GO	
16	44	-48	1.498	1.498	0	+14	+5	+16	2½N	15E	GO	0-63	100		1.507	1.507	30	40	GO	NO GO	GO	
13	43	-46	1.499	1.499	+4	-4	+4	+12	0	8E	GO	63-125	120		1.506	1.506	30	125	GO	NO GO	GO	
2	44	-40	1.499	1.499	+14	-14	-8	+15	11S	14½E	GO	63-125	120	RIDGES 3/4" & 1 3/4" DOWN	1.506	1.505	40	70	GO	NO GO	GO	
8	46	-42	1.501	1.500	+9	-2	+2	+12	3½S	7E	GO	63-125	125		1.505	1.505	40	50	GO	NO GO	GO	
11	47	-47	1.499	1.499	+7	+13	+7	+1	0	6W	GO	0-63	100		1.506	1.506	45	60	GO	NO GO	GO	
22	46	-41	1.499	1.499	-22	-22	+22	+14	22N	18E	NO 2"	63-125	100		1.510	1.510	40	40	GO	NO GO	GO	
25	47	-22	1.501	1.501	-16	-9	+14	+13	15N	11E	GO	68-125	150		1.508	1.507	20	60	GO	NO GO	GO	
36	46	-9	1.500	1.500	+14	+6	-5	+2	9½S	3W	GO	0-63	60		1.509	1.509	50	90	GO	NO GO	GO	5" DOWN - GROOVE
39	47	-38	1.499	1.499	-1	+4	+5	+1	3N	1½W	GO	63-125	100		1.506	1.506	40	60	GO	NO GO	GO	
52	50	-44	1.501	1.501	-10	-12	+19	+23	11½N	19½W	NO GO	63-125	150								NO GO	GO AFTER HONE TO

| | | |

13.C.3

ROD TUBE LINE BORING

L UNIT

TUBE NOS		BASIC 1.800 AFTER BORING & BEFORE HONING											AFTER HONING							
		LARGE TUBE TO ROD TUBE	TOP BORE 1" DOWN		VERTICALITY				AVERAGE		FUNC GAGE	FINISHES RMS		REMARKS	TOP BORE 1" DOWN		FINISHES		PLUG GAGE		FUNC GAGE	REMARKS
X	Y		X	Y	N	E	S	W	N-S	E-W		TOP 2"	BELOW 2"		X	Y	TOP 2"	BELOW 2"	1.503	1.509		
30	2	-.46	1.501	1.501	+5	+5	+5	+5	0	0.	GO	63-125	90		1.507	1.507	40	40	GO	NO GO	GO	
25	5	-.51	1.500	1.500	+4	+4	+10	+10	3N	3E	GO	0-63	60		1.506	1.506	25	130	GO	NO GO	GO	RIDGE-HALF WAY DOWN
39	5	-.43	1.502	1.502	-2	-2	-7	-12	2½S	4½E	GO	125-UP	200		1.510	1.510	50	40	GO	NO GO	GO	
20	8	-.40	1.501	1.500	-10	+3	+15	+5	12½N	1E	GO	63-125	250		1.506	1.506	20	90	GO	NO GO	GO	
32	8	-.45	1.500	1.500	-8	0	+10	+9	9N	4½E	GO	125-UP	180		1.510	1.510	30	80	GO	NO GO	GO	SCRATCH-2½" DOWN
16	10	-.33	1.499	1.502	+23	-17	-17	+24	20S	20½E	GO	0-63	50		1.506	1.506	20	75	GO	NO GO	GO	
26	10	-.49	1.500	1.500	-10	+3	+9	-3	9½N	3W	GO	0-63	63		1.505	1.505	40	30	GO	NO GO	GO	
29	11	-.38	1.501	1.501	-12	-11	+16	+14	14N	12½E	GO	63-125	125		1.507	1.506	20	75	GO	NO GO	GO	
43	11	-.27	1.499	1.499	+2	+10	+8	-2	5N	6W	GO	63-125	100		1.506	1.506	40	60	GO	NO GO	GO	
21	13	-.38	1.500	1.500	+5	0	+4	+7	½S	3½E	GO	125-UP	200		1.508	1.507	30	95	GO	NO GO	GO	
35	13	-.31	1.500	1.500	+9	+9	-4	-5	6½S	7W	GO	125-UP	200		1.507	1.508	50	40	GO	NO GO	GO	
10	14	-.45	1.499	1.499	-14	+1	-10	+11	2N	5E	GO	63-125	125		1.506	1.506	30	70	GO	NO GO	GO	
24	14	-.36	1.498	1.498	+5	-3	-15	-2	9S	½E	GO	63-125	125		1.508	1.508	20	85	GO	NO GO	GO	
19	17	-.43	1.499	1.498	+6	0	+3	+8	1½S	4E	GO	0-63	50		1.507	1.507	30	100	GO	NO GO	GO	
30	16	-.33	1.501	1.501	+10	-15	0	+25	5S	20E	GO	63-125	100		1.506	1.506	25	75	GO	NO GO	GO	
33	17	-.30	1.499	1.499	-5	0	+7	+3	6N	1½E	GO	125-UP	200		1.505	1.505	60	35	GO	NO GO	GO	
47	17	-.23	1.500	1.500	-5	+20	+7	+16	6N	2W	GO	63-125	125		1.509	1.509	35	60	GO	NO GO	GO	SCRATCH-6" DOWN
25	19	-.25	1.499	1.499	0	-7	+3	+14	1½N	10½E	GO	0-63	125		1.508	1.507	20	75	GO	NO GO	GO	
39	19	-.30	1.499	1.499	+2	+7	-5	-3	8½S	5W	GO	0-63	125		1.506	1.506	40	70	GO	NO GO	GO	
28	20	-.38	1.501	1.502	+13	+8	-6	+2	9½S	3W	GO	125-UP	500	1" from top 1.509 ridge	1.509	1.509	30	125	GO	NO GO	GO	
42	20	-.14	1.501	1.500	-10	-5	-3	-9	3½N	2W	GO	63-125	125		1.506	1.506	50	250	GO	NO GO	GO	SCRATCHES BELOW 2"
14	20	-.50	1.500	1.499	+24	-23	-15	+28	19½S	23½E	GO	63-125	125		1.508	1.508	50	40	GO	NO GO	GO	
9	23	-.38	1.500	1.499	-11	+4	+24	+5	11½N	½E	GO	0-63	70		1.506	1.506	40	40	GO	NO GO	GO	
20	22	-.43	1.499	1.499	-1	-15	+13	+23	7N	19E	GO	63-125	75		1.506	1.506	35	60	GO	NO GO	GO	
13	23	-.16	1.503	1.503	+20	+1	-6	+14	13S	6½E	GO	63-125	200		1.506	1.506	30	100	GO	NO GO	GO	SCRATCHES BELOW 2"
44	22	-.23	1.498	1.500	+7	+13	+7	-2	0	7½W	GO	63-125	90		1.506	1.506	50	35	GO	NO GO	GO	GROOVE-4" DOWN
37	23	-.23	1.499	1.499	+1	-2	+8	+12	3½N	7E	GO	0-63	63		1.506	1.506	45	125	GO	NO GO	GO	SCRATCH-4" FROM BOTTOM
51	23	-.45	1.500	1.499	-6	+12	+12	-8	9N	10W	GO	0-63	60		1.506	1.506	40	60	GO	NO GO	GO	SCRATCH-3" FROM BOTTOM

13	25	-48	1.499	1.499	+7	+25	+5	-13	15	19W	NO GO 1½"	63-125	125	
12	26	-42	1.498	1.498	+3	+15	+9	0	3N	7½W	GO	63-125	90	
9	25	-44	1.500	1.500	-1	+10	+12	+4	6½N	3W	GO	63-125	125	
8	26	-43	1.499	1.499	+5	-4	-5	+10	10S	7E	GO	63-125	125	
5	25	-45	1.499	1.500	+4	+1	+9	+14	2½N	6½E	GO	125-UP	150	
4	26	-40	1.499	1.499	+9	+13	+3	-5	3S	9W	GO	0-63	60	
10	28	-46	1.499	1.498	+3	-3	+9	+12	3N	7½E	GO	0-63	63	
13	29	-44	1.499	1.499	-10	-4	+16	+7	18N	5½E	GO	63-125	100	
14	28	-44	1.498	1.498	-16	0	-5	+10	8½N	5E	GO	0-63	125	
17	29	-41	1.499	1.499	-4	-2	+8	+8	6N	5E	GO	63-125	70	
18	28	-36	1.501	1.499	-8	+11	+12	-5	10N	8W	GO	63-125	100	
11	29	-10	1.499	1.499	+1	+11	+1	-7	0	9W	GO	125-UP	300	RIDGES & GROOVES
0	32	-43	1.498	1.499	-12	-3	+20	+12	16N	7½E	GO	63-125	125	REPLACED TUBE GROOVE IN O-RING AREA
17	31	-10	1.499	1.499	+3	+4	+5	+4	1N	0	GO	0-63	60	
16	32	-36	1.499	1.498	-8	-30	+15	+34	11½N	32E	NO GO 2½"	63-125	200	
33	31	-30	1.502	1.502	+22	-2	-11	+12	6½S	7E	GO	63-125	125	
2	32	-45	1.499	1.499	-5	-8	-3	+17	1N	12½E	GO	0-63	63	
9	31	-42	1.499	1.499	+4	+4	+5	+7	1½N	11½E	GO	0-63	63	
8	32	-38	1.500	1.499	-1	-14	+10	+24	5½N	19E	GO	63-125	150	
3	35	-45	1.499	1.499	+10	+23	-3	-14	6½S	18½W	GO	0-63	63	SCRATCH 1" DOWN
4	34	-45	1.499	1.499	+13	-1	0	+15	6½S	8E	GO	0-63	100	
7	35	-45	1.499	1.499	+8	+5	+2	+7	3S	1E	GO	0-63	63	
8	34	.00	1.507	1.507	-2	-1	+10	+8	6N	4½E	GO	125-UP	200	ROUGH FINISH
1	35	-.10	1.509	1.509	+10	+14	+2	+4	4S	5W	GO	63-125	125	
2	34	-42	1.499	1.500	+4	+17	+8	-6	2N	11½N	GO	63-125	100	
5	35	-.11	1.500	1.500	+5	+3	+10	+6	2½N	1½E	GO	125-UP	250	ROUGH FINISH

1.507	1.507	35	70	GO	NO GO	GO	
1.507	1.507	40	45	GO	NO GO	GO	
1.506	1.506	60	75	GO	NO GO	GO	
1.505	1.505	50	125	GO	NO GO	GO	
1.505	1.505	45	40	GO	NO GO	GO	SCRATCHES BELOW 2"
1.506	1.506	40	125	GO	NO GO	GO	
1.509	1.509	20	40	GO	NO GO	GO	
1.505	1.505	30	40	GO	NO GO	GO	
1.506	1.506	40	125	GO	NO GO	GO	
1.507	1.507	25	40	GO	NO GO	GO	
1.505	1.506	20	125	GO	NO GO	GO	SCRATCHES BELOW 2"
1.508	1.508	40	125	GO	NO GO	GO	
1.509	1.509	20	50	GO	NO GO	GO	
1.506	1.505	30	60	GO	NO GO	GO	
1.509	1.509	20	100	GO	NO GO	GO	
1.506	1.506	45	125	GO	NO GO	GO	SCRATCHES BELOW 2"
1.507	1.507	20	45	GO	NO GO	GO	
1.506	1.506	40	30	GO	NO GO	GO	
1.506	1.505	40	125	GO	NO GO	GO	
1.513	1.513	60	60	GO	NO GO	GO	Rug-8" down
1.508	1.508	30	80	GO	NO GO	GO	
1.506	1.506	50	60	GO	NO GO	GO	
1.512	1.512	60	125	GO	NO GO	GO	
1.510	1.510	60	100	GO	NO GO	GO	
1.507	1.507	55	70	GO	NO GO	GO	
1.513	1.513	60	60	GO	NO GO	GO	8" down

the O-ring area; however, no sharp edges remained and the tubes were considered acceptable. However; tubes X50-Y32 and X48-Y64 did not clean up at this dimension. These tubes were machined out of the unit, replaced, line bored, honed in the range of 1.509" to 1.510", inspected and accepted.

Tubes X52-Y50, X12-Y80 and X37-Y79 would not seat the functional gage properly after honing their bores to a maximum of 1.510". The Design Division granted permission to open up the corresponding top tube sheet rod tube bores to a maximum of 1.3275" in order that the functional gage seat properly in the tubes. Tubes X52-Y50 and X12-Y80 seated the functional gage after opening up the corresponding top tube sheet rod tube bores to 1.327". Tube X37-Y79 was reconsidered on the basis of verticality. ($21\frac{1}{32}$S - $39\frac{1}{32}$W) It was believed that this tube showed a verticality over the average limit and therefore it was replaced. After boring and honing, tube X37-Y79 was re-inspected and accepted.

When the plenum was removed from the line boring set-up each rod tube was gaged from the bottom side using a 1.503" diameter plug gage. This gage would not enter 118 rod tubes. In addition a visual inspection on these 118 rod tube bores from the bottom end revealed the presence of many scratches. In lieu of this, all bores (working from the bottom side of the unit) were honed to a maximum diameter of 1.510". A visual and re-plug gaging of these tubes proved satisfactory and they were accepted.

For final results covering rod tube replacements, discrepancies and data, see Exhibit #13-C.

c. Second Cut on Large Tubes

The second cut on the large tubes was the semi-finish boring to a 4.340" in diameter. Prior to the second cut or boring operation, all large tube base plates were set by New York Ship mechanics using their centralizing mandrel and "high hat" level. To determine whether or not pre-set base plates were centrally located over the mid-point of the top tube sheet tube, the electronic gage was used. This preliminary centrality check of base plates with the electronic gage was necessary to assure that boring of a plenum tube to the mid-point of the corresponding top tube sheet tube was being accomplished. In some cases it was necessary to either shift or tilt bases. However, in other cases where more adverse conditions existed, it was necessary to shift and tilt a base for any one given tube. (The procedure for shifting and tilting base plates is covered in Section 15B-(2), d, e, and f) A methodical check with the electronic gage was made on all base plates prior to the second cut until the semi-finish boring job was completed.

d. Inspections Prior to Final Cut

The same general procedure discussed in paragraph "c" above was followed. The electronic gage was inserted back into the base plate in order to determine whether the base plate moved after making the second bore. Approximately 50% of the bases were re-adjusted slightly to maintain base plate centrality and levelness. As pointed out in Section 15B-(2)f of this manual, it was also necessary to tilt 77 base plates in insure tubes with adverse conditions would seat the functional gage properly after final boring. (The procedure for base plate tilting is covered in Section 15B-(2)e of this manual) This inspection with the electronic gage was made until all large tubes checked out satisfactory and then the tubes were finished line bored.

e. Inspections Performed on Finished Bored Plenum Tubes

[1.] General

The inspections of the final bore will be divided into two categories, namely:

(a) Inspections made with electronic gage.

(b) Inspections made with other gages.

[2.] Inspections Made with Electronic Gage

(a) General

Results of the final bore were obtained in a somewhat different manner (excluding "P"unit) than heretofore. There were two "special" bases made; each base having a different pilot diameter. (See photo serial number 223, Part III, Section F)

(b) Procedure

Using a bore gage set for 4.375" diameter, check the top land of plenum for bore size. After the bore size has checked "OK" (4.375-4.378" approximately), the boring fixture base must be removed and the bore swabbed clean until dry, including the tube in the top tube sheet.

Select the "special" base for the gage which has a pilot diameter nearest (one the minus side) to that of the bore size. Position the base and lock into position by means of locking fingers. Level the base by means of a precision level as close as possible. The precision level should be positioned in line with the axis, first in one direction and then the other. After this step is completed, position the electronic gage and adjust

the base for level by means of the "All-way" level. (Bolted to top of electronic gage housing) Extend the plungers with the north plungers aligned in a northerly direction and continue as follows:

(c) Results

1. Centrality of Mid-length Bore of Top Tube Sheet Tube

a. Use center stage of plungers with selector set on centrality.

b. Read top-center dial for N-S reading and bottom center dial for E-W reading.

c. Record the full dial readings showing the proper plus or minus signs for each.

Results of the above are listed under column labeled "centrality" in Exhibit #13-D, Results of Line Boring

3. Inspections Made with Other Gages

(a) Bore Size

1. At 1½" below top surface of plenum chamber tube in the X and Y directions, bore sizes were measured using a standard dial indicator gage and ring gage. This measurement was between the O-ring areas.

2. From one to three inches below the chamfer on the bottom land of the plenum tube, bore sizes were again measured using the bore gage.

(b) Verticality

The inclination with respect to the vertical of the plenum chamber bore of each tube was measured with a verticality gage in the north, east, south, and west directions. For operation and use of this gage, see Part III, Section L.

(c) Surface Finish of Bore an Plenum Tube in RMS Micro-Inches

The finish of the top and bottom land of all plenum tubes was determined by using ones fingernail and comparing with roughness standards. All results were segregated into one of the following classifications: (1) 0-63, (2) 63-125, (3) 125-up.

EXHIBIT #13-D

RESULTS OF LARGE TUBE LINE BORING

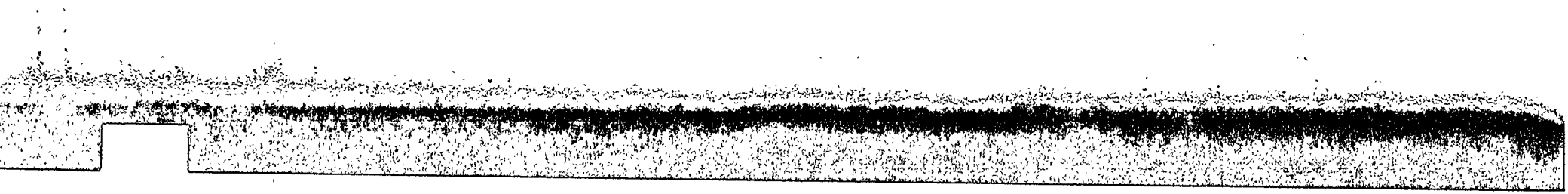
RESULTS OF LINE BORING

L UNIT

BASIC BORE A.375 — BASIC BORE H.385

TUBE NOS X	Y	NVS	BORE MEAS. BEFORE HONING T.L.	B.L.	VERTICALITY N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY PLENUM N	E	S	W	CENTER TUBE SHEET N	E	S	W	AVERAGE N-S	AVERAGE E-W	FUNCTIONAL GAGE GO	NO GO	FINISH BEFORE HONING 0-63	63-125	125-UP	AFTER HONING BORE MEAS. T.L.	B.L.	FINISH-RMS T.L.	B.L.	REMARKS
21	3		+2	+2	+2	+3	+2	+2	0	0									-13	+10	GO		X			+1	+2	35	45	
23	3		+2	+2	+1	0	+1	+2	0	1E									-32	+2	GO		X			+1	+3	30	35	
25	3		+1	+1	+3	+5	+3	-1	0	3W									-18	+11	GO			X		+2	+3	20	30	
27	3		+2	+2	+2	+2	+2	+3	0	½E									-5	+23	GO		X			+1	+1	35	30	
29	3		+1	+1	0	0	+3	+6	1½N	3E									-19	+21	GO		X			0	+1	20	40	
31	3		+2	+1	+3	+4	+4	+4	½N	0									-10	+18	GO		X			+1	+1	30	40	
33	3		+1	+1	+2	+5	-3	0	7½S	2½W									+15	-15	GO			X		+3	+2	25	40	
35	3		+4	+4	+5	+6	-1	-2	3S	4W									+30	-5	GO				X	+2	+3	30	35	SPIRAL BORE IN BOTTOM BORE BEGINS 4½" FROM BOTTOM ENDS 3⅞" FROM BOTTOM OF TUBE.
14	6		+4	+3	+5	+4	+4	+3	½S	1½W									-11	+10	GO		X			+1	+1	30	45	
18	6		+3	+2	+3	+2	+1	+4	1S	1E									-6	+10	GO		X			+2	+2	25	35	
20	6		+5	+5	+4	0	0	+2	2S	1E									-20	+5	GO			X		0	+2	25	35	
22	6		+2	+2	+4	+4	+1	0	1½S	2W									-18	+13	GO		X			+1	+1	30	30	
24	6		+1	+1	+2	+8	+6	-1	2N	4½W									-22	+5	GO		X			+2	+1	30	35	
26	6		+1	0	+3	+8	+4	-2	½N	5W									+8	0	GO		X			+2	+3	30	50	
28	6		+2	+3	-3	-1	-3	-6	0	2½W									-10	-14	GO			X		+3	+2	20	40	
30	6		+4	+5	+2	+6	+6	+2	2N	2W									-3	+8	GO		X			+4	+1	35	35	
32	6		+4	+4	+10	+4	+5	+9	2½S	2½E									+3	+17	GO			X		+1	+2	30	30	
34	6		+2	+2	+8	+11	+7	+7	½S	2W									+16	-8	GO		X			+3	+3	30	30	
36	6		+1	+1	+12	+7	+6	+9	3S	1E									-13	+10	GO		X			+1	+2	35	35	
38	6		+2	+2	+3	+2	-4	0	3½S	1W									-1	-5	GO		X			+2	+1	35	40	
40	6		+2	+2	+1	-3	+4	+0	0	6½E									-7	-14	GO		X			+2	+4	30	25	
13	9		+5	+5	+5	+2	+3	+2	1S	0									-24	-6	GO			X		+2	+2	35	25	
15	9		+1	+1	+8	+7	-1	+3	4½S	2W									-1	-2	GO		X			0	+3	25	45	
17	9		+2	+2	+2	+3	+2	0	0	1½W									-13	+10	GO		X			+2	+2	30	20	
19	9		+5	+3	0	+1	+2	+3	1N	1E									-25	+3	GO		X			+3	0	30	40	
21	9		+4	+4	-1	+5	+1	-5	1N	5W									-9	-5	GO			X		+4	+1	30	30	
23	9		+3	+3	+1	-1	-3	0	2S	½E									-25	-5	GO		X			+1	+2	40	30	
25	9		+1	+1	+4	+4	+4	+5	0	½E									-21	-18	GO			X		+2	+1	30	25	
27	9		+3	+2	+5	+5	+3	+2	1S	1½W									-4	+6	GO		X			0	+1	30	30	
29	9		+3	+2	+1	+4	+2	-2	½N	3W									0	-7	GO		X			+1	+4	35	25	
31	9		+3	+3	+3	+3	+3	0	0	0									-19	+12	GO		X			+2	+3	30	30	
33	9		+1	+1	+8	+2	-1	+9	4½S	3½E									+18	-11	GO		X			+2	+3	25	35	TRIANGULAR GOUGE 2¼" DOWN ¼" x ⅛" SIDE 010" DEEP.
35	9		+2	+2	+2	+3	0	0	1S	1½W									-32	-5	GO		X			+2	+3	30	20	
37	9		-2	-2	+14	+5	+5	+8	4½S	4E									+3	-13	GO		X			+1	+2	35	25	
39	9		+3	+3	+4	+10	+10	+7	½N	1¼W									-4	+11	GO			X		+1	+1	35	45	
41	9		+1	+1	+1	-1	-8	+5	9½S	3E									+18	-42	NO GO				X	+3	+2	30	35	
43	9		+3	+2	+2	-2	-11	+7	12S	17E									+45	-77	GO				X	+5	+4	35	25	GO AFTER HONING
12	12		+1	+1	+7	+8	+3	0	2S	4W									-11	+13	GO		X			+2	+2	25	40	
14	12		+1	0	+5	+4	+5	+3	0	½W									-9	+20	GO		X			+2	+3	25	25	
16	12		+2	+2	+1	+3	+4	+3	1½N	0									-22	+1	GO		X			+1	+1	35	30	
18	12		+6	+4	0	+1	0	0	0	½N									-19	-7	GO		X			+1	+1	30	25	
20	12		+1	+1	+1	+1	+1	+1	0	0									-17	+8	GO		X			0	0	30	25	
22	12		+3	+3	+6	+5	-5	-4	5½S	4½W									-14	+7	GO		X			0	+1	30	25	
24	12		+2	+2	+2	+4	+4	0	1N	2W									-30	+14	GO		X			+2	+2	35	25	
																										+3	0	25	25	

28	12																																
30	12																																
32	12																																
34	12																																
36	12																																
38	12																																
40	12																																
42	12																																
44	12																																
9	15																																
11	15																																
13	15																																
15	15																																
17	15																																
19	15																																



13.D.
2

RESULTS OF LINE BORING

L UNIT

BASIC BORE 4.375 — BASIC BORE 4.385

TUBE NOS X	TUBE NOS Y	TUBE NOS NVS	BORE MEAS. BEFORE HONING T.L.	BORE MEAS. BEFORE HONING B.L.	VERTICALITY N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY PLENUM N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY CENTER TUBE SHEET N	E	S	W	AVERAGE N-S	AVERAGE E-W	FUNCTIONAL GAGE GO AND GO	FINISH BEFORE HONING 0-63	63-125	125-UP	AFTER HONING BORE MEAS. T.L	B.L.	FINISH-RMS T.L.	B.L.	REMARKS
21	15		+2	+2	-1	0	0	-1	½N	½W											-14	+4	GO	X			+2	+1	35	25	
23	15		+3	+3	-3	-1	-4	-5	½S	2W											-9	-13	GO	X			+1	+2	20	25	
25	15		+2	+2	-1	+2	+1	-2	IN	2W											-17	-5	GO	X			+1	+1	30	25	
27	15		0	8	-6	-6	-2	-2	2N	2E											-29	+5	GO	X			+1	+1	25	25	
29	15		+2	+2	+1	+1	0	0	2S	2W											+2	-4	GO	X			+1	+2	30	40	
31	15		+4	+4	-1	-4	-6	-3	2½S	1½E											-11	-2	GO	X			+1	+2	40	35	
33	15		+3	+3	+1	+2	-2	-3	1½S	2½W											-3	-8	GO	X			8	+1	30	45	
35	15		+3	+3	-1	+6	+6	-1	3½N	3½W											-3	+2	GO	X			+1	+3	20	35	
37	15		+3	+4	+5	+5	+1	+1	2S	2W											-8	-22	GO	X			8	+3	25	30	
39	15		+5	+5	-1	-1	-1	-2	0	½W											-28	-14	GO	X			8	+3	35	40	
41	15		+2	+1	+2	+2	+5	+5	1½N	1½E											-13	+3	GO	X			+1	+5	35	40	
43	15		+2	+1	+12	+9	+4	+5	4S	2W											+63	+7	GO	X			0	+5	35	45	
45	15		+1	+1	+20	+7	+3	+15	8½S	4E											+84	-33	GO	X			8	+4	25	40	
47	15		+13	+1	+4	-5	0	+10	2S	7½E											+62	-46	GO	X			+4	+1	30	40	TUBE SHOULDER BP HOLDING TO ZERO BORE DIAM IN TOLERANCE TO NEAREST 1VT-6P-ROUND.
8	18		+3	+1	+2	+3	+2	0	0	1½W											0	+12	GO	X			+2	0	30	25	
10	18		+1	+1	+7	+4	+2	+6	2½S	1E											+1	+5	GO	X			+2	+1	30	30	
12	18		+5	+5	+2	0	-2	-2	2S	1W											-15	+3	GO	X			+3	+1	40	25	
14	18		+1	+1	+2	+2	0	-2	1S	2W											-9	+6	GO	X			+2	+2	35	30	
16	18		+3	+3	0	+2	+2	0	IN	1W											-19	+10	GO	X			+1	+1	35	35	
18	18		+4	+2	+4	+4	+3	+3	½S	½W											-7	+7	GO	X			+2	+1	45	25	
20	18		+2	+2	+1	+1	+1	-1	0	1W											-16	+2	GO	X			+2	+1	45	35	
22	18		+3	+3	+2	+3	-2	-3	2S	3W											-5	-11	GO	X			+1	+1	35	30	
24	18		+2	+2	+5	+3	-1	-1	3S	2W											-7	+9	GO	X			0	+1	25	25	
26	18		+2	+2	0	0	-1	-1	1½S	½W											-13	+3	GO	X			+2	+2	30	30	
28	18		+2	+2	0	+4	+5	0	2½N	2W											-9	+7	GO	X			+2	+1	30	35	
30	18		+6	+4	-1	0	-1	-1	0	½W											-9	-4	GO	X			+2	+2	20	40	
32	18		+5	+5	0	+6	+2	-6	1N	6N											+6	-6	GO	X			+1	0	30	40	
34	18		+2	+2	+2	+2	+3	+2	½N	0											-12	+8	GO	X			+3	+1	45	20	
36	18		+2	+2	+6	+11	0	-7	3S	9W											+20	+14	GO	X			0	+1	40	15	
38	18		0	0	-2	-2	-2	-3	0	½W											-13	+6	GO	X			+2	+1	30	40	
40	18		0	0	+4	+12	+4	+7	5N	2½W											+6	0	GO	X			+1	+2	40	30	
42	18		+1	+1	+8	+4	+2	+7	3S	1½E											+7	-15	GO	X			+1	+2	25	30	
44	18		+6	+6	+5	+2	-5	-2	5S	2W											+13	-38	GO		X		0	+2	30	35	
46	18		+2	+2	+15	+8	-3	+5	9S	1½W											+35	-41	GO	X			+2	+2	25	25	
48	18		+2	+2	+8	-1	-5	+1	6½S	1E											+22	-33	GO	X			0	+3	35	35	
7	21		+3	+3	+4	+2	0	+2	2S	0											-8	0	GO	X			0	+1	20	30	
9	21		+4	+3	+10	+12	+8	+9	1S	1½W											+8	+2	GO	X			0	+2	30	35	
11	21		+5	+5	+5	+3	+1	+1	2S	1W											-19	+6	GO	X			+1	+1	25	30	
13	21		0	0	+2	+1	-2	-1	2S	1W											-1	+4	GO	X			+2	+1	25	30	
15	21		+2	+2	0	-2	0	+2	0	2E											-12	+10	GO	X			+3	+1	20	35	
17	21		+2	+2	0	+5	+1	-4	½N	4½W											-6	+11	GO	X			+1	0	30	30	
19	21		+2	+2	+4	+13	+2	+2	1S	½W											-11	+5	GO	X			+1	+1	30	35	
21	21		+3	+3	+5	0	-3	-1	4S	1½W											-19	+2	GO		X		+2	+1	25	30	
23	21		+1	+1	+6	+4	+2	+5	2S	½E																						
			+2	+1																											
			+4	+4																											

| | | |

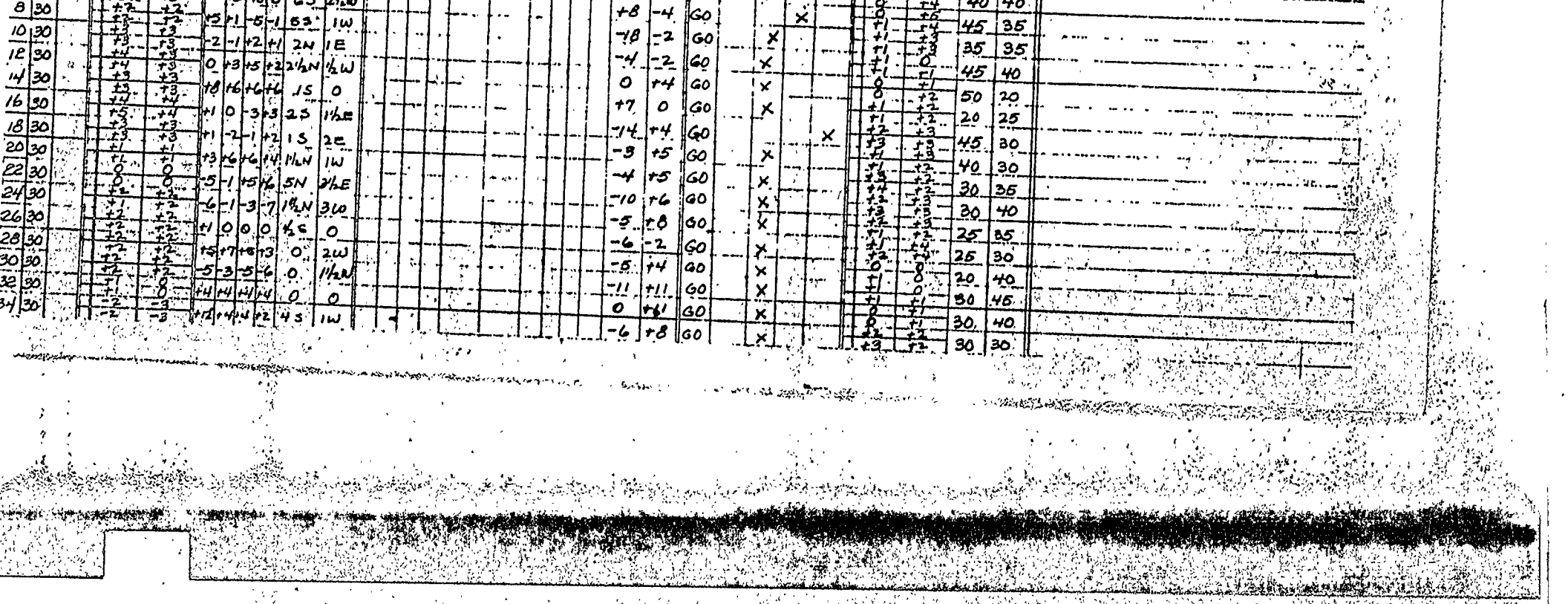
13.D.3

RESULTS OF LINE BORING

L UNIT

BASIC BORE 4.375 — BASIC BORE 4.385

TUBE NOS X	V	NVS	BORE MEAS. BEFORE HONING T.L.	B.L.	VERTICALITY N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY P.L. N	E	S	W	PLENUM AVERAGE N-S	PLENUM AVERAGE E-W	CENTER TUBE SHEET N	E	S	W	AVERAGE N-S	AVERAGE E-W	FUNCTIONAL GAGE GO	NO GO	FINISH BEFORE HONING 0-63	63-125	125-UP	AFTER HONING BORE MEAS. T.L	B.L.	FINISH - RMS T.L	B.L.	REMARKS
12	24		+1	+1																	-24	-4	GO		X			0	+1	25	30	
14	24		+2	+2	+2	0	-2	+3	2S	1½E																						
16	24		+2	+2	+3	+3	-3	+5	4S	4W											-16	-8	GO		X			+2	+3	30	30	
18	24		+2	+2	+8	+11	+8	+6	0	2½W											+3	+10	GO		X			+2	+3			
20	24		+4	+5																								0	+3	25	45	
22	24		+2	+1	+7	+6	+3	+2	2S	2W											-1	+6	GO		X			0	+3			
24	24		+3	+2	+3	0	+8	+6	0	3E																		+1	+2	30	50	
26	24		+3	+2	+5	0	-3	+3	4S	1½E											-22	+10	GO		X			0	+4			
28	24		+3	+1	-1	-1	0	-2	½N	½W											-9	+8	GO		X			+1	+3	25	30	
30	24		+4	+4																	-4	+4	GO		X			+3	+4			
32	24		+3	+3	+2	-1	0	+5	1S	3E																		+3	+3	35	30	
34	24		+1	0																	-15	+5		NO GO	X			+1	+2			
36	24		+1	0	+6	+5	+1	+1	2½S	2W																		+1	+2	30	40	
38	24		+2	+2																	-11	+1	GO		X			+5	+5			
40	24		+2	+2	0	-3	+3	+6	1½N	4½E																		+5	+5	35	45	GO AFTER HONING
42	24		+2	+2	0	+3	+3	0	1½N	1½W											-16	+11	GO		X			+3	+3			
44	24		+2	+2	+6	+5	+3	+2	1N	1½W											-12	-7	GO		X			+2	+2	50	40	
46	24		+1	+1	-1	-1	-1	-1	0	0											-4	+3	GO		X			+2	+2			
48	24		0	0																	-4	-1	GO		X			+2	+2	30	40	
50	24		+3	+3	+5	+10	+11	+7	3N	1½W																		+2	+2			
5	27		+2	+2	+1	+1	-1	-1	1S	1W											-5	+2	GO		X			+2	+2	40	35	
7	27		0	0																	-7	0	GO		X			+2	+2	35	40	
9	27		+1	+1	+12	+6	+4	+5	4S	4½E											+10	-7	GO		X			+2	+2			
11	27		+1	+1																	+20	-21	GO		X			+2	+2	30	40	
13	27		0	0	+1	0	+1	+8	0	4E											+10	-63	GO		X			+1	+2			
15	27		+2	+2	+8	-2	0	+10	9S	11E																		0	+2	60	35	
17	27		+4	+2	+12	0	+5	+9	3½S	7½E											-12	-73	GO		X			+1	+2			
19	27		+3	+2	+5	-6	-8	+7	6½S	6½E											+95	-85	GO		X			0	+2	40	30	
21	27		+2	+2	+2	+6	-1	-6	1½S	6W																		+5	+2			
23	27		+1	+1																	-20	+4	GO		X			+3	+2	40	40	
25	27		+1	+1	0	0	0	0	0	0																		+2	+5			
27	27		+5	+4	+4	-1	0	-4	2S	1½W											+1	-4	GO		X			+1	+3	30	30	
29	27		+2	+4																	-13	+10	GO		X			+3	+2			
31	27		+1	0	+10	+8	+8	+10	1S	1E											-8	+16	GO		X			+3	+1	30	35	
33	27		+1	0																								+1	+3			
35	27		0	0	+18	+12	+5	+6	4S	3½W											-10	+5	GO		X			0	+3	40	45	
37	27		+2	+2																	-6	-3	GO		X			+1	+1			
39	27		+2	+2	+7	+6	+2	+3	2½S	1½W											-24	-15	GO		X			+1	+1	30	35	
41	27		+4	+2																								+1	+1			
43	27		+3	+2	+3	-1	-1	+1	2S	1E											-24	-15	GO		X			0	+1	45	25	
45	27		+1	+1																								+2	+2			
47	27		+1	+1	+3	+6	+3	-2	0	4W											-6	+3	GO		X			+3	+2	40	25	
49	27		+4	+4																								0	+1			
51	27		+1	+1	+8	+2	-5	+3	7½S	½E											-13	+8	GO		X			0	+1	40	40	
4	30		+2	+2																								0	+2			
			+1	+1	+1	+1	0	+2	½S	½E											-12	+13	GO		X			0	+1	30	45	
			+1	+1																								+1	+3			
			+1	+1	+2	+5	+5	0	1½N	2½W											+7	+5	GO		X			+1	+3	30	40	
			+3	+3																								+3	+1			
			+3	+3	+2	+4	+2	+1	0	1½W											-8	+10	GO		X			+3	0	25	35	
			+3	+2																								+1	+3			
			+2	+2	+1	+3	+5	+3	2N	0											-10	+10	GO		X			+1	+2	25	40	
			+2	+2																								0	+6			
			+3	+3	+3	+6	+6	+3	1½N	1½W											-7	+5	GO		X			0	+4	25	45	
			+3	+3																								+1	+6			
			+2	+2	+7	+7	+4	+4	1½S	1½W											-19	-5	GO		X			+1	+4	25	40	
			+2	+1																								0	+1			
			+2	+1	+2	+1	-2	0	2S	½W											-20	0	GO		X			+1	0	30	60	
			+4	+4																								+1	+1			
			0	0	0	0	0	0	0	0											-7	+3	GO		X			+1	+2	25	125	
			0	0																								0	+1			
			+2	+2	+2	+3	+4	0	1N	1½W											-17	+17	GO		X			0	+1	40	40	
			+2	+2																								+2	+3			
			+1	+1	+4	-5	-6	+11	5S	6E											-7	-20	SHUT 1"		X			+2	+3	40	30	
			+1	+1																								+5	+3			
			0	-1	0	-7	+2	+8	1N	7½E											-7	-50	GO		X			0	+1	30	130	GO AFTER HONING
			+2	+2																								+1	+2			
			+1	+1	+1	-2	-2	+4	3S	3E											+7	-50	GO		X			+1	+2	40	45	
			+1	+1																								+1	+3			
			+2	+2	+3	+7	-2	+4	7½S	1½W											+11	-50	GO		X			+1	+3	35	40	
			+2	+2																								0	+2			
			+2	+2	+2	+8	+5	+9	3½S	½E											+34	-21	GO		X			0	+5	30	80	
			+2	+2																								+1	+2			
			+2	+2	+10	-4	-7	+7	8½S	5½E											-7	-39	GO		X			+1	+2	30	85	
			-1	-1																								+3	+3			
			0	-1	+4	-1	0	+4	2S	½E											+40	-40	GO		X			+1	+2	30	85	



13.D.
4

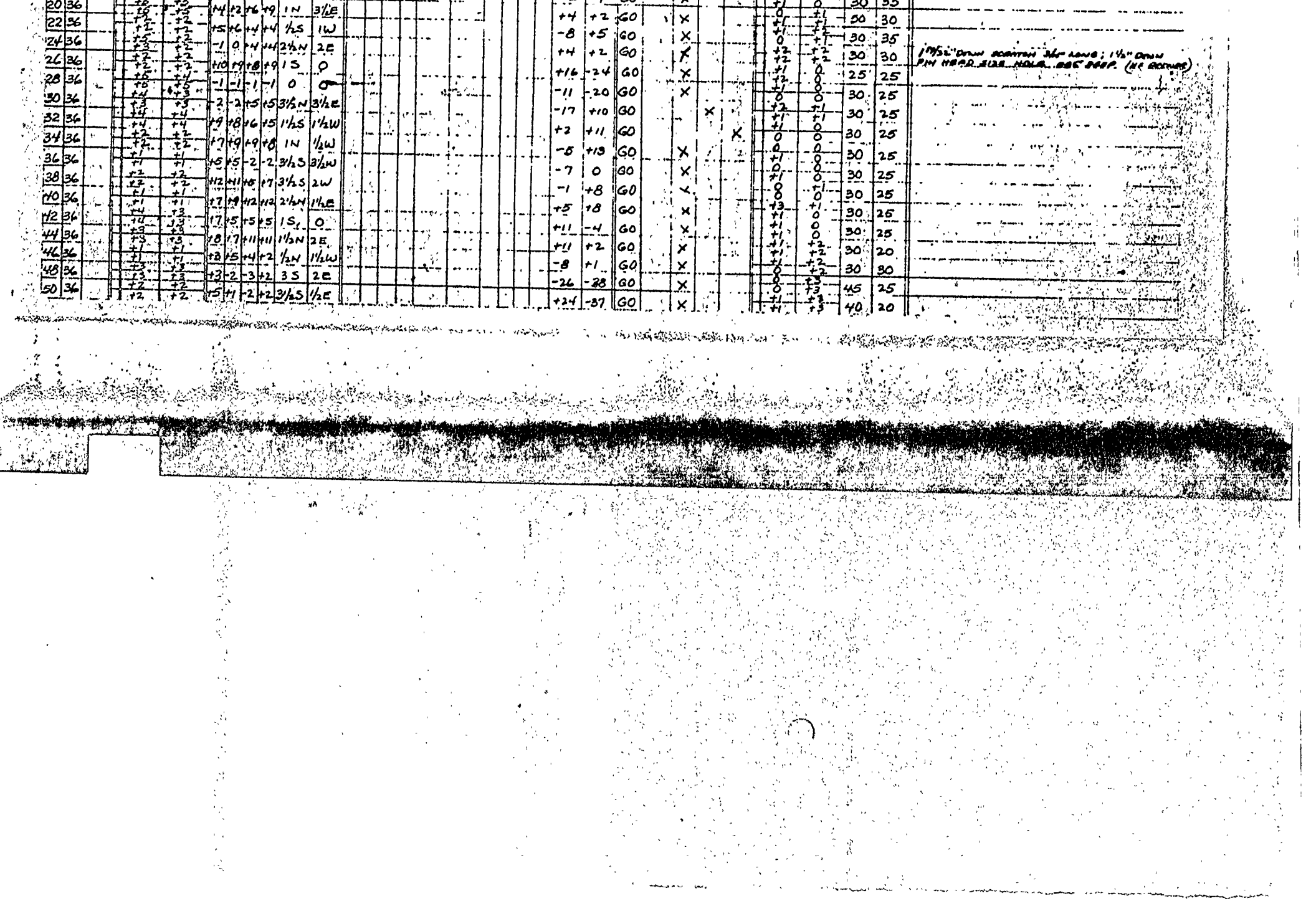
RESULTS OF LINE BORING

L UNIT

BASIC BORE 4.375

BASIC BORE 4.385

TUBE NOS X	TUBE NOS Y	TUBE NOS NVS	BORE MEAS. BEFORE HONING T.L.	BORE MEAS. BEFORE HONING B.L.	VERTICALITY N	VERTICALITY E	VERTICALITY S	VERTICALITY W	VERTICALITY AVERAGE N-S	VERTICALITY AVERAGE E-W	CENTRALITY PLENUM N	CENTRALITY PLENUM E	CENTRALITY PLENUM S	CENTRALITY PLENUM W	CENTRALITY PLENUM AVERAGE N-S	CENTRALITY PLENUM AVERAGE E-W	CENTRALITY CENTER TUBE SHEET N	CENTRALITY CENTER TUBE SHEET E	CENTRALITY CENTER TUBE SHEET S	CENTRALITY CENTER TUBE SHEET W	CENTRALITY CENTER TUBE SHEET AVERAGE N-S	CENTRALITY CENTER TUBE SHEET AVERAGE E-W	FUNCTIONAL GAGE GO	FUNCTIONAL GAGE NO GO	FINISH BEFORE HONING 0-63	FINISH BEFORE HONING 63-125	FINISH BEFORE HONING 125-UP	AFTER HONING BORE MEAS. T.L.	AFTER HONING BORE MEAS. B.L.	AFTER HONING FINISH-RMS T.L.	AFTER HONING FINISH-RMS B.L.	REMARKS
36	30		+3	+3	+4	+4	+3	+2	1½S	1W											-8	+20	GO			X		+1	+3	25	35	
38	30		+2	+2	+3	+2	+1	0	1S	1W											-6	+2	GO			X		+2	+3	35	35	
40	30		+1	+1	+7	+5	+7	+8	0	1½E											+2	+16	GO			X		+1	+2	30	35	
42	30		+1	+1	+12	+3	-2	+7	7S	2E											+32	-17	GO			X		0	+1	30	30	
44	30		+2	+1	+12	+8	+3	+8	4½S	0											+40	-18	GO			X		0	+1	25	30	
46	30		+1	+1	+4	-3	+1	+8	1½S	5½E											+19	-10	GO			X		0	+1	25	35	
48	30		+3	+3	+10	0	-6	+2	8S	1E											+24	-30	GO			X		+1	+2	25	30	
50	30		+1	+1	+21	+4	-4	+11	12½S	3½E											+47	-35	GO			X		0	+2	25	30	
52	30		+2	+3	+3	+1	-11	-2	7S	1½W											+15	-28	GO				X	+1	+2	35	30	
3	33		+2	+2	+1	+2	+3	+1	1N	½W											-18	+13	GO			X		0	+2	20	25	
5	33		+3	+3	+4	+4	+10	+10	3N	3E											+10	+5	GO			X		+1	+3	45	30	
7	33		+2	+2	+6	+6	+6	+6	0	0											-5	-5	GO			X		+1	+1	55	50	
9	33		+2	+2	+1	+1	+1	+1	0	0											0	-2	GO			X		0	+2	55	50	
11	33		-1	-1	+9	+7	+9	+10	0	1½E											-7	+2	GO			X		+1	+2	45	35	
13	33		+3	+3	+5	+3	+6	+7	1½N	2E											-7	-3	GO			X		+1	+3	50	35	
15	33		+2	+2	-1	0	+2	0	1½N	0											+6	+4	GO			X		+1	+1	35	40	
17	33		+2	+2	+9	+9	+10	+10	½N	½E											-4	+10	GO			X		0	+2	55	35	
19	33		+2	+2	+2	+2	-3	-1	2½S	3W											-5	-1	GO			X		+1	+2	25	45	
21	33		0	0	+11	+8	+5	+10	3S	1E											-5	0	GO			X		+2	+3	45	30	
23	33		+2	+2	-3	+1	+1	-2	2N	1½N											+2	+6	GO			X		+1	+2	40	30	
25	33		+5	+5	0	+3	+2	-1	1N	2W											-15	-8	GO			X		0	+2	25	35	
27	33		0	0	+6	+6	+2	0	2S	3W											-12	+15	GO			X		0	+3	45	40	
29	33		+2	+1	+1	+1	+7	+5	3N	2E											-9	+7	GO			X		+2	+1	40	45	
31	33		+1	+1	+5	+6	+5	+6	0	0											-12	+10	GO			X		+1	0	40	35	
33	33		+3	+3	+5	-1	-6	-3	3½S	1E											-6	-10	GO			X		+2	+3	50	40	
35	33		0	0	+5	+5	+6	+5	½N	0											-10	+2	GO			X		+2	+3	30	35	
37	33		+2	+2	+2	+4	+2	0	0	2W											0	+2	GO			X		0	+2	30	45	
39	33		+1	+1	+6	+9	+4	0	1S	4½W											-7	-5	GO			X		0	+3	30	20	
41	33		+3	+2	+1	-1	+2	+1	½N	1E											-20	+3	GO				X	+1	+2	30	50	
43	33		+3	+3	+6	+2	-6	-2	6S	2W											-11	+3	GO			X		+1	+2	30	45	
45	33		+3	+3	+2	-2	-2	+1	2S	1½E											-20	-16	GO			X		0	+1	30	60	
47	33		+2	+1	+5	0	+1	+5	2S	2½E											-10	-15	SNUG 2"				X	0	+2	30	45	
49	33		0	0	+9	+4	-1	+3	5S	½W											-2	+1	GO			X		+2	+2	40	40	GO AFTER HONING
51	33		+3	+4	+5	0	-5	0	5S	0											+9	-24	GO				X	0	+1	35	45	
53	33		+2	+2	+8	-5	-5	+7	6½S	6E											+50	-52	GO				X	+2	+1	40	30	
2	36		+2	+2	+1	+2	-1	0	1S	1W											-1	-7	GO			X		+2	+2	40	45	
4	36		+1	+1	+8	+2	+3	+8	2½S	3E											+7	+7	GO			X		+1	+1	40	40	
6	36		+1	+2	+5	0	0	+3	2½S	1½E											-10	+8	GO			X		+1	+3	45	35	
8	36		+3	+2	+11	+9	+4	+10	5½S	½E											-19	+2	GO			X		+2	+2	45	40	
10	36		+1	0	+1	+1	+2	+2	1½N	½E											-11	0	GO			X		0	+2	25	40	
12	36		+2	+2	+3	0	-1	-1	2S	½W											-7	-3	GO			X		+1	+1	30	40	
14	36		+1	+1	-2	-2	+2	+2	2N	2E											-7	+5	GO			X		+2	+1	30	20	
16	36		+2	+1	+8	+6	+4	+4	2S	1W											-9	-7	GO				X	0	+2	30	40	



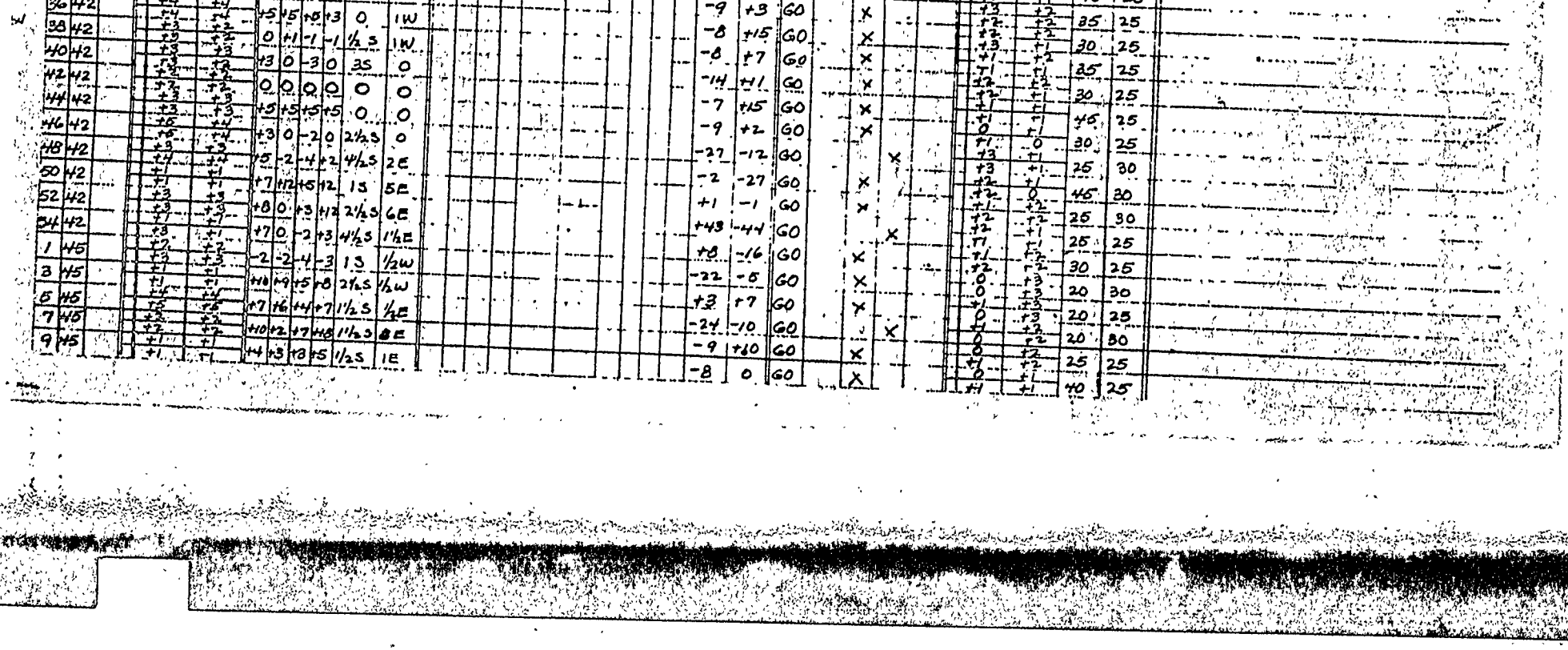
RESULTS OF LINE BORING

L UNIT

BASIC BORE 4.375

BASIC BORE 4.385

TUBE NOS X	TUBE NOS V	NVS	BORE MEAS. BEFORE HONING T.L.	BORE MEAS. BEFORE HONING B.L.	VERTICALITY N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY PLENUM B.L. N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY CENTER TUBE SHEET N	E	S	W	AVERAGE N-S	AVERAGE E-W	FUNCTIONAL GAGE GO	NO GO	FINISH BEFORE HONING 0-63	63-125	125-UP	AFTER HONING BORE MEAS. T.L.	BORE MEAS. B.L.	FINISH-RMS T.L.	FINISH-RMS B.L.	REMARKS
52	36		X +2	+1	+3	+6	+2	+10	5½S	2E											+14	-65	GO			X		X	+1				
54	36		Y +7	+2	+20	-5	-5	+20	12½S	12½E											+39	-104	GO		X			+1	+1	40	20	
3	39		+2	+3	+4	+4	0	0	2S	2W											+3	-4	GO			X		0	+1			
5	39		+3	+3	+5	+3	-7	-1	6S	2W											-7	-12	GO			X		+2	+2	40	25	
7	39		+2	+1	8	0															+2	+9	GO			X		+2	+2	35	30	
9	39		8	0	+13	+12	+6	+4	3½S	4W											+5	-2	GO			X		+1	+2	45	35	
11	39		+1	+1	+8	+10	+9	+5	½N	2½W											+10	0	GO			X		+2	+2	45	40	
13	39		+3	+2	+9	+6	+6	+8	½N	1E											-11	-3	GO			X		+5	+2	25	45	
15	39		+2	+2	+1	-5	-8	-4	4½S	½E											-6	+10	GO			X		+6	+3	25	30	
17	39		0	8	10	-5	+5	+9	7½N	7E											+4	+5	GO			X		+4	+3	30	35	
19	39		+4	+4	+9	+11	+7	+6	1S	2½W											-8	+11	GO			X		0	+2			
21	39		+3	+5	+12	+2	+5	+11	3½S	4½E											+8	+2	GO			X		+1	+2	30	35	
23	39		+2	+2	+1	0															-5	0	GO			X		+2	+1	30	30	
25	39		+1	0	+10	+11	+3	+2	3½S	4½W											-14	+2	GO			X		+2	+1			
27	39	~	+2	+2	+13	+9	+5	+7	5S	1W											-3	-4	GO			X		0	+3	50	40	
29	39		+4	+4	+14	+12	+9	+5	2½S	3½W											+7	+26	GO			X		+3	+2	35	25	
31	39		0	0	+1	-2	-4	0	2½S	1E											-6	+2	GO			X		+1	+2	35	40	
33	39		0	0	+6	+8	+11	+9	2½N	½E											-15	+5	GO			X		+1	+3	30	35	
35	39		+2	+2	+4	+1	+2	+2	1S	½E											-5	+10	GO			X		+1	+2	30	40	
37	39		+3	+3	-1	-1	+1	-1	1N	0											-7	+3	GO			X		0	+1	25	30	
39	39		+2	+1	+5	+5	+5	+5	0	0											-5	-10	GO			X		+2	+1	35	35	
41	39		+2	+2	+7	+11	+5	+5	1S	3W											-20	+8	GO			X		+3	+1	35	35	
43	39		+9	+9	+4	+5	+5	+3	½N	1W											-21	+16	GO			X		+2	0	35	35	
45	39		+2	+1	+3	+2	+1	+3	1S	½E											-20	-4	GO			X		+1	+3			
47	39		+1	+1	+1	-1	-1	+1	1S	1E											-13	+10	GO			X		0	+2	25	25	
49	39		+2	+1	+1	0	0	0	½S	0											-12	-18	SNUG 3"			X		+2	+3			
51	39		+2	+1	-1	0	+1	0	1N	0											-23	-23	GO			X		+1	+3	20	20	
53	39		+1	+2	+2	0	-2	-2	2S	2W											+14	-48	GO			X		+3	+5	30	26	GO AFTER HONING
2	42		+3	+2	+2	-2	+5	+6	1½N	4E											-5	+10	GO			X		+2	+2	25	25	
4	42		+2	+2	+12	+14	+13	+13	4½S	4½E											+2	+8	GO			X		+1	+2	30	35	
6	42		+2	+2	-2	+4	+4	-2	3N	3W											-8	+7	GO			X		+1	0	40	25	
8	42		+2	+2	+8	+9	+9	+8	½N	½W											+9	+10	GO			X		0	0	35	25	
10	42		+2	+2	+8	+6	+6	+8	1S	1E											-7	+8	GO			X		+1	0	43	30	
12	42		+2	+2	-3	+4	+11	+8	7N	2E											-24	+6	GO			X		+1	0	40	35	
14	42		+3	+2	+4	0	0	+3	2S	1½E											+1	+5	GO			X		0	0	40	30	
16	42		0	-1	-4	-2	+3	+6	3½N	4E											-5	+3	GO			X		+3	+2	40	35	
18	42		+1	+1	-4	+6	0	0	2N	3W											+3	-2	GO		X			+1	+2			
20	42		+2	+2	+8	+9	+8	+9	0	0											-8	+9	GO			X		+2	+5	30	40	
22	42		+5	+5	+8	+5	+3	+2	2½S	1½W											+12	+10	GO			X		+2	+4	30	30	
24	42		+2	+2	+8	+2	+8	+9	1½N	3½E											-5	-1	GO			X		+2	+3	30	40	
26	42		+1	0	+11	+11	+9	+9	1S	1W											-9	-3	GO			X		+2	+3	30	35	
28	42		+3	+3	0	+1	0	-1	0	1W											+13	+12	GO			X		0	+1	35	35	
30	42		+2	+2	+8	+5	+5	+7	1½S	1E											-8	+12	GO			X		0	+3	45	35	
32	42		+1	+1	+8	+8	0	+6	9S	8½W																		0	+2	25	30	
			+1	+1	0	0	+3	+3	1½N	1½E																		+1	+3	30	35	
			+1	+1	+5	+7	+5	+4	0	1½W																		0	+2	30	40	
																												+1	+2			



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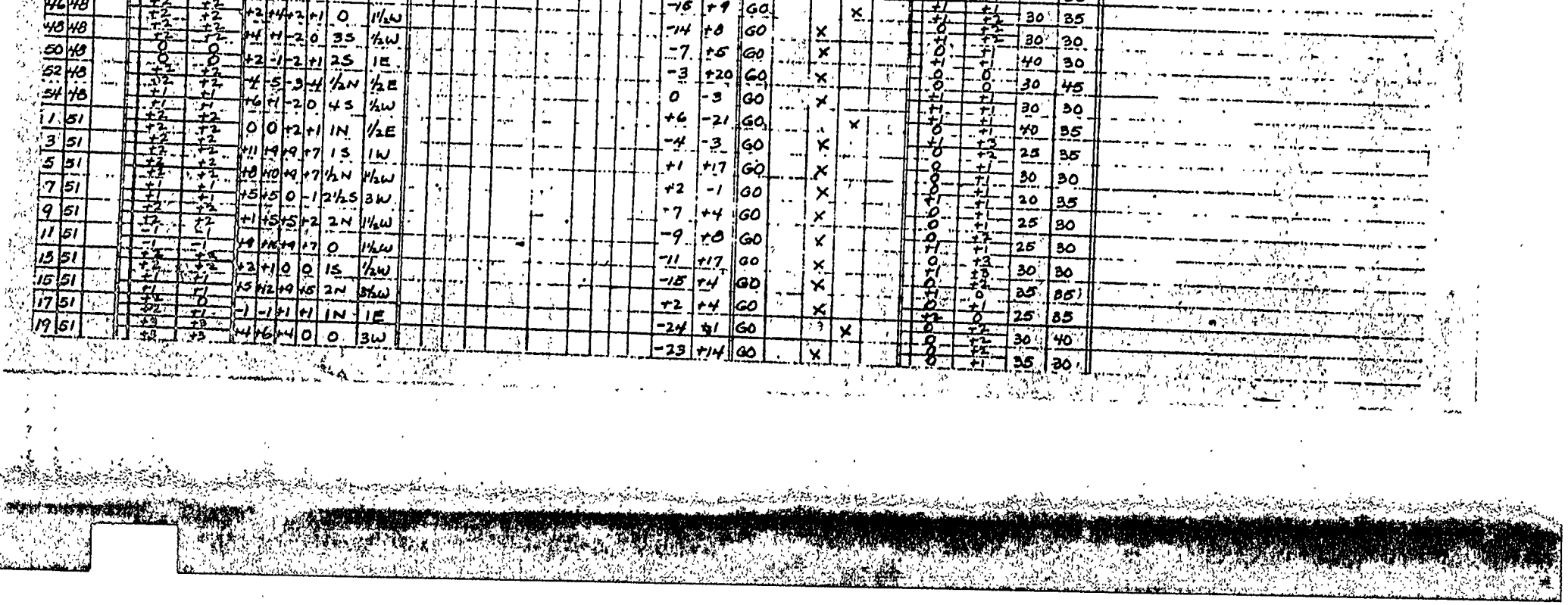
RESULTS OF LINE BORING

L UNIT

BASIC BORE 4.375

BASIC BORE 4.385

TUBE NOS X	V	NVS	BORE MEAS. BEFORE HONING T.L.	B.L.	VERTICALITY N	E	S	W	AVERAGE N-S	E-W	CENTRALITY B.L. N	E	S	W	PLENUM AVERAGE N-S	E-W	CENTER TUBE SHEET N	E	S	W	AVERAGE N-S	E-W	FUNCTIONAL GAGE GO	NO GO	FINISH BEFORE HONING 0-63	63-125	125-UP	AFTER HONING BORE MEAS. T.L.	B.L.	FINISH-RMS T.L.	B.L.	REMARKS
11	45		X +2	+2	+4	+6	+6	+4	4S	4E							+3	+2	GO		X		X +9						
			Y +2	+2																			Y 0	+2							
13	45		+2	+2	+5	+5	+7	+8	1N	1½E							-7	+11	GO		X		0	+2				30	25		
15	45		+1	+1	+11	+5	+5	+2	3S	3½E							0	+6	GO		X		0	+2				30	25		
17	45		+5	+3	+2	+3	0	-2	1S	2½W							-18	+2	GO		X		0	0				30	30		
19	45		+1	+1	+4	+4	+2	0	1S	2W							-15	0	GO		X		+1	0				40	20		
21	45		+2	+2	+3	0	0	+4	1½S	2E							-5	+9	GO			X	+1	+1				30	25		
23	45		+3	+3	+4	+5	0	-2	2S	3½W							-12	0	GO		X		0	+1				30	20		
25	45		+2	+2	+4	+8	+5	+4	½N	2W							-13	+7	GO		X		0	+1				35	25		
27	45		+2	+2	+8	+6	+3	+2	1N	2W							+6	+13	GO		X		0	0				45	30		
29	45		+2	+2	+5	+9	+9	+6	2N	2W							-2	+17	GO		X		0	+1				35	30		
31	45		+2	+3	+3	+4	+2	0	½S	2W							-3	+10	GO		X		0	+1				35	25		
33	45		+3	+3	+8	+10	+8	+6	0	2W							-5	+18	GO		X		0	+1				35	35		
35	45		+1	+1	+5	0	0	+2	2½S	1E							-6	+12	GO			X	0	+2				25	35		
37	45		+2	+2	+4	+5	+2	+1	1S	2W							-9	+10	GO		X		0	+2				30	30		
39	45		+1	+1	+5	+4	+1	+5	2S	½E							-9	+5	GO		X		+1	0				30	35		
41	45		+1	+1	-2	-2	+1	-1	1½N	½E							-5	+11	GO		X		+1	+1				40	25		
43	45		+2	+2	0	-5	-8	-3	4S	1E							-2	+7	GO		X		0	0				35	25		
45	45		+2	+2	+3	0	+2	+3	½S	1½E							-30	+3	GO		X		0	+1				35	25		
47	45		+2	+2	+2	0	+1	+2	½S	1E							-4	-6	GO		X		0	+1				30	30		
49	45		+3	+3	+1	+1	-1	-2	1S	1½W							-21	-6	GO		X		0	+2				40	40		
51	45		+6	+6	-2	0	+1	0	1½N	0													+1	+2				25	35		
53	45		0	0	+12	+4	+3	+6	7½S	1E							-7	+11	GO			X	+1	+2				25	25		
55	45		+2	+2	+2	-12	+3	+11	7½N	14½E							+32	-16	GO		X		0	+2				40	30		
2	48		+2	+2	+2	+2	+3	+2	½N	0							-31	-55	GO			X	+1	+1				40	30		
4	48		-1	-1	+8	+8	+8	+8	0	0							-34	-7	GO		X		+1	+2				30	30		
6	48		+1	+1	+5	+8	+13	+10	4N	1E							-1	-27	GO		X		0	+2				40	30		
8	48		+2	+2	-2	-1	-5	-7	1½S	3W							-15	-18	GO		X		+1	+1				20	25		
10	48		+1	+1	+9	+9	+8	+7	½S	1W							-27	-14	GO		X		+2	+2				55	25		
12	48		+2	+2	+3	0	+2	+4	½S	2E							+2	+16	GO		X		+2	+1				55	25		
14	48		+1	8	+7	+12	+12	+8	2½N	2W							-21	+12	GO		X		0	+1				60	30		
16	48		+4	+3	-1	-2	-2	-2	½S	0							+2	+1	GO		X		+1	0				50	35		
18	48		+1	+1	0	0	+1	0	1½N	0							-9	+4	GO		X		+1	+1				35	35		
20	48		+2	+2	+3	+3	+5	+5	1N	1E							-11	+12	GO		X		+2	0				35	30		
22	48		0	0	+9	+3	0	+9	4½S	3E							-19	+12	GO		X		0	+1				30	30		
24	48		+1	+1	+7	+4	+5	+2	1S	1E							+1	-6	GO		X		+1	+1				30	40		
26	48		+2	+2	+3	+3	+3	+3	0	0							-13	+1	GO		X		0	0				35	35		
28	48		+1	+1	+12	+8	+6	+8	3S	0							-14	+9	GO			X	0	+1				35	20		
30	48		0	0	+6	+6	+5	+3	½S	1½W							+8	0	GO		X		+1	0				30	30		
32	48		+1	+1	+6	+2	-1	+1	3½S	1½W							-8	+11	GO		X		+1	0				35	30		
34	48		0	0	+10	+10	+8	+6	1S	2W							-14	-4	GO		X		0	+2				25	30		
26	48		-2	-2	+9	+9	+9	+9	0	0							-2	+15	GO		X		0	+1				30	25		
38	48		+8	+8	-1	-1	-2	-2	½S	½W							-6	+7	GO		X		0	+1				30	30		
40	48		+5	+5	0	0	0	0	0	0							-8	-5	GO		X		0	+2				30	35		
42	48		+3	+3	+2	+1	-5	-6	½N	6E							-15	+10	GO		X		0	+2				30	30		



RESULTS OF LINE BORING

L UNIT

BASIC BORE 4.375 — BASIC BORE 4.385

TUBE NOS X	TUBE NOS Y	TUBE NOS NVS	BORE MEAS. BEFORE HONING T.L.	BORE MEAS. BEFORE HONING B.L.	VERTICALITY N	VERTICALITY E	VERTICALITY S	VERTICALITY W	VERTICALITY CORRECT N-S	VERTICALITY CORRECT E-W	CENTRALITY B.L. PLENUM BEFORE HONING N-S	CENTRALITY B.L. PLENUM BEFORE HONING E-W	CENTRALITY CENTER TUBE SHEET N	CENTRALITY CENTER TUBE SHEET E	CENTRALITY CENTER TUBE SHEET S	CENTRALITY CENTER TUBE SHEET W	CENTRALITY CENTER TUBE SHEET CORRECT N-S	CENTRALITY CENTER TUBE SHEET CORRECT E-W	FUNCTIONAL GAGE .85	FUNCTIONAL GAGE .90	FUNCTIONAL GAGE .95	FINISH BEFORE HONING 0-13	FINISH BEFORE HONING 13-25	FINISH BEFORE HONING 125-up	AFTER HONING BORE MEAS. T.L.	AFTER HONING BORE MEAS. B.L.	AFTER HONING FINISH RMS T.L.	AFTER HONING FINISH RMS B.L.	REMARKS
21	51		0	0	+2	+10	+5	+7	3½S	½W							-21	-1	GO			X			W +2	+1		
23	51		+2	+1	+2	+1	0	0	1S	½W							-19	-4	GO			X			Y +2	+1	25	35
25	51		+3	+3	+3	+8	-3	-3	3S	3W							-6	+3	GO			X			0	+1	40	30
27	51		+2	+2	+5	+8	+8	+3	1½N	2½W							+1	+17	GO			X			0	+1	20	30
29	51		+1	0	+8	+12	+9	+10	½N	1W							+10	+7	GO			X			0	+2	30	40
31	51		+3	+3	+1	-1	+1	+1	0	1E							-4	+4	GO			X			+1	+2	35	40
33	61		+3	+3	0	0	0	0	0	0							+2	+2	GO			X			0	+2	40	30
35	51		+2	+2	+2	0	0	0	1S	0							-11	+14	GO			X			+1	+1	35	35
37	51		+1	+1	+3	+8	0	0	1½S	1½W							-15	0	GO			X			+1	+2	30	35
39	51		+2	+2	+1	-7	+3	-2	½N	2½E							-9	+3	GO			X			0	+1	30	25
41	51		+3	+3	+1	+6	+2	-3	½N	4½W							-13	+22	GO				X		0	+2	45	20
43	51		+1	+1	+3	-4	-2	+4	2½S	4E							-8	+6	GO			X			+1	+3	40	45
45	51		+2	+1	+5	0	-1	+2	3S	1E							-18	+13		+GO 2"		X			0	+2	35	50
47	51		+1	+1	+3	+1	-1	-2	2S	1½W							-7	-1	GO			X			+4	+5	20	30	GO AFTER HONING
49	51		+5	+5	0	0	0	0	0	0							-6	+6	GO			X			+1	0	35	35
51	51		+1	+1	0	-1	-1	+1	1½S	1E							+11	+9	GO			X			0	+1	40	40
53	51		+3	+3	+4	-1	+1	+4	1½S	2½E							-23	-1	GO			X			0	+3	40	85
55	51		+3	+3	+4	0	0	+4	2S	2E							0	-62	GO				X		+1	+2	25	25
2	54		0	0	+6	+3	-1	0	3½S	1½W							-9	-4	GO			X			+2	+1	25	20
4	54		+1	+1	+6	+10	+9	+8	1½N	1W							-9	-16	GO			X			0	+1	25	30
6	54		+1	+1	+5	+9	+8	+3	1½N	3W							-7	+15	GO			X			0	+2	30	25
8	54		0	0	+8	+8	+9	+9	½N	½E							0	-3	GO			X			0	+1	25	25
10	54		+3	+3	0	0	0	0	0	0							-11	+10	GO			X			+1	+2	30	25
12	54		+2	+2	+11	+9	+7	+1	1½N	4W							-14	+9	GO			X			+1	+1	25	30
14	54		+1	+1	+3	+6	+6	+3	1½N	1½W							-12	+10	GO			X			+1	0	30	30
16	54		+3	+3	+4	-4	-4	+4	4S	4E							-19	+8	GO			X			+1	+2	30	40
18	54		+3	+3	+7	+5	0	0	3½S	2½W							-29	-4	GO			X			+1	+2	25	25
20	54		+1	+1	+3	+3	+1	+1	1S	1N							-8	+17	GO			X			0	+1	35	30
22	54		+1	+1	+16	+18	+11	+12	2½N	2E							0	+22	GO			X			0	0	20	60
24	54		+2	+2	-3	-4	-5	-6	1S	1W							-10	+10	GO			X			+1	+2	45	30
26	54		+5	+5	+7	+9	+7	+3	0	3W							-9	-3	GO			X			0	+3	25	25
28	54		+1	+1	+9	+8	+10	+9	½N	½E							-9	+7	GO			X			+1	+2	30	45
30	54		0	0	-3	-6	-4	0	½S	3E							-7	+3	GO			X			+1	+1	40	85
32	54		+3	+3	+4	+9	+1	+3	1½S	0							-6	+4	GO			X			+1	+3	40	30
34	54		+4	+3	+12	+13	+8	+4	3N	½E							-6	+8	GO			X			0	+2	30	30
36	54		+3	+3	+1	0	+1	+5	0	2½E							-10	+16	GO				X		0	+4	30	25
38	54		+5	+6	+1	0	+3	+3	1N	1½E							-22	0	GO			X			0	+1	35	40
40	54		+1	+2	+5	+11	+10	+7	2½N	2W							-14	+3	GO			X			0	+1	25	35
42	54		+3	+4	0	0	0	+1	0	½E							-9	+11	GO			X			0	+3	40	40
44	54		+3	+3	+11	+5	+6	+3	2½N	1W							-7	+6	GO			X			0	+1	35	35
46	54		+2	+2	+4	+6	+6	+3	1S	1½E							-3	+15	GO			X			0	+1	30	60
48	54		+2	+2	0	-1	+1	+1	½N	1E							-2	+8	GO			X			0	+1	35	50
50	54		+5	+5	0	-3	0	+4	0	3½E							-9	+6	GO					X	0	+1	30	80
52	54		+3	+3	+3	+5	0	+7	1½S	1½W															+1	+1	40	60
																									+2	0		

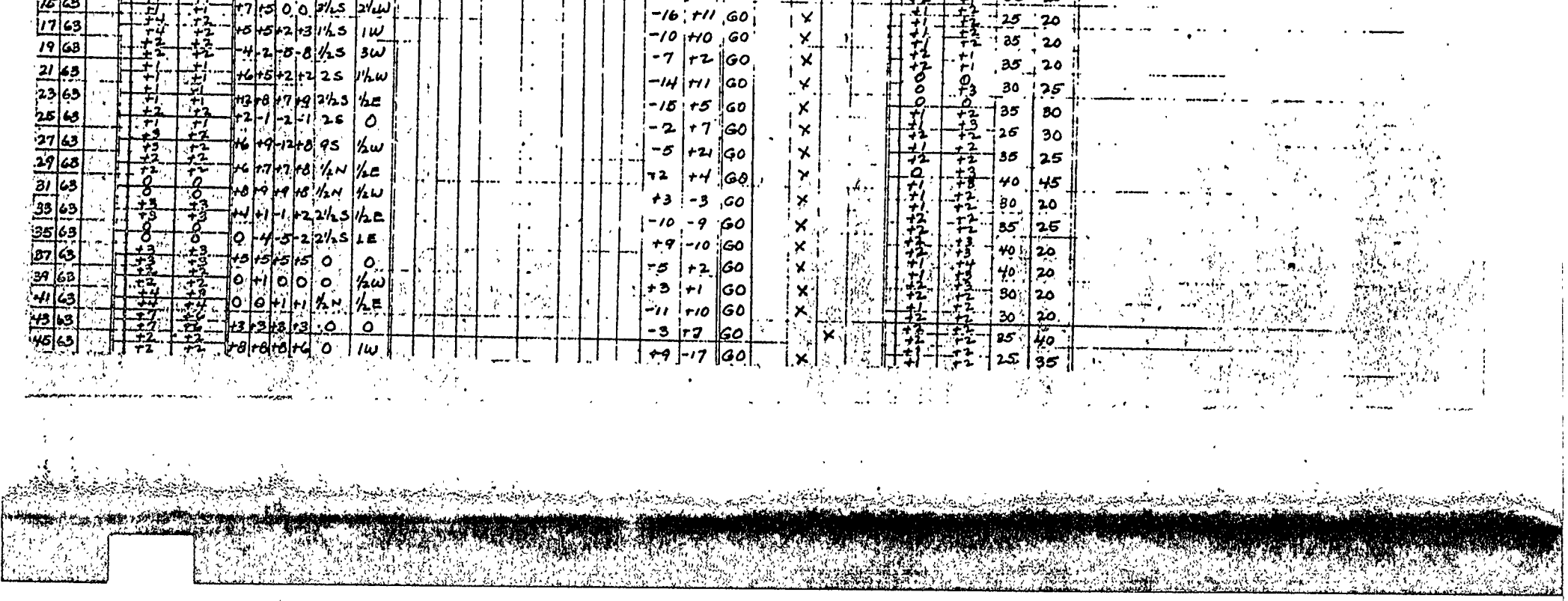
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RESULTS OF LINE BORING

L UNIT

BASIC BORE .4375 — BASIC BORE .4385

TUBE NOS X	TUBE NOS Y	TUBE NOS NVS	BORE MEAS. BEFORE HONING T.L.	BORE MEAS. BEFORE HONING B.L.	VERTICALITY N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY D.L. N	E	S	W	CENTRALITY PLENUM AVERAGE N-S	CENTRALITY PLENUM AVERAGE E-W	CENTRALITY CENTER TUBE SHEET N	E	S	W	CENTRALITY CENTER TUBE SHEET AVERAGE N-S	CENTRALITY CENTER TUBE SHEET AVERAGE E-W	FUNCTIONAL GAGE GO	FUNCTIONAL GAGE NO GO	FINISH BEFORE HONING 0-63	FINISH BEFORE HONING 63-125	FINISH BEFORE HONING 125-UP	AFTER HONING BORE MEAS. T.L.	AFTER HONING BORE MEAS. B.L.	AFTER HONING FINISH-RMS T.L.	AFTER HONING FINISH-RMS B.L.	REMARKS
53	57		+2	+2	+4	+4	+5	+5	½N	½E							-4	-2	GO			X			0	+1	35	25	VERTICAL SCRATCHES
55	57		+2	+2	+9	+10	+7	+8	1S	2½W							+13	+8	GO			X			+2	+3			
37	57		0	0	0	+2	+4	-3	2N	2½W							-18	0	GO			X			+1	+2	25	20	
39	57		+1	+1	+1	0	-2	0	1½S	0							-10	0	GO			X			+1	+3	25	30	
41	57		+1	+1	+4	+2	+2	+5	1S	1½E							+2	+4	GO			X			+2	+1	30	50	
43	57		+3	+3	-2	-4	-4	-2	1N	1W							-11	+3	GO			X			0	0	40	25	
45	57		+3	+2	+5	+4	+2	+5	1½S	½E							-10	-13	GO			X			0	+2	35	30	
47	57		+1	+1	+1	0	0	0	½S	0							-7	-6	GO			X			+1	0	40	25	
49	57		+7	+6	-1	-1	-1	-1	0	0							-18	+7	GO				X		0	+3	35	25	
51	57		+3	+3	+2	+1	0	0	1S	½W							-27	-7	GO			X			0	+2	30	25	
53	57		+2	+3	+1	+3	+6	+4	2½N	½E							+35	-38	GO			X			0	+1	35	25	
2	60		+4	+2	+4	0	0	+4	2S	2E							+5	+10	GO			X			+1	+1	35	30	
4	60		+2	+2	+7	+9	+9	+7	1N	1W							+11	0	GO			X			+2	+3	30	30	
6	60		+2	+1	+6	+4	+4	+5	1S	½E							-6	+6	GO			X			+2	+2	30	45	
8	60		+2	+2	+2	+3	+2	+3	0	0							-16	-33	GO			X			0	+3	25	45	
10	60		+2	+1	+5	+5	+5	+3	0	1W							-8	-20	GO			X			0	+2	25	45	
12	60		+2	+2	-1	-1	-1	-1	0	0							-5	-2	GO			X			0	+4	25	45	
14	60		+1	+1	+1	+1	+7	+6	3N	2½E							-4	+13	GO			X			+1	+3	35	30	
16	60		+2	+2	+1	0	0	0	½S	0							-6	+7	GO			X			+4	+4	60	45	
18	60		+1	0	+8	+6	+5	+6	1½S	0							-12	+1	GO			X			+2	+2	60	50	
20	60		0	0	0	-2	+1	+4	½N	3E							-15	+2	GO			X			0	+3	25	25	
22	60		+5	+5	-1	+1	+1	+1	1E	0							-7	+14	GO				X		0	+1	25	25	
24	60		+2	+2	+4	-2	0	+4	2S	4E							-18	+10	GO			X			+1	+1	30	30	
26	60		+3	+2	+8	+8	+9	+4	½N	½E							-9	+11	GO			X			+1	+2	35	40	
28	60		+1	+1	+14	+14	+6	+3	4N	5½W							+17	+11	GO			X			+1	0	40	30	
30	60		+5	+5	+8	+7	+4	+5	2S	1W							+11	+5	GO				X		+1	+4	30	40	
32	60		+2	+2	+4	+3	-1	-1	2½S	2W							-7	+3	GO			X			+1	+2	30	20	
34	60		+3	+3	+5	+1	+1	+5	2S	2E							+2	+16	GO			X			+2	+1	40	20	
36	60		+1	+2	+8	+8	+10	+8	1N	0							0	+8	GO				X		+1	+2	40	25	
38	60		+5	+4	+8	+2	+5	+8	1N	3E							-12	-2	GO			X			+2	+2	30	25	
40	60		+4	+3	-1	+2	+6	+3	3½N	1½E							-5	+7	GO			X			0	+2	30	25	
42	60		+3	+1	0	0	0	+4	0	2E							-15	+8	GO			X			+1	+2	30	25	
44	60		+3	+3	-2	+3	+2	-3	2N	3W							+2	+4	GO			X			+2	+1	35	25	
46	60		+5	+5	-4	-3	-3	-3	½N	0							+7	+1	GO			X			+1	+1	40	25	
48	60		+3	+5	+1	0	0	0	½S	0							-10	+12	GO			X			+1	+2	30	25	
50	60		+1	+1	+3	-1	+1	+4	1S	2½E							-2	+2	GO			X			+1	+2	30	25	
52	60		+1	+1	+2	+5	+7	+4	2½N	½W							+6	+2	GO			X			+1	+1	35	40	
54	60		+3	+3	+5	+5	+10	-5	7½S	5W							0	+7	GO SINGLE 2" NO GO 5"			X			+1	+5	30	40	GO AFTER HONING
3	63		0	0	+2	-4	+4	-1	1N	1½E							-5	-5				X			+2	+4	30	20	GO AFTER HONING
5	63		0	0	+8	+8	+8	+8	0	0							-10	+8	GO			X			0	+3	30	20	
7	63		+2	+2	+2	+5	+4	+3	1N	1W							-15	+12	GO			X			+1	+1	30	20	
9	63		0	0	+11	+17	+11	+5	0	6W							-7	+9	GO			X			+1	+2	30	20	
11	63		+3	0	+4	+4	+4	+3	0	½W							-10	+3	GO				X		0	+2			



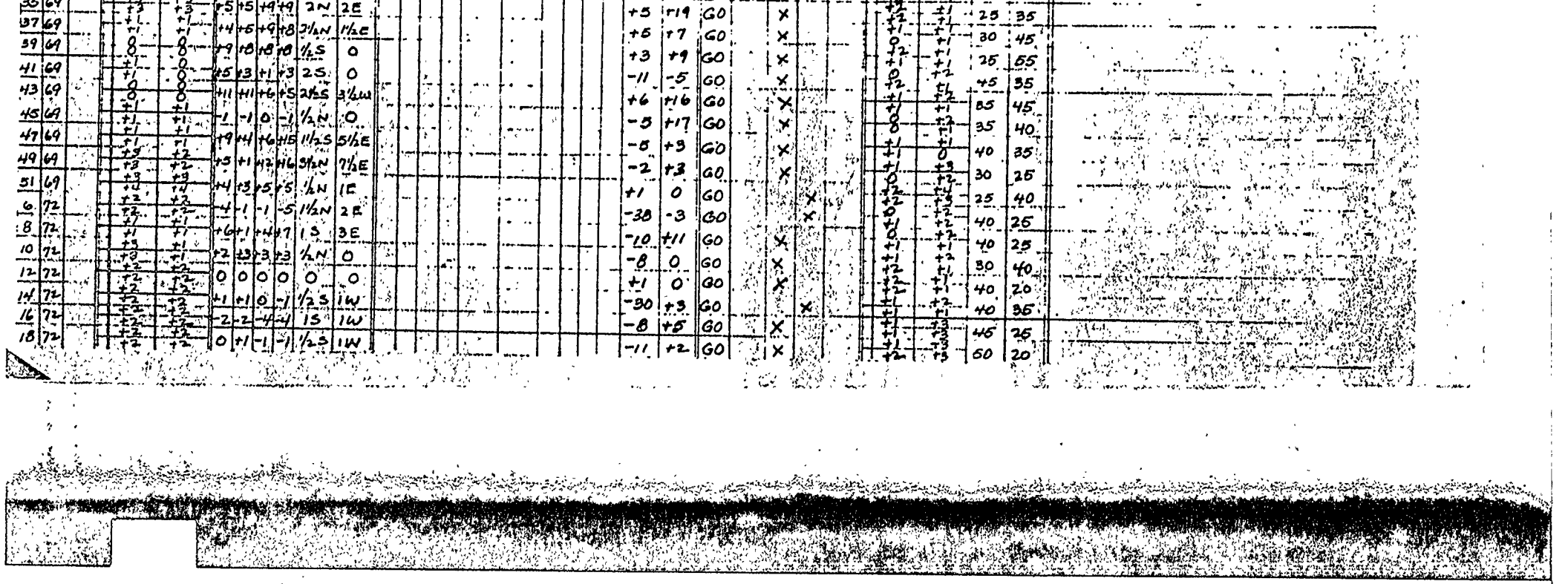
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RESULTS OF LINE BORING

L UNIT

BASIC BORE 4.375 — BASIC BORE 4.385

TUBE NOS X	TUBE NOS V	TUBE NOS NV5	BORE MEAS. BEFORE HONING T.L.	BORE MEAS. BEFORE HONING B.L.	VERTICALITY N	VERTICALITY E	VERTICALITY S	VERTICALITY W	VERTICALITY AVERAGES N-S	VERTICALITY AVERAGES E-W	CENTRALITY PLENUM N	PLENUM E	PLENUM S	PLENUM W	PLENUM AVERAGES N-S	PLENUM AVERAGES E-W	CENTRALITY CENTER TUBE SHEET N	CENTER TUBE SHEET E	CENTER TUBE SHEET S	CENTER TUBE SHEET W	CENTER TUBE SHEET AVERAGES N-S	CENTER TUBE SHEET AVERAGES E-W	FUNCTIONAL GAGE GO AND GO	FINISH BEFORE HONING 0-63	FINISH BEFORE HONING 63-125	FINISH BEFORE HONING 125-UP	AFTER HONING BORE MEAS. T.L	AFTER HONING BORE MEAS. B.L.	AFTER HONING FINISH - RMS T.L.	AFTER HONING FINISH - RMS B.L.	REMARKS
47	63		+1	0	+8	+5	+10	+3	IN	4E							+5	+10					GO		X		X	+2	25	40	
49	63		0	0																											
51	63		+1	+2	0	0	0	-4	0	2W							-2	+7					GO		X			+1	30	35	
53	63		+4	+4	+4	+4	-1	-1	2½S	2½W							-2	+8					GO			X		0	25	25	
4	66		+1	+1	+5	+6	-3	-3	4S	4½W							+22	+15					GO		X			+1	35	35	
6	66		+2	+2	+5	+5	+4	+2	½S	1½W							-16	+4					GO		X			+3	45	25	
8	66		+1	+1	+12	+11	+3	+3	4½S	4W							-3	+10					GO		X			0	50	25	
10	66		+2	+2	0	+2	+1	+1	½N	½W							-18	+10					GO		X			+2	35	25	
12	66		+1	+1	+2	+2	+3	+1	½N	½W							-19	+6					GO			X		+3	35	25	
14	66		+2	+2	0	+6	+6	0	3N	3W							-5	+10					GO			X		+1	35	25	
16	66		+3	+3	+3	+3	+2	0	½S	1½W							-5	0					GO		X			0	40	25	
18	66		+2	+2	-1	-1	-1	-1	0	0							-11	-3					GO		X			+1	20	25	
20	66		+2	+1	+4	+2	+3	+1	½S	½E							0	-1					GO		X			0	15	25	
22	66		+1	0	+5	+5	0	0	2½S	2½W							0	+5					GO		X			+1	15	25	
24	66		+3	+3	+4	0	-2	+4	3S	2E							-31	+6					GO		X			0	20	25	
26	66		+2	+2	+9	+8	+8	+11	½S	1½E							+8	+7					GO			X		+2	30	25	
28	66		+2	+2	+1	+1	+1	+1	0	0							-1	+5					GO		X			0	25	35	
30	66		+6	+6	+1	0	0	+3	½S	1½E							+1	+9					GO			X		+1	35	30	
32	66		+1	+1	+5	+3	+3	+5	1S	1E							-7	+2					GO		X			0	30	25	
34	66		+1	+1	-2	+2	+2	+1	2N	½W							-2	+7					GO			X		+2	40	30	
36	66		-1	-1	+9	+7	+7	+9	1S	1E							+14	+14					GO		X			+1	40	30	
38	66		+3	+3	+4	+1	+2	+5	1S	2E							-2	+4					GO		X			0	30	35	
40	66		0	0	+4	+12	+10	+5	3N	3½W							+7	+1					GO		X			+2	25	35	
42	66		+2	+2	+6	+1	+2	+3	2S	1E							-2	+3					GO		X			+1	40	25	
44	66		+2	+2	-2	-2	-4	-4	1S	1W							-8	-9					GO		X			0	45	25	
46	66		0	0	+4	+1	+6	+10	1N	4½E							-10	+12					GO		X			+1	30	40	
48	66		+4	+4	+6	+6	+4	+4	1S	1W							-8	+6					GO		X			0	35	35	
50	66		-1	-1	+6	+6	+10	+9	2½N	1½E							+4	+10					GO		X			+1	30	30	
52	66		+4	+4	+9	+2	+4	+10	2½S	4E							-15	-24					GO		X			+3	40	30	
5	69		+1	+1	0	0	0	0	0	0							-9	+6					GO		X			0	35	45	
7	69		+1	+1	+7	+4	-2	+2	4½S	1W							-24	+10					GO			X		+2	40	25	
9	69		+1	+1	+1	+5	+11	+7	5N	1E							-25	+23					GO		X			+2	45	30	
11	69		+2	+2	-4	-4	-4	-4	0	0							-10	+5					GO		X			+1	25	20	
13	69		+1	8	+5	+3	+2	+2	1½S	½W							0	-3					GO		X			+2	30	35	
15	69		+5	+4	0	0	-3	-4	1½S	2W							-2	+6					GO		X			0	45	30	
17	69		0	0	+6	0	0	+5	3S	2½E							+13	+7					GO				X	+2	30	45	
19	69		0	0	+2	0	0	+1	1S	½E							-11	+10					GO		X			+1	30	20	
21	69		+5	+5	0	0	0	-1	0	½W							-10	+2					GO			X		+2	35	20	
23	69		+2	+2	-2	-2	0	+1	1N	1½E							-7	+3					GO		X			+1	25	20	
25	69		+3	+3	+3	+4	0	-2	1½S	3W							+3	+12					GO			X		+1	30	30	
27	69		+1	+1	-2	+2	0	+1	1N	½W							-3	+4					GO		X			+3	25	25	
29	69		+2	+1	+5	+5	+5	+5	0	0							-6	+2					GO		X			0	30	35	
31	69		+1	+1	+5	+1	+1	+4	2S	1½E							0	+2					GO		X			+1	25	40	
			0	0																								0			
			+2	+3	+4	+8	+6	+2	1N	3W							-1	+1					GO		X			+2	25	25	



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RESULTS OF LINE BORING

L UNIT

BASIC BORE 4.375 — BASIC BORE 4.385

TUBE NOS X	TUBE NOS Y	TUBE NOS NVS	BORE MEAS. BEFORE HONING T.L.	BORE MEAS. BEFORE HONING B.L.	VERTICALITY N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY B.L. PLENUM N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY CENTER TUBE SHEET N	E	S	W	AVERAGE N-S	AVERAGE E-W	FUNCTIONAL GAGE GO	FUNCTIONAL GAGE NO GO	FINISH BEFORE HONING 0-63	FINISH BEFORE HONING 63-125	FINISH BEFORE HONING 125-UP	AFTER HONING BORE MEAS. T.L.	AFTER HONING BORE MEAS. B.L.	AFTER HONING FINISH - RMS T.L.	AFTER HONING FINISH - RMS B.L.	REMARKS
20	72		+4	+3	-10	-3	-3	-4	3½N	1½W							-14	+2	GO		X											
22	72		+3	+3	+2	0	0	0	1S	0							-2	+8	GO			X										
24	72		+3	+3	0	0	+4	+3	2N	1½E							-23	+14	GO		X											
26	72		+1	+1	+5	+6	+5	+7	0	½E							-17	+10	GO		X											
28	72		+2	+1	+5	0	-3	+4	4S	2E							-3	0	GO		X											
30	72		+4	+4	+3	+4	+6	+3	1½N	½W							+15	+8	GO		X											
32	72		+1	+1	-3	+2	+5	+7	4N	2½E							-4	+4	GO		X											
34	72		+2	+2	0	+1	+1	0	½N	1½W							-2	0	GO		X											
36	72		+1	+1	0	-2	-1	+1	1½S	1½E							+2	+2	GO		X											
38	72		+2	+2	0	+2	+4	+4	2W	1E							+3	-4	GO		X											
40	72		+1	+2	+5	+2	0	+1	2½S	1W							-11	+2	GO			X										
42	72		+2	+2	+10	+10	+10	+10	0	0							+9	+4	GO		X											
44	72		+1	+1	+1	+2	0	-1	1½S	1½W							-12	-5	GO		X											
46	72		+2	+2	+11	+10	+6	+9	2½S	½W							-3	+10	GO			X										
48	72		+2	+2	+10	0	+5	+8	2½S	9E							-11	+22	SNUG 2"	X												
50	72		+1	+1	+2	+2	+4	+4	1N	1E							+4	+1	GO		X											GO AFTER HONING
7	75		0	0	+1	+1	-1	-2	1S	1½W							-21	+20	GO			X										
9	75		+2	+2	+2	+2	+4	+4	1N	1E							-10	+10	GO		X											
11	75		+2	+2	0	0	0	0	0	0							-6	+20	GO		X											
13	75		+3	+2	+3	+3	+3	+1	5N	1W							-24	+35	SNUG 1"	X												
15	75		+2	+1	0	+2	+2	0	1N	1W							-25	+10	GO			X										GO AFTER HONING
17	75		+3	+3	+1	0	+1	+2	0	1E							-8	+9	GO		X											
19	75		+1	+1	+3	0	+2	+2	½S	1E							-19	+2	GO		X											
21	75		+2	+2	+2	-2	-4	+1	3S	1½E							-13	+16	GO			X										
23	75		+5	+5	+6	0	-3	+1	4½S	½E							-12	-1	GO		X											
25	75		+3	+3	0	-6	-8	-2	4S	2E							-10	+12	GO		X											
27	75		+2	+1	+1	-1	-1	+1	1S	1E							-16	+20	GO			X										
29	75		+4	+4	+7	+1	0	+4	3½S	1½E							-10	+7	GO		X											
31	75		+1	+1	0	-1	0	0	0	0							-4	+3	GO		X											
33	75		+4	+4	-2	+1	+1	+1	1½N	0							-15	0	GO			X										
35	75		+1	+1	+3	0	-1	+3	2S	1½E							+4	+4	GO		X											
37	75		+2	+2	+3	+3	+3	+3	0	0							+1	-6	GO		X											
39	75		+2	+2	+3	+5	+5	+2	1N	1½W							+1	+1	GO		X											
41	75		+1	+1	+6	+5	+4	+8	½S	1½E							+6	+8	GO			X										
43	75		+3	+3	+5	+2	+4	+8	1½S	3E							+4	-10	GO			X										
45	75		+2	+3	+7	+7	+8	+6	½N	½W							-4	+8	GO		X											
47	75		+4	+4	+1	+3	+4	+8	1½N	2½E							-3	+12	GO		X											
49	75		-2	-2	+8	+10	+8	+6	P	2W							-8	+24	GO		X											
8	78		+3	+3	0	+5	+5	+9	2½N	2E							-25	+14	GO		X											
10	78		+2	+2	+3	+4	+3	+4	0	0							-7	+8	GO		X											
12	78		+3	+3	+4	+8	+6	+2	1½N	3W							-7	+12	GO		X											
14	78		+1	+1	-3	+5	+8	+4	6½N	½W							-20	+7	GO		X											
16	78		+2	+2	0	0	+2	+2	1N	1E							-6	+16	GO			X										
18	78		0	0	-4	-1	+2	0	3N	½E																						
			+2	+2	+2	-2	+3	+4	½N	3E																						

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RESULTS OF LINE BORING

L UNIT

BASIC BORE 4.375 — BASIC BORE 4.385

TUBE NOS X	TUBE NOS V	TUBE NOS NVS	BORE MEAS. BEFORE HONING T.L.	BORE MEAS. BEFORE HONING B.L.	VERTICALITY M	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY P.L. PLENUM N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY CENTER TUBE SHEET N	E	S	W	AVERAGE N-S	AVERAGE E-W	FUNCTIONAL GAGE GO	NO GO	FINISH BEFORE HONING 0-63	63-125	125-UP	AFTER HONING BORE MEAS. T.L.	B.L.	FINISH-RMS T.L.	B.L.	REMARKS
11	81		+4	+4	+7	+4	-3	+1	5S	1½W							-26	+15	GO		X				+1	+1	50	30	
13	81		0	0	+5	+5	+3	0	1S	2½W							-15	+15	GO		X				+2	+1			
15	81		+1	+1	+2	+2	+1	+1	½S	½W							-28	+7	GO		X				+1	+2	40	30	
17	81		+2	+2	0	+1	+4	+3	2N	1E							-12	+9	GO		X				+1	+1			
19	81		+2	+2	+5	0	-2	0	3½S	0							-33	+19	GO		X				0	+2	35	40	
21	81		+3	+3	-2	+5	0	-5	1N	5W							-11	+12	GO			X			+1	+3			
23	81		+3	+4	+4	+4	-3	-2	3½S	3W							-5	+13	GO		X				0	+3	35	30	
25	81		+2	+2	-4	+2	-1	+2	1½N	0							-28	+8	GO		X				0	+4			
27	81		+4	+4	+5	+3	-2	+1	3½S	1W							-2	+2	GO		X				+2	+4	40	35	
29	81		0	0	+6	+2	+6	+9	0	3½E							-12	+15	GO		X				+2	+3	35	40	
31	81		+1	+1	-3	+1	0	0	1½N	½W							-5	+5	GO		X				0	0			
33	81		+2	+2	-3	-6	-4	-3	1½S	1½E							-1	+8	GO		X				0	+2	35	45	
35	81		+1	+1	+7	+5	+6	+6	1S	½E							-3	+6	GO		X				+2	+3			
37	81		+1	0	0	+2	+5	+3	2½N	½E							0	+5	GO		X				+2	+3	35	25	
39	81		+2	+2	+8	+5	+4	+5	2S	0							-2	+8	GO		X				+2	+2	35	20	
41	81		+2	+1	+3	+4	+4	+4	½N	0							-4	+5	GO		X				0	+3			
43	81		0	0	+10	+7	+7	+12	1½S	2½E							-8	+16	GO		X				+1	+3	30	25	
45	81		+2	+2	-2	+1	0	-2	1N	1½W							-10	+10	GO			X			+1	+4			
47	81		+3	+3	+2	+4	+12	+11	6N	3½E							-11	+17	GO			X			0	+4	40	20	
12	84		+2	+2	+6	+12	+4	-4	½S	8W							+8	+4	SNUG 3"		X				+1	+1			
14	84		+2	+2	+3	+1	+4	+6	½N	2½E							-26	+4	GO		X				+3	+6	35	25	GO AFTER HONING
16	84		+2	+2	-4	-4	-7	-4	1½S	0							-16	-1	GO		X				0	+2	35	30	
18	84		+2	+2	0	0	0	0	0	0							-4	+12	GO		X				+1	+3			
20	84		+1	+1	0	0	+1	+1	½N	½E							-14	+12	GO		X				0	+3	40	30	
22	84		+3	+2	-1	-3	-6	-5	2½S	1N							-21	+10	GO		X				0	+3			
24	84		+2	+2	0	-2	+4	+4	2N	3E							-4	+10	GO		X				+3	+2	45	35	
26	84		+3	+3	+8	+4	+3	+4	2½S	0							-4	+13	GO		X				+3	+2	35	25	
28	84		+3	+2	+2	+4	+4	+2	1N	1W							-1	-1	GO		X				+1	+4			
30	84		+1	+1	+4	0	0	0	2S	0							0	+10	GO		X				+3	+4	25	35	
32	84		+4	+3	+1	+4	+3	+1	1N	1½W							-2	+14	GO		X				+3	+3			
34	84		+2	+2	+5	+4	+4	+2	½S	1W							+1	+6	GO		X				0	+3	30	35	
36	84		+3	+3	0	+2	+1	0	½N	1W							-1	+9	SNUG 2"			X			0	+2			
38	84		+4	+4	0	0	0	0	0	0							-8	+9	GO				X		+1	+2	30	30	
40	84		+3	+2	+8	+10	+6	+4	1S	3W							-7	+15	GO		X				+1	+1			
42	84		0	0	+5	-4	0	+7	2½S	5½E							-10	+7	GO		X				0	+2	30	20	
44	84		+1	+1	+1	0	+3	+3	1N	1½E							-12	+15	GO		X				+1	+2			
13	87		+3	+2	+4	+8	+4	+2	0	3W							-8	+6	GO		X				0	+1	30	20	
15	87		+3	+3	+4	+1	+3	+9	½S	4E							-44	-4	GO		X				+1	+3			
17	87		+1	+1	+4	+4	+5	+3	½N	½W							-21	+5	GO		X				+2	+3	25	25	
19	87		+1	+1	+2	+2	0	-2	1S	2W															+3	+2			
																									+2	+2	35	25	
																									0	+5	35	25	

| | | |

13.D.
12

RESULTS OF LINE BORING

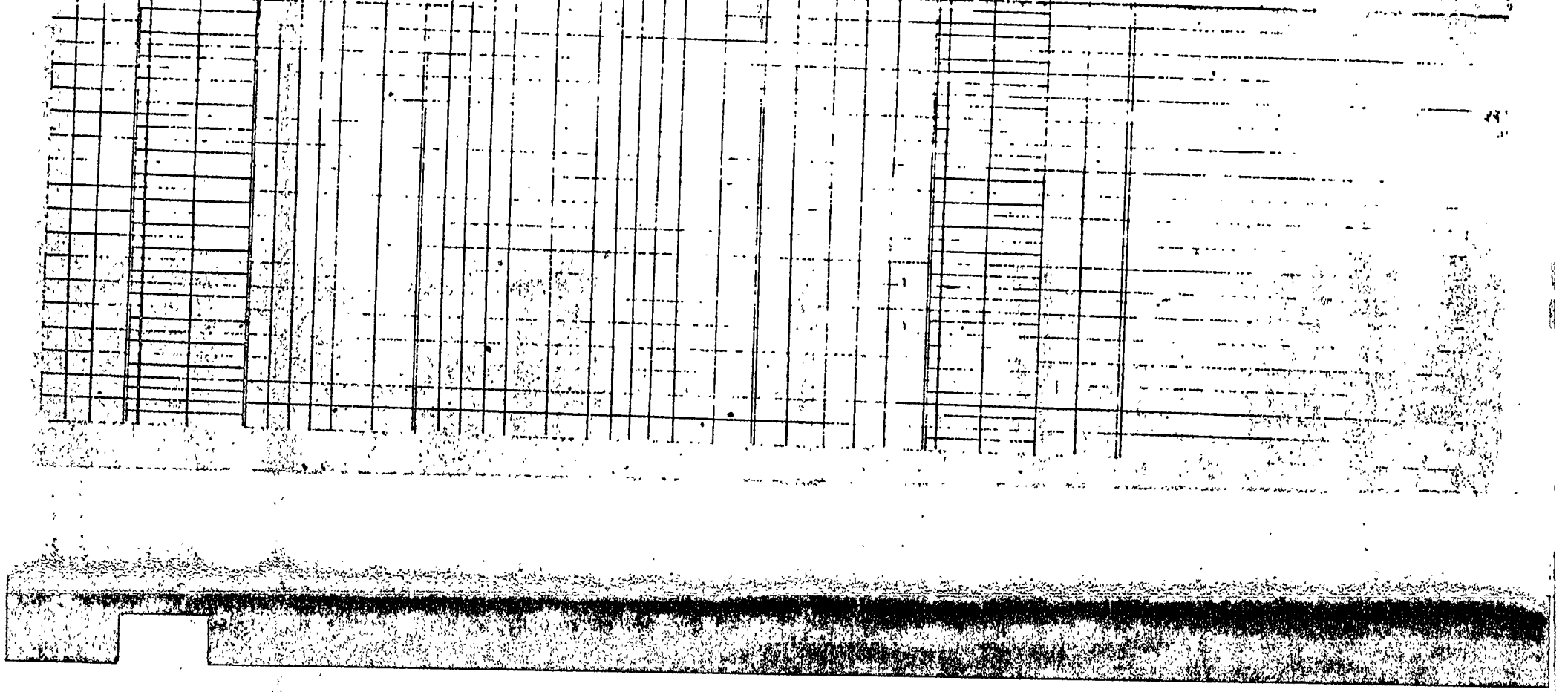
L UNIT.

BASIC BORE 4.375

TUBE NOS X	TUBE NOS Y	TUBE NOS NVS	BORE MEAS. BEFORE HONING T.L.	BORE MEAS. BEFORE HONING B.L.	VERTICALITY N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY PLENUM N	E	S	W	AVERAGE N-S	AVERAGE E-W	CENTRALITY CENTER TUBE SHEET N	E	S	W	AVERAGE N-S	AVERAGE E-W	FUNCTIONAL GAGE GO	FUNCTIONAL GAGE NO GO	FINISH BEFORE HONING 0-63	FINISH BEFORE HONING 63-125	FINISH BEFORE HONING 125-UP
32	90		X +3	+3	-1	0	0	0	½N	0											-8	+15	GO				
34	90		Y +3	+3	+2	+4	+4	+3	1N	1½W											-5	+12	GO			X	
36	90		+3	+3	+7	-1	-3	+3	5S	2E											-13	+3	GO			X	
38	90		+2	+1	+4	+4	-3	-2	3½S	3W											-6	+10	GO			X	
40	90		+4	+3	+4	+4	+3	+1	½S	1½W											-10	+5	GO			X	
21	93		+2	+2	+4	+4	+3	+1	½S	1½W											+1	+10	GO			X	
23	93		+1	0	+6	+4	+4	+4	1S	0											-6	-1	GO				X
25	93		+3	+3	0	+8	+8	-2	4N	5W											-19	+15	GO			X	
27	93		+2	+1	+1	0	+5	+5	2N	2½E											-2	-6	GO			X	
29	93		+2	+2	0	+3	+5	+3	2½N	0											-2	0	GO			X	
31	93		+1	+1	+1	0	+1	0	0	0											-10	+9	GO				X
33	93		+2	+2	+6	0	-4	+3	5S	1½E											-4	+21	GO				X
35	93		+4	+4	+3	+6	-2	-5	2½S	5½W											-5	+1	GO			X	
			+1	+1	-3	0	+3	0	3N	0																	

BASIC BORE 4.385

AFTER HONING BORE MEAS. T.L.	AFTER HONING BORE MEAS. B.L.	AFTER HONING FINISH-RMS T.L.	AFTER HONING FINISH-RMS B.L.	REMARKS
X +1	+2			
Y +1	+2	35	20	
+2	+1			
+2	+2	30	25	
0	+1			
0	+2	40	25	
+2	0			
+2	0	30	25	
0	+2			
+1	+2	40	25	
+1	+1			
+1	+1	25	25	
0	+2			
0	+2	25	25	
0	0			
+1	0	25	25	
+1	+1			
+2	0	30	30	
+2	+2			
0	+1	25	25	
0	+1			
+1	+1	40	35	
+2	+1			
+2	+1	40	30	
+1	+2			
+2	+2	40	25	



(d) Functional Gaging

All large tubes were gaged using a 4.365" diameter functional gage. This functional gage was a 5'-7" piece of CARBON Steel tubing, the top 14" of which had a diameter of 4.365" and the remainder 4.330". This gage was inserted in the bore after the line boring operation and before honing to determine if the tube would functional gage. For those bores in which the functional gage would not properly seat, the plenum bore was opened up to a maximum of 4.390" by honing at a later date. After functional gaging a total of fourteen (14) tubes exhibited a tight fit of the 4.365" diameter functional gage. These tubes were: X32-Y12; X44-Y39; X3-Y63, X41-Y9, X26-Y24, X47-Y33, X54-Y60, X13-Y87, X9-Y81, X12-Y84, X11-Y15, X45-Y51, X44-Y39, X54-Y60.

The above tubes were later honed to a maximum of 4.390" after which all accepted the 4.375" diameter functional gage with the exception of the following, and they were repaired before separating the units: (1) The top land of tube X29-Y57 was honed oversize in an effort to make the 4.375" diameter functional gage seat properly. To correct the situtation and bring the top land within acceptable tolerances, New York Ship "heli-arc shrunk" by depositing successive beads of weld metal on the O.D. of the tube. Numerous passes were made until the top land had shrunk enough to be re-honed. After rehoning to a maximum of 4.390", the 4.375" diameter functional gage seated properly and the tube was accepted. (2) The top land of tube X47-Y15 was found to be out-of-round and oversize. This tube was "heli-arc shrunk" and re-honed until the bore was within tolerance. The final condition of this tube is listed in Exhibit #13-D, Results of Line Boring. (3) The top land of tube X24-Y36 had deep scratches in the O-ring area after the tube was honed to 4.393". (Design Division gave consent to open top land .003" oversize for removal of scratches in this particular tube) This tube was "heli-arc shrunk" and re-honed until satisfactory. For final condition of bore, see Exhibit #13-D, Results of Line Boring.

Note: (1) Plenum tubes after line boring were required to accept a 4.365" diameter functional gage. ~~Tube diameter functional gage.~~ Tube diameters (plenum) at this time were bored between 4.375" and 4.380" in diameter.

Note: (Con'd)

(2) Plenum tubes after honing were required to accept a 4.375" diameter functional gage. Finish tube diameters were honed to 4.385" + .005" -.000". In some cases tubes were honed to 4.393" before functional gage would seat properly; however, this was done only with the consent of the Design Division.

f. Inspections After Chamfering Large Tubes

After line boring all large tubes, the top ends were chamfered (5/32" x 10°) using a special teflon piloted fly cutter. After chamfering all large tube ends to dimensions shown in Dwg. 2-1, Section 16A-(2)b of this manual, all chamfers were checked using a 10° beveled gage which was a prototype of the required chamfer dimensions. Also, a visual check was made for evidence of tool "chatter" and burrs. No discrepancies were found and the job was approved.

When chamfering of large tube ends on the top side was completed, inspected and accepted; the plenum chamber was turned bottom side up and a 1/8" x 45° chamfer was machined into the bottom ends of all large tubes, with the exception of the six gas tubes. As a result of a change in design, the six gas tubes were chamfered 1/4" x 45°. See section 16C-(18) of this manual for resume of gas tube chamfer inspections. The 1/8" x 45° beveled gage which was a prototype of the required chamfer dimensions. Also, a visual inspection was made for evidence of tool "chatter" and burrs. No discrepancies were found and the job was accepted.

16. Inspection Performed After Line Boring and Prior to Shipping

A. "R" Unit

(1) Zy-glo Test

All of the 673 large tube ends (top and bottom) were zy-glo tested to determine if any lamination or cracks were present. This inspection came about as a result of finding a laminated cast tube in the "P" tank bottom assembly. Tube ends on the "L" plenum chamber were visually inspected for the above stated defects and found satisfactory.

The zy-glo test was performed in the following manner:

1. Tube ends were cleaned with F.O. 128 or carbon tetrachloride.

2. Zy-glo penetrant oil (Type ZL-1) was swabbed on tube ends and allowed one hour to penetrate.

3. Tube ends were washed with water or carbon tet.

4. Tube ends were dusted with developing powder (Type ZP-2) and allowed one hour to develop.

5. Excess developing powder was removed by air jetting.

6. Tube ends were then visually inspected for cracks and laminations using a General Electric 15 watt black fluorescent lamp. A hand-type Navy Signal Gun was used to hold the lamp and direct rays to area under test.

(2) Slot Milling Operation

a. "V" Slot Inspection

Prior to milling of the three "V" slots in the top end of all 5¼" diameter plenum tubes, Y-Y axes were scribed on the top of tube ends parallel to the major Y-Y axis by du Pont Inspectors. (A detail procedure outlining the method used for scribing these lines is covered in Part III, Section II-A-3b) These lines were used(after slot milling) for positioning the angle gage to check orientation of slots with respect to a tube Y axis. (Use of angle gage is discussed in above referenced section.)

After three "V" slots had been milled in the top ends of all large tubes, they were inspected visually for burrs and for size and location. Size was checked by means of a functional gage as described in Part III, Section II-a-2. Location or orientation was checked by using a special angle gage described in Part III, Section II-A-3.

During the course of inspection, some slots were found to be oversize and some undersize. Those that were oversize were built up by welding and then re-milled and inspected. Design gave permission to accept undersize slots with the provision that the functional gage would properly fit the slots. All "V" slots were inspected and accepted on this basis. See Exhibit #14 for results of final inspections made on "V" slots.

b. Square Slot Inspection

Two square slots were milled in the bottom end of all large plenum tubes along the "X" axis. (See Dwg. 2-1).

Approximately 10 per cent were checked during the machining operation for size using a 6" scale graduated in 1/64" to determine if the milling cutter was cutting to the required width and depth.

After machining all square slots, a ½" x 2" x 6" machined block was fit in the two square slots. The distance from the 2" machined block face to the I.D. of the tube was measured on one side and then on the other. For slots to be within tolerance, these two measurements had to compare with ± 1/64". Approximately one-third of the slots were inspected in this manner and accepted.

EXHIBIT #11

"V" SLOT INSPECTION (FINAL)

E. I. DU PONT DE NEMOURS & CO., INC.

Report Number 315-R

Construction Division

[redacted]

CC: H. W. Gosney, F.P.M.
R. K. Mason, F.P.M.- SRP (3)
H. L. Bunker - J. G. Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
R. H. Potts (2)
J. B. Johnson - File

November 12, 1952
New York Ship - Camden, N. J.

This material contains information affecting the national defense of the United States within the meaning of the espionage laws, Title 18, U.S.C., Secs. 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM Stanley R. Cochran DATE October 30, 1952

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Plenum Chamber EQ.PC.NO. 155-R

DRAWING NOS. W-130909 JOB RATING

VENDOR New York Shipbuilding Corporation LOCATION Camden, N. J.

This is a final report on inspections made on V-notch slots on top ends of all Plenum Chamber tubes. Inspections were made intermittently from Aug. 5 to Oct. 30, 1952, by duPont Inspection.

Inspection consisted of determining size and orientation of V-notch slots. Orientation was checked by use of a special gage shown on drawing no. D-112872. Size was checked by means of a functional gage shown on drawing no. D-112818.

During the course of inspection, several slots were found to be oversize and several undersize. J. G. Brewer of Design gave clearance to accept undersize slots with the provision that the functional gage would properly fit the slots. A list of slots which were oversize and beyond angular orientation tolerance was submitted to A. Arthur of Design.

This discrepancy list is as on the attached charts.

All slots listed on the attached charts were re-inspected. Results of re-inspection are shown beside the original figures which are crossed out.

[redacted]

[redacted]

FIELD INSPECTOR'S REPORT

FROM Cochran

Report Number 315-R
Page 2 of 2

With the revised discrepancy list, A. Arthur of Design extended the angular tolerance to -1° and all slots were accepted with the exception of those marked by an asterisk with the discrepancy encircled. These were reworked by New York Shipbuilding Corp. with the following results:

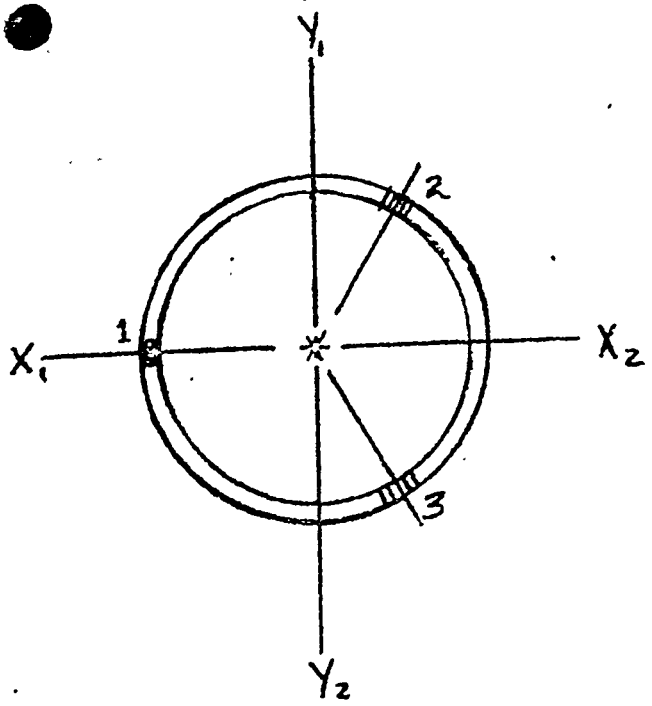
Tube X	Tube Y	Slot No.	Angle Deviation	Functional Gage Clearance "L"
13	15	1	+1°	.012
19	51	1	0°	.010
50	48	1	0°	.014
25	81	2	+1°	.018
36	36	2	+1°	.020
38	42	2	+1°	.015
15	45	1	+1°	.021

The inspection was final and job accepted.

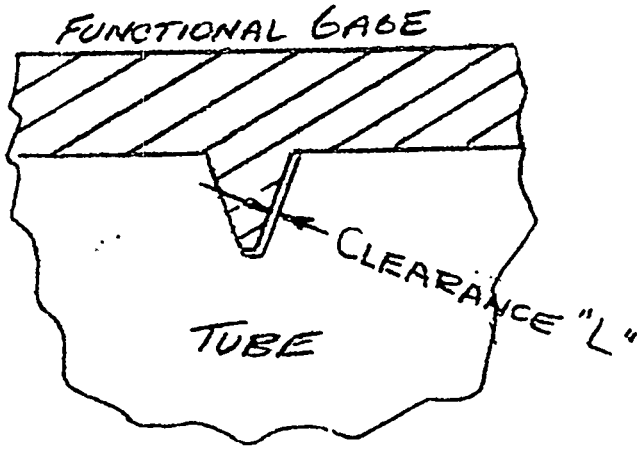
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Attach. 5

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DISCREPANCY LIST



PLAN VIEW – TUBE END



NO. 1 SLOTS OVER ANGULAR TOLERANCE OF ± 1/2°

TUBE X	TUBE Y	ANGLE DEVIATION	FUNCTIONAL GAGE CHECK	FUNCTIONAL GAGE CL. "L"
23	3	3/4°	ok	.000
31	3	1°	ok	.006
33	3	1°	ok	.012
22	6	~~+1/2°~~ 0°	ok	.020
15	9	1°	ok	.014
32	12	3/4°	ok	.018
11	15	3/4°	ok	.017
(13)	(15)	(1 1/2°)	ok	.020
32	18	1°	ok	.018
38	18	3/4°	ok	.024
[redacted]	24	1°	ok	.013
19	33	1°	ok	.018
3	39	3/4°	ok	.019
30	42	1°	ok	.014

TUBE X	TUBE Y	ANGLE DEVIATION	FUNCTIONAL GAGE CHECK	FUNCTIONAL CLEARANCE "L"
32	48	1°	ok	.006
*(50)	48	(ESTIMATE 2°)	ok	.012
*(19)	51	(ESTIMATE 3°)	ok	.014
2	54	3/4°	ok	.011
20	54	3/4°	ok	.004
13	57	1°	ok	.009
26	60	1°	ok	.020
46	60	1°	ok	.021 ~~.020~~
7	63	1°	ok	.009
41	63	1°	ok	.016
43	63	3/4°	ok	.026
49	63	1°	ok	.020
46	72	3/4°	ok	.021
42	84	3/4°	ok	.025

[redacted]

[redacted]

DISCREPANCY REPORT

[redacted]

2. NO. 1 SLOTS OVERSIZE

TUBE X	TUBE Y	ANGLE DEVIATION	FUNCTIONAL GAGE CHECK	FUNCTIONAL GAGE CL. "L"	TUBE X	TUBE Y	ANGLE DEVIATION	FUNCTIONAL GAGE CHECK	FUNCTIONAL GAGE CL. "L"
29	9	1/2°	ok	~~.024~~ .022	40	60	1/4°	ok	~~.024~~ .022
26	12	1/4°	ok	.028	42	60	1/4°	ok	.025
9	15	1/4°	ok	.029	50	60	1/2°	ok	.026
21	15	1/2°	ok	.023	52	60	1/4°	ok	~~.025~~ .023
25	15	0°	ok	.023	3	63	1/4°	ok	~~.025~~ .023
22	18	1/2°	ok	.026	43	63	3/4°	ok	.026
4	18	1/4°	ok	.024	45	63	1/2°	ok	~~.027~~ .027
8	18	~~3/4~~°	ok	.024	8	66	1/4°	ok	~~.022~~ .022
25	21	1/2°	ok	.023	33	69	0°	ok	.028
0	24	1/4°	ok	.024	35	69	1/4°	ok	~~.024~~ .026
3	27	0°	ok	.039	37	69	0°	ok	.026
5	27	.0°	ok	~~.024~~ .026	39	69	0°	ok	~~.026~~ .024
7	27	1/4°	ok	~~.024~~ .022	41	69	0°	ok	~~.025~~ .021
9	27	0°	ok	.024	10	72	0°	ok	~~.028~~ .025
13	27	1/4°	ok	.028	14	72	1/4°	ok	.024
6	36	0°	ok	~~.024~~ .022	18	72	0°	ok	~~.024~~ .022
2	36	0°	ok	.024	30	72	0°	ok	.025
16	36	1/4°	ok	.024	36	72	0°	ok	.028
2	36	1/2°	ok	.025	21	75	0°	ok	.028
24	36	0°	ok	.030	35	81	1/2°	ok	~~.025~~ .027
11	39	0°	ok	.026	37	81	1/4°	ok	~~.035~~ .030
5	45	1/2°	ok	(.039)	40	84	1/4°	ok	~~.025~~ .024
2	45	1/2°	ok	.025	42	84	3/4°	ok	.025
29	45	1/2°	ok	.024	36	54	0°	ok	~~.024~~ .022
23	45	0°	ok	~~.028~~ .026					

[redacted]

DISCREPANCY LIST

No. 2 SLOTS OVER ANGULAR TOLERANCE OF ± 1/2°

TUBE X	TUBE Y	ANGLE DEVIATION	FUNCTIONAL GAGE CHECK	FUNCTIONAL CLEARANCE "L"	TUBE X	TUBE Y	ANGLE DEVIATION	FUNCTIONAL GAGE CHECK	FUNCTIONAL CLEARANCE "L"
32	6	3/4°	ok	.014	35	33	1°	ok	.022
20	12	3/4°	ok	.010	41	33	3/4°	ok	.008
8	12	1°	ok	.010	2	36	3/4°	ok	.004
9	15	1°	ok	.010	* 36	36	1 1/2°	ok	.016
7	15	~~PLAY~~ 1/4°	ok	~~.052~~ .019	37	39	1°	ok	.016
0	24	3/4°	ok	.013	* 38	42	1 1/2°	ok	.017
7	27	1°	ok	.012	12	66	1°	ok	.012
3	27	1°	ok	.007	37	75	1°	ok	.011
3	30	1°	ok	.011	38	78	1°	ok	.016
2	30	1°	ok	.018	48	78	3/4°	ok	.009
6	0	1°	ok	.006	* 25	81	1 1/2°	ok	.040

NO. 2 SLOTS OVERSIZE

TUBE X	TUBE Y	ANGLE DEVIATION	FUNCTIONAL GAGE CHECK	FUNCTIONAL CLEARANCE "L"	TUBE X	TUBE Y	ANGLE DEVIATION	FUNCTIONAL GAGE CHECK	FUNCTIONAL CLEARANCE "L"
3	9	1 1/2°	ok	.023	18	42	1/4°	ok	.023
2	12	0°	ok	.023	37	45	1/4°	ok	.025
3	15	1/4°	ok	~~.036~~ .019	2	48	1/2°	ok	.024
5	15	1/2°	ok	~~.032~~ .020	38	48	1/2°	ok	.025
7	15	~~PLAY~~ 1/4°	ok	~~.052~~ .019	15	57	1/4°	ok	.024
3	18	1/4°	ok	~~.030~~ .027	52	60	0°	ok	.022
2	30	1/4°	ok	.023	17	63	0°	ok	.024
2	30	1/4°	ok	.024	18	66	0°	ok	.024
[redacted]	36	0°	ok	.024	40	66	0°	ok	.023
1	39	1/4°	ok	.023	19	69	1/4°	ok	~~.035~~ .025
			[redacted]		20	72	0°	ok	.027

[redacted]

DISCREPANCY LIST

(CONT'D.) NO. 2 SLOTS OVERSIZE

TUBE BASE X	TUBE BASE Y	ANGLE DEVIATION	FUNCTIONAL GAGE CHECK	FUNCTIONAL GAGE CL. "L"	TUBE X	TUBE Y	ANGLE DEVIATION	FUNCTIONAL GAGE CHECK	FUNCTIONAL GAGE CL "L"
0	72	1/2°	ok	.024	43	81	0°	ok	.026
25	81	1 1/2°	ok	.040	32	84	1/4°	ok	.025

NO. 3 SLOTS OVER ANGULAR TOLERANCE OF ± 1/2°

TUBE BASE X	TUBE BASE Y	ANGLE DEVIATION	FUNCTIONAL GAGE CHECK	FUNCTIONAL GAGE CL. "L"	TUBE X	TUBE Y	ANGLE DEVIATION	FUNCTIONAL GAGE CHECK	FUNCTIONAL GAGE CL. "L"
3	9	3/4°	ok	.018	49	51	1/2°	ok	~~.024~~ .026
1	15	3/4°	ok	.016	55	51	3/4°	ok	~~.020~~ .018
8	18	3/4°	ok	.014	47	57	3/4°	ok	.020
7	21	1°	ok	.015	45	63	3/4°	ok	~~.029~~ .014
5	33	1°	ok	.016	47	63	1°	ok	.014
8	36	1°	ok	.011	51	63	3/4°	ok	.020
1	45	3/4°	ok	.013	34	66	3/4°	ok	.018
3	45	3/4°	ok	.010	44	66	3/4°	ok	.020
2	48	1°	ok	.008	46	66	3/4°	ok	.008
5	[redacted]	1°	ok	.014	22	84	1°	ok	.016
					20	90	3/4°	ok	.018

[redacted]

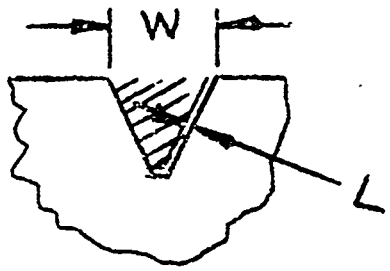
[redacted]

DISCREPANCY LIST

, NO. 3 SLOTS OVERSIZE

BE		ANGLE DEVIATION	FUNCTIONAL GAGE CHECK	FUNCTIONAL GAGE CL. "L"	TUBE		ANGLE DEVIATION	FUNCTIONAL GAGE CHECK	FUNCTIONAL GAGE CL "L"
'	Y				X	Y			
3	9	0°	ok	~~.029~~ .027	19	63	1/2°	ok	~~.025~~ .023
4	12	1/2°	ok	~~.030~~ .028	33	63	0°	ok	~~.027~~ .023
2	12	1/4°	~~ok~~	.031	45	63	3/4°	ok	~~.029~~ .014
1	15	0°	~~ok~~	.032	49	69	1/2°	ok	~~.034~~ .026
0	18	1/2°	~~ok~~	~~.024~~ .022	42	72	1/4°	ok	.028
1	39	1/4°	~~ok~~	.023	44	72	1/2°	ok	.027
3	42	1/2°	~~ok~~	.023	48	72	1/2°	ok	~~.024~~ .026
1	48	0°	ok	.023	50	72	1/2°	ok	~~.024~~ .022
0	51	1/2°	ok	~~.024~~ .026	28	78	0°	ok	~~.030~~ .025
2	7	0°	ok	.027	33	93	0°	ok	.024
4	54	1/4°	~~ok~~	.023					

LISTED BELOW IS A TABLE FOR CONVERTING FUNCTIONAL GAGE CLEARANCE "L" TO SLOT WIDTH "W" AT END OF TUBE.

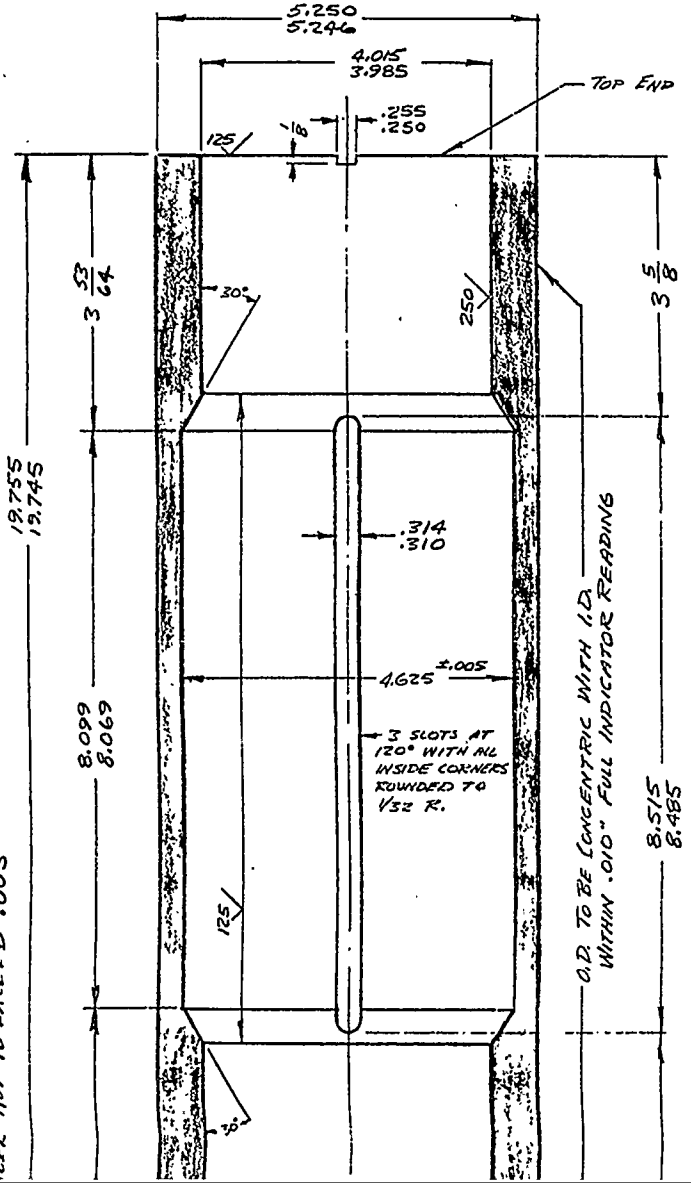


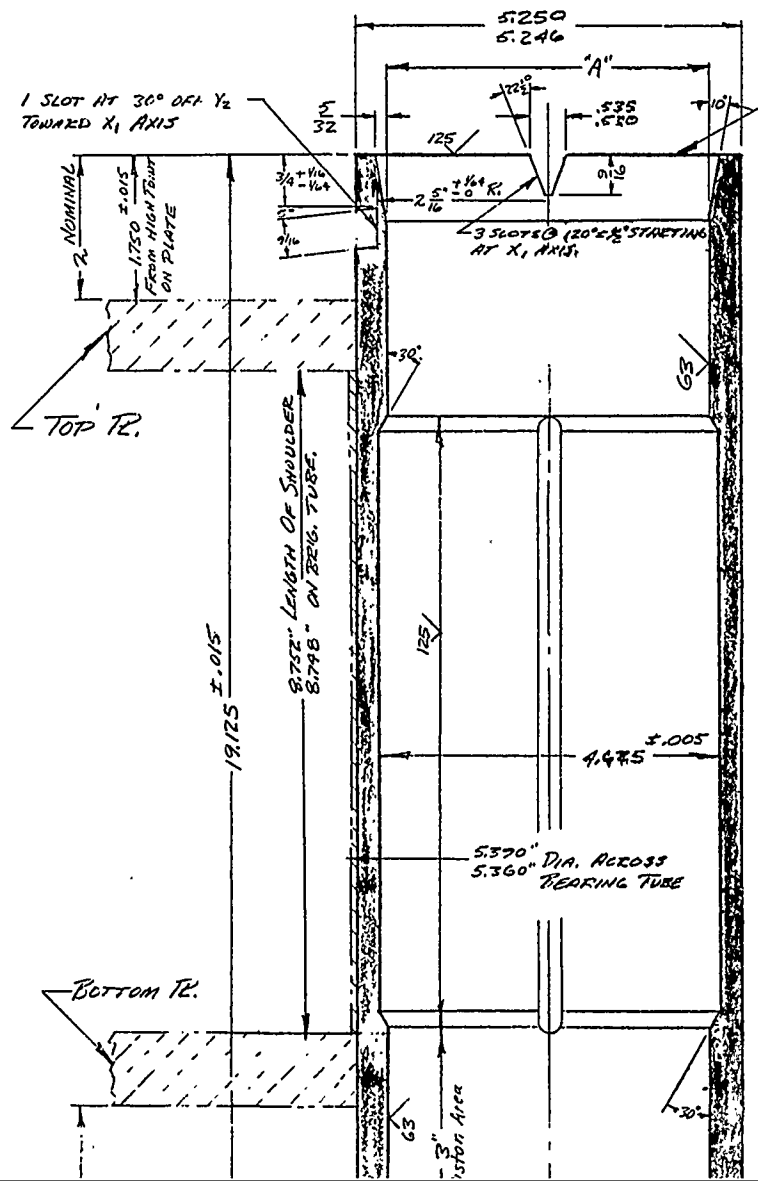
-	.000	.002	.004	.006	.008	.010	.012	.014
W	.512	.514	.516	.518	.520	.523	.525	.527
-	.018	.022	.024	.026	.028	.030		
W	.531	.536	.538	.540	.542	.544		

[redacted]

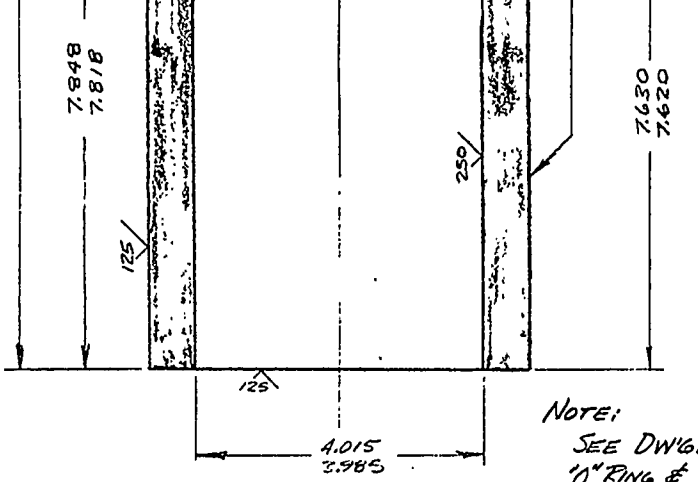
[redacted]

PLENUM CHAMBER – LARGE TUBE



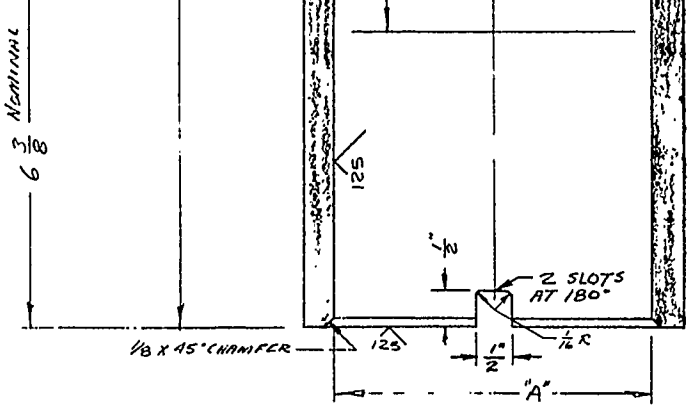


NOTES:
1. TOP ENDS OF TUBES TO BE FINISHED IN SAME PLANE WITHIN 1/32"
2. BOTTOM ENDS OF TUBES TO BE FINISHED IN SAME PLANE WITHIN .015".
3. VERTICALITY TOLERANCE OF FINISH BORED TUBE IS .005" PER FT.
4. FINAL ALIGNMENT TOLERANCE OF TUBE TO BE .015", THIS IS ALIGNMENT OF TOP BORE OF PLENUM TUBE WITH RESPECT TO MID-LENGTH BORE OF CORRESPONDING TOP TUBE SHEET TUBE.



PRE-MACHINED TUBE,
(PRIOR TO INSTALLATION).

NOTE:
SEE DW'G. 1-2 FOR LOCATION OF "O" RING & PISTON RING SEAL AREAS.



DIMENSION "A"	
BORE TO	4.375 - 4.380
HONE TO	4.385 - 4.390 WITH .002 MAX. OUT OF ROUND

FINISH MACHINED TUBE, (AFTER INSTALLATION).
TYPICAL FOR 58% NON BEARING & 91 BEARING TUBES ON "R", "P", "L", "C". 600 NON BEARING & 73 BEARING TUBES ON "K."

M & E SECTION
GOV'T CONTRACTS

DW'G. 2-1

BY: S.R. COCHRAN
MAR-53

During the course of this inspection, square slots were also checked for burrs and repairs were made by hand filing.

(3) Re-honing of Rod Tubes

At this time it was requested by the Inspection Department that New York Ship re-hone the top land of all rod tubes from 1.505" to 1.510". (The original I.D. was honed between 1.500 and 1.505" and accepted.) This request was approved by Design.) This additional honing was necessary to remove tool marks, scratches and other mechanical defects in the top land rod tube bore. See du Pont drawing W-130911 for rod tube details and specifications.

Upon completion of re-honing all rod tubes to the new bore diameter (1.505" to 1.510"), the Inspection Department checked the top land of all rod tubes for finish (RMS) and bore size. A Starrett $1\frac{1}{2}$" telescopic gage and 0-2" micrometers were used to measure the inside diameter. A profilometer was used to measure the finish (RMS), except rod tube X11-Y61 which had a deep scratch 1 5/8" below the top end of the tube. This defect was accepted per Design. See Exhibit #15 for results of the above inspections.

Next, the verticality of all rod tubes was taken with the unit in its operating position. Results of this inspection are shown in Exhibit 15-A. For use of verticality gage, see Part III, Section II-L.

(4) Final Pattern Measurements

After all machining and repair work had been completed on large tubes, final pattern measurements were taken to show the position of each tube center from the X and Y centerlines. Patterns were taken on both the top and bottom sides of the unit. All measurements were taken using ligament gages. Part II-A, Section 18 describes the manner in which ligament gages were used. Part III - Section II-C describes how the gages were calibrated and how pattern coordinates were calculated. Part II-A, Section 13-a, describes how the X and Y centerlines on the top were established. Pattern coordinates were later computed and referenced from these axes. For results of pattern measurements taken on the Top and bottom sides of the "R" plenum chamber, see Exhibit #16.

(5) Large Tube to Rod Tube Ligament Measurements

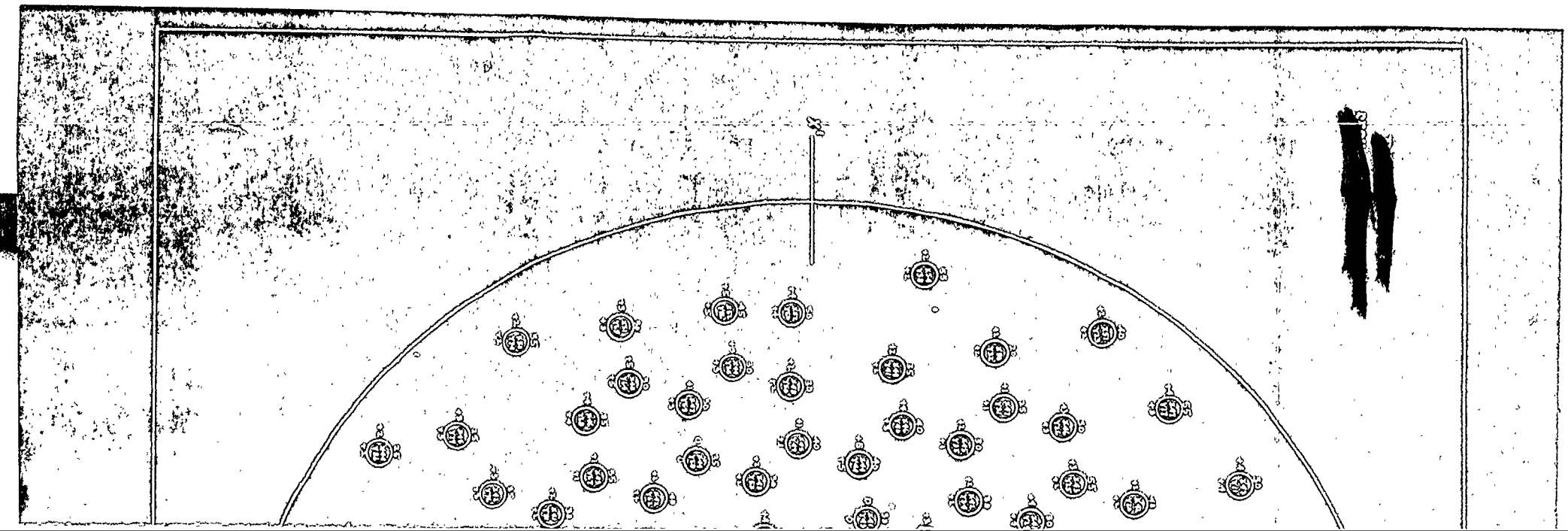
The plenum chamber "R" unit was the first sub-assembly on which these type measurements were taken. Exhibit #17 (presented herewith) indicates where the ligament measurements between large tube and rod tube were taken. For the procedure used to measure large tube to rod tube ligament distances, see Part III, Section II-B1.

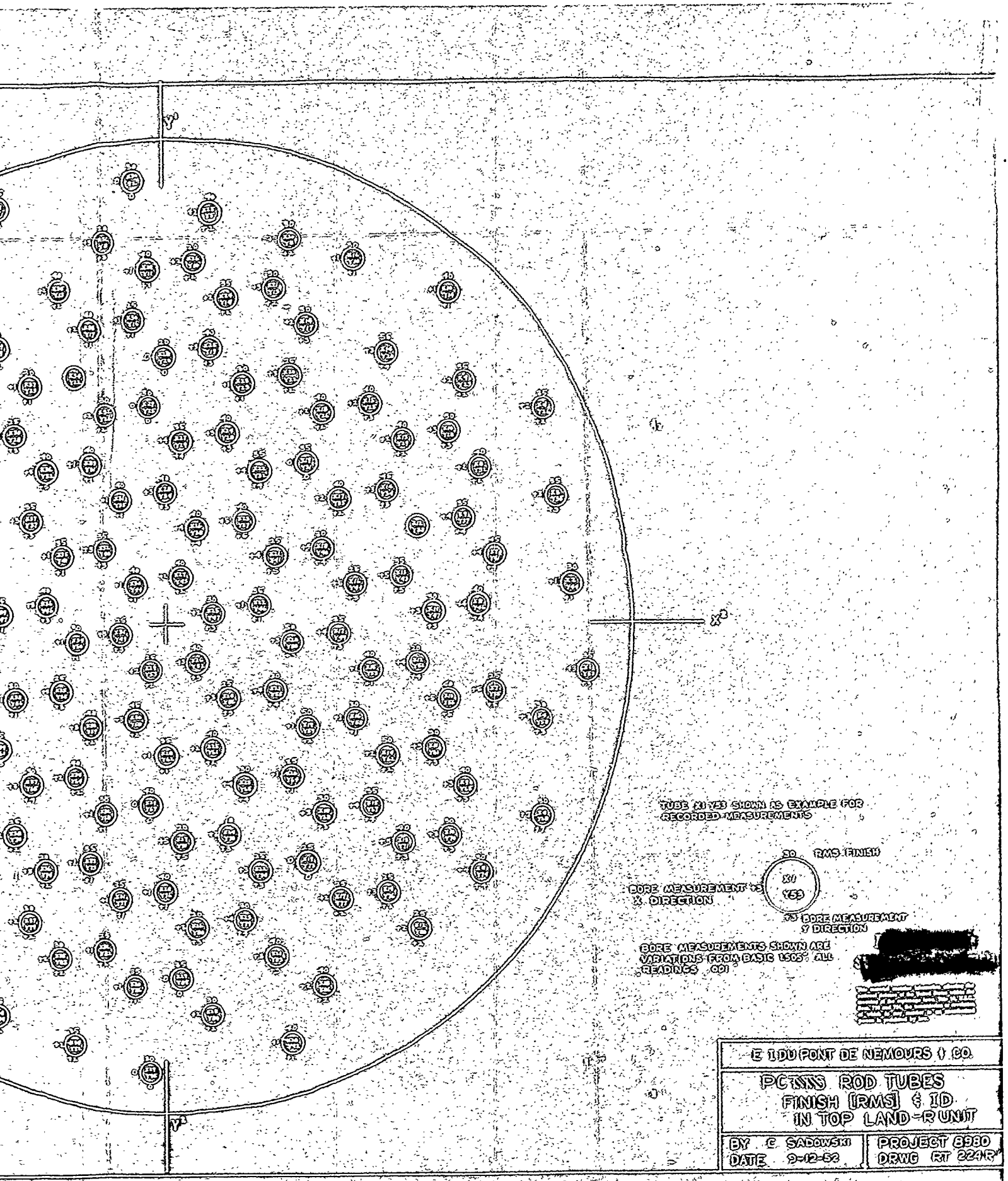
All results shown in Exhibit #17 were within the required tolerance and accepted. Du Pont drawing W-130991 states the required specificatio

EXHIBIT #15

"R" UNIT PLENUM CHAMBER ROD TUBE FINISH (RMS) AND

INSIDE DIAMETERS IN TOP LAND





TUBE #1 #23 SHOWN AS EXAMPLE FOR RECORDED MEASUREMENTS

30 RMS FINISH

BORE MEASUREMENT X DIRECTION → 31 / 63 ← 63 BORE MEASUREMENT Y DIRECTION

BORE MEASUREMENTS SHOWN ARE VARIATIONS FROM BASIC 1.505" ALL READINGS .001

[redacted]

E I DU PONT DE NEMOURS & CO.

PC[redacted] ROD TUBES
FINISH [RMS] & ID
IN TOP LAND-R UNIT

BY C SADOWSKI
DATE 9-12-62

PROJECT 8980
DRWG RT 224-R

EXHIBIT #15-A

FINAL ROD TUBE VERTICALITY

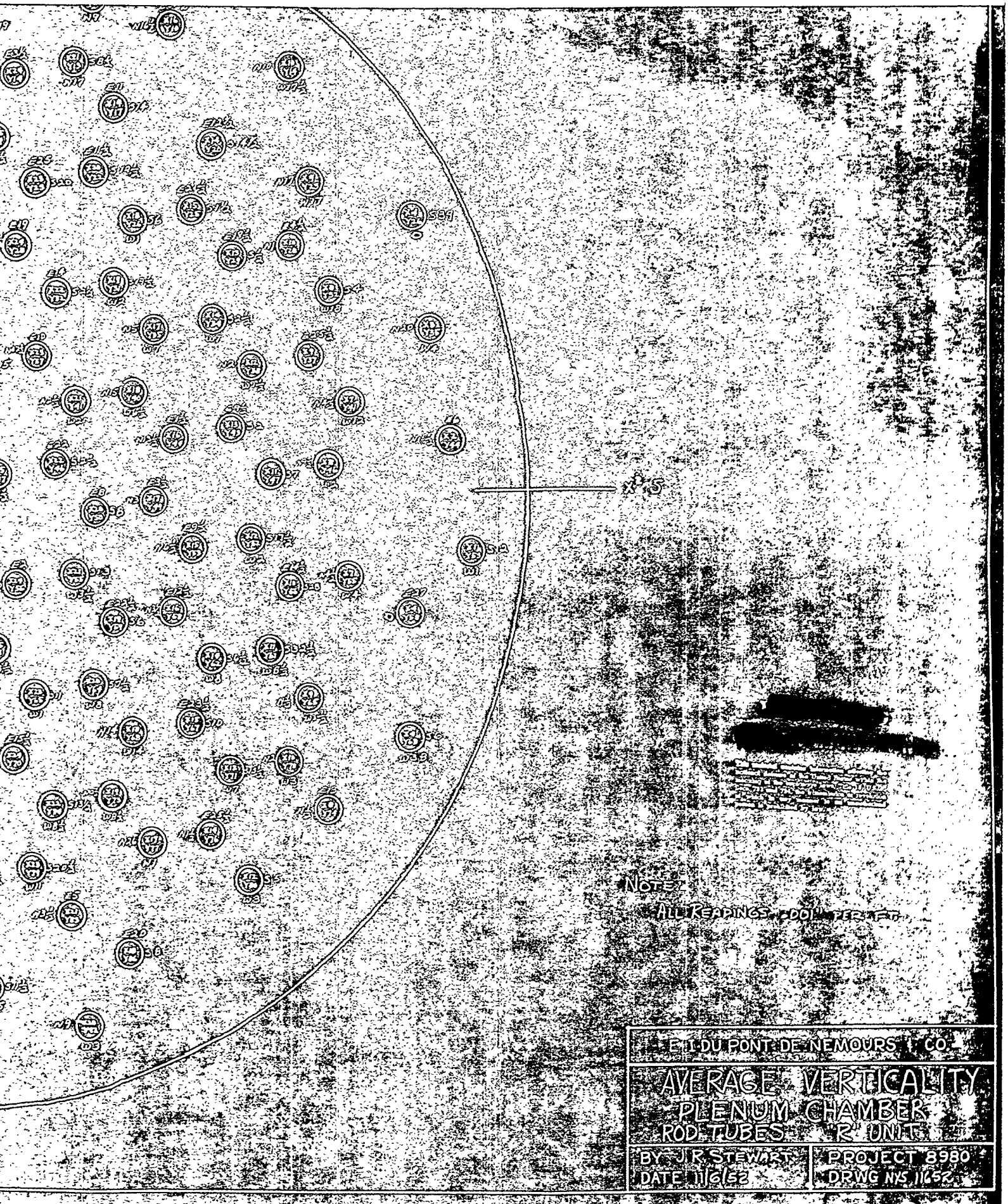
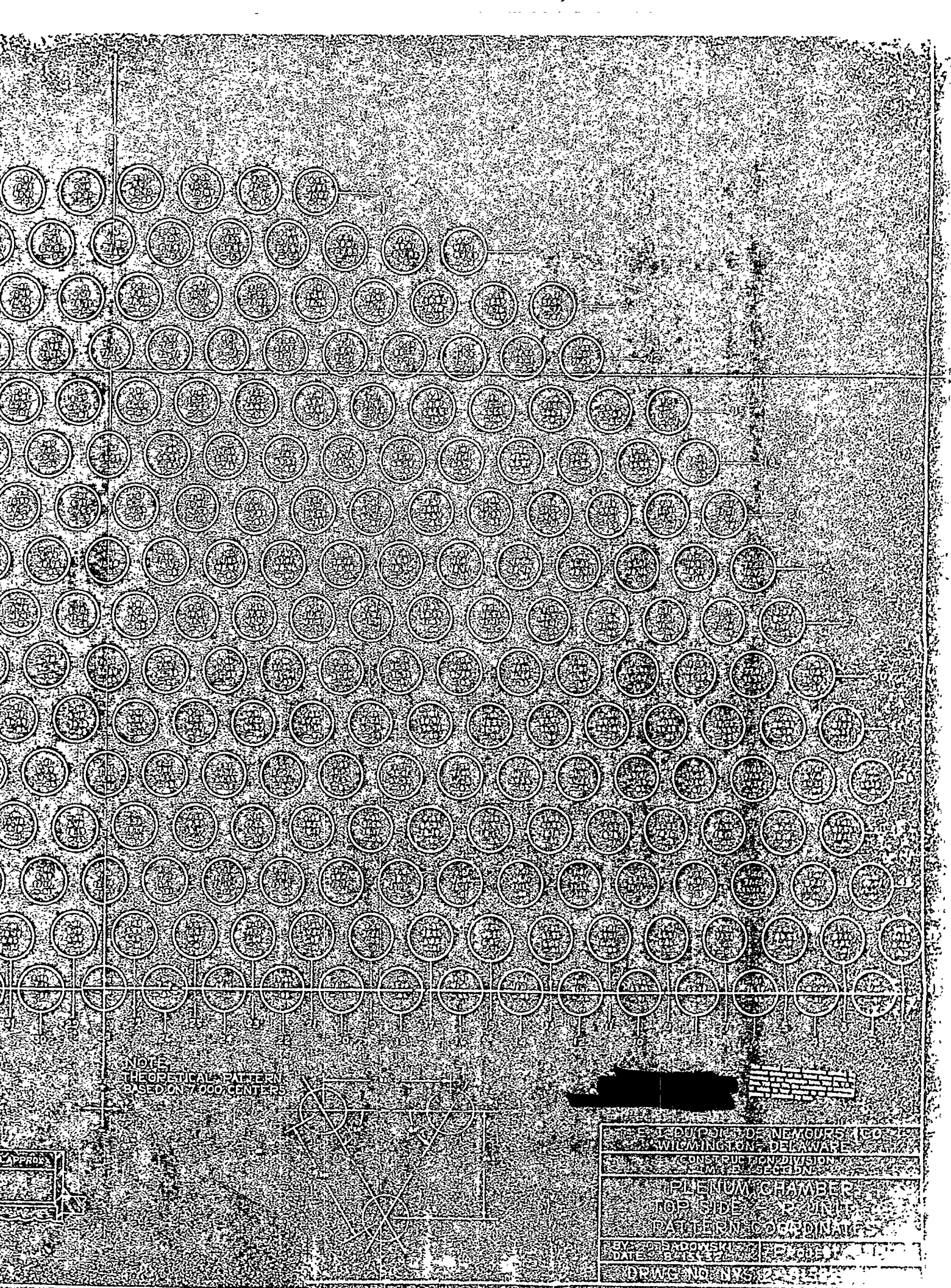

NOTE:
ALL READINGS 1.000" PERSAF.
E. I. DU PONT DE NEMOURS & CO.
AVERAGE VERTICALITY
PLENUM CHAMBER
ROD TUBES "R" UNIT
BY J.R. STEWART
DATE 11/6/52
PROJECT 8980
DRWG NYS. 11652

EXHIBIT #16

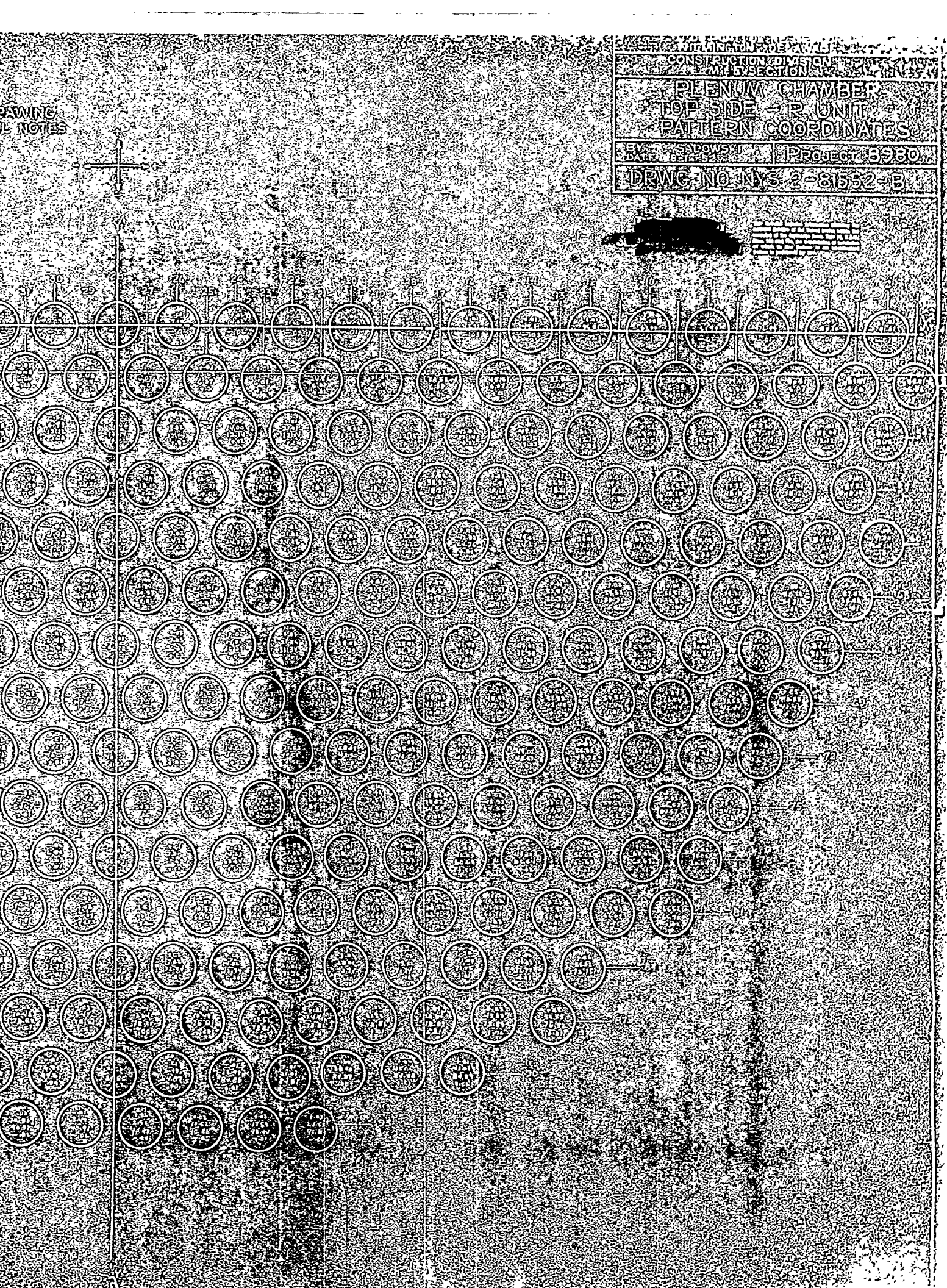
Presented herewith are drawings showing pattern coordinates for the top and bottom sides of the plenum chamber "R" unit.

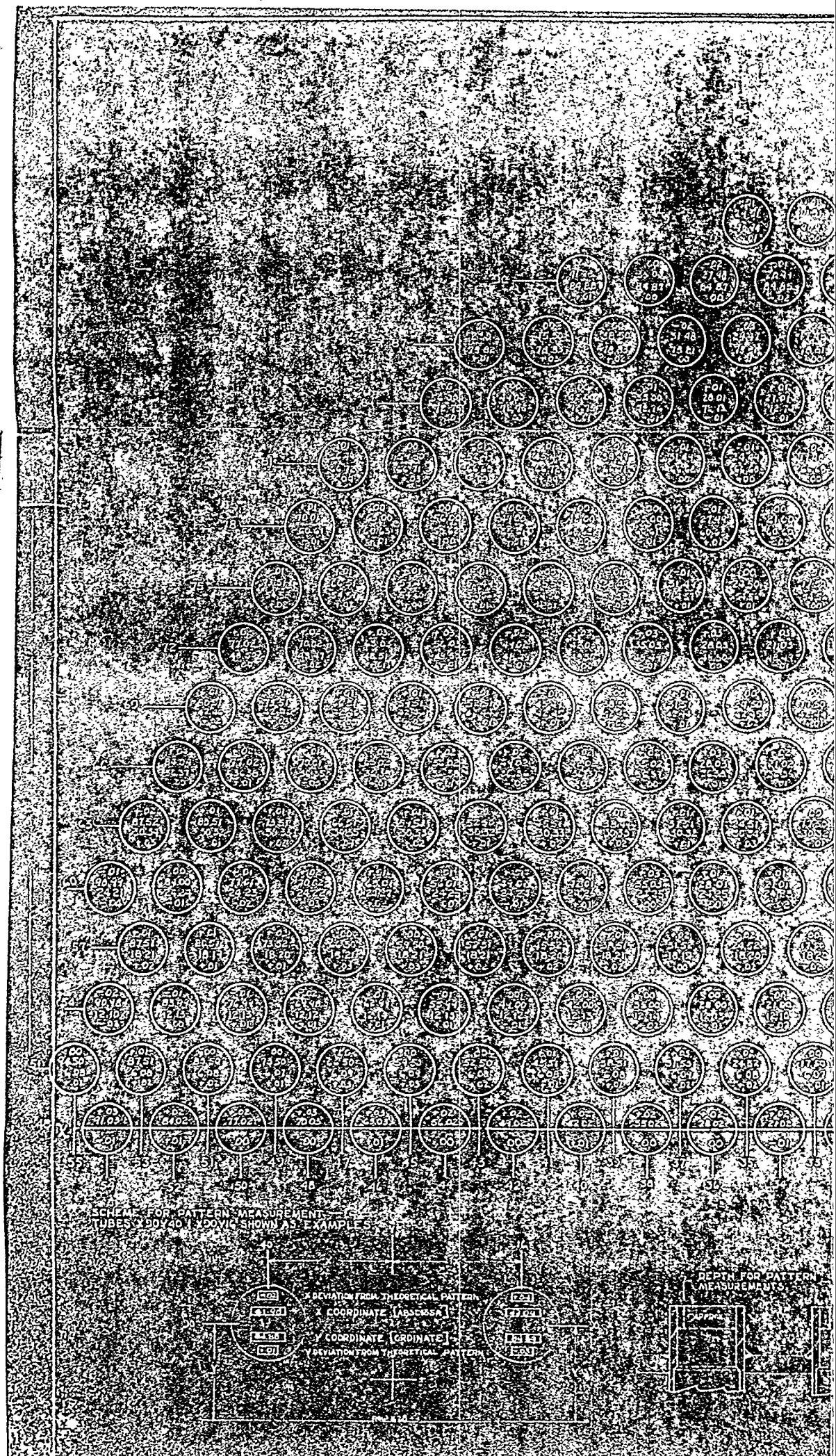
The physical measurements used for calculating the tube patterns were taken before the nozzle vane design was changed. However, check measurements before and after welding of new type nozzle vanes indicated no appreciable change in the tube locations, tube bores, or profile of the tube ends in the nozzle area; therefore, the original results of these patterns were considered reliable. For resume of inspections performed during vane removal, see Sketch 11 of this manual.

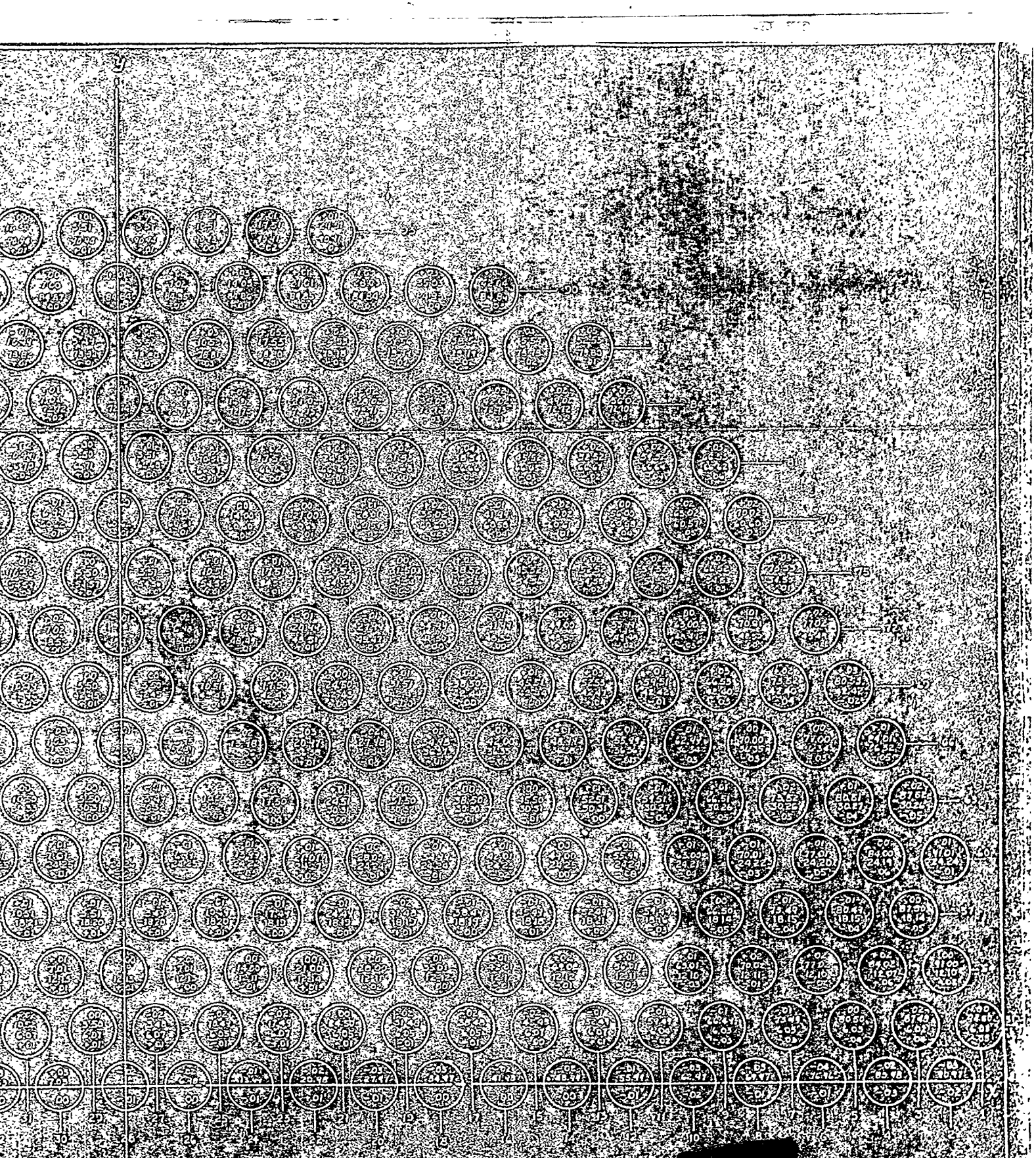
PATTERN SCHEME
TUBES X dy = Y dx
TUBES / AMPERE
X DEVIATION FROM THEORETICAL PATTERN
X COORDINATE (ABSCISSA)
Y COORDINATE
Y DEVIATION FROM THEORETICAL PATTERN
PATTERN MEASUREMENT
LOCATION


NOTE
THEORETICAL PATTERN
BASED ON 7.000 CENTERS
E. I. DU PONT DE NEMOURS & CO.
WILMINGTON, DELAWARE
CONSTRUCTION DIVISION
PLENUM CHAMBER
TOP SIDE PUNCH
PATTERN COORDINATES
BY
DATE
DRWG NO

PLEASE SEE COMPANION
NASA-CR-532-A FOR GENE


CONSTRUCTION DIVISION
PLENUM CHAMBER
TOP SIDE - R UNIT
PATTERN COORDINATES
PROJECT 8980
DRWG NO NYS 2-81552-B


SCHEME FOR PATTERN MEASUREMENTS
TUBES 20 X 40 SHOWN AS EXAMPLE
X DEVIATION FROM THEORETICAL PATTERN
X COORDINATE (ABSCISSA)
Y COORDINATE (ORDINATE)
Y DEVIATION FROM THEORETICAL PATTERN
DEPTH FOR PATTERN MEASUREMENTS



NOTE
THEORETICAL PATTERN BASED
ON 2.0 CC CENTERS

NOTE
COORDINATES AND DEVIATIONS AS LISTED ABOVE
HAVE BEEN ROUNDED OFF FROM THREE DECIMAL
PLACES, AND TOGETHER MAY NOT TOTAL THE
THEORETICAL TWO DECIMAL DISTANCE. FOR
EXAMPLE, THE THEORETICAL DISTANCE OF ROW V-4
FROM X-15 (12.124 INCHES) TUBE MEASURED DISTANCE
OF TUBE V-4 X-20 (12.10) INCHES, THEREFORE
COMPUTED DEVIATION IS .024 INCHES. TUBE V-5
PLOTTED AS 12.18 INCHES (.056 DEVIATION) .032 INCHES
AND .024 AND .032 INCHES

E I DU PONT DE NEMOURS & CO.
WILMINGTON, DELAWARE
CONSTRUCTION DIVISION
M. E. SECTION

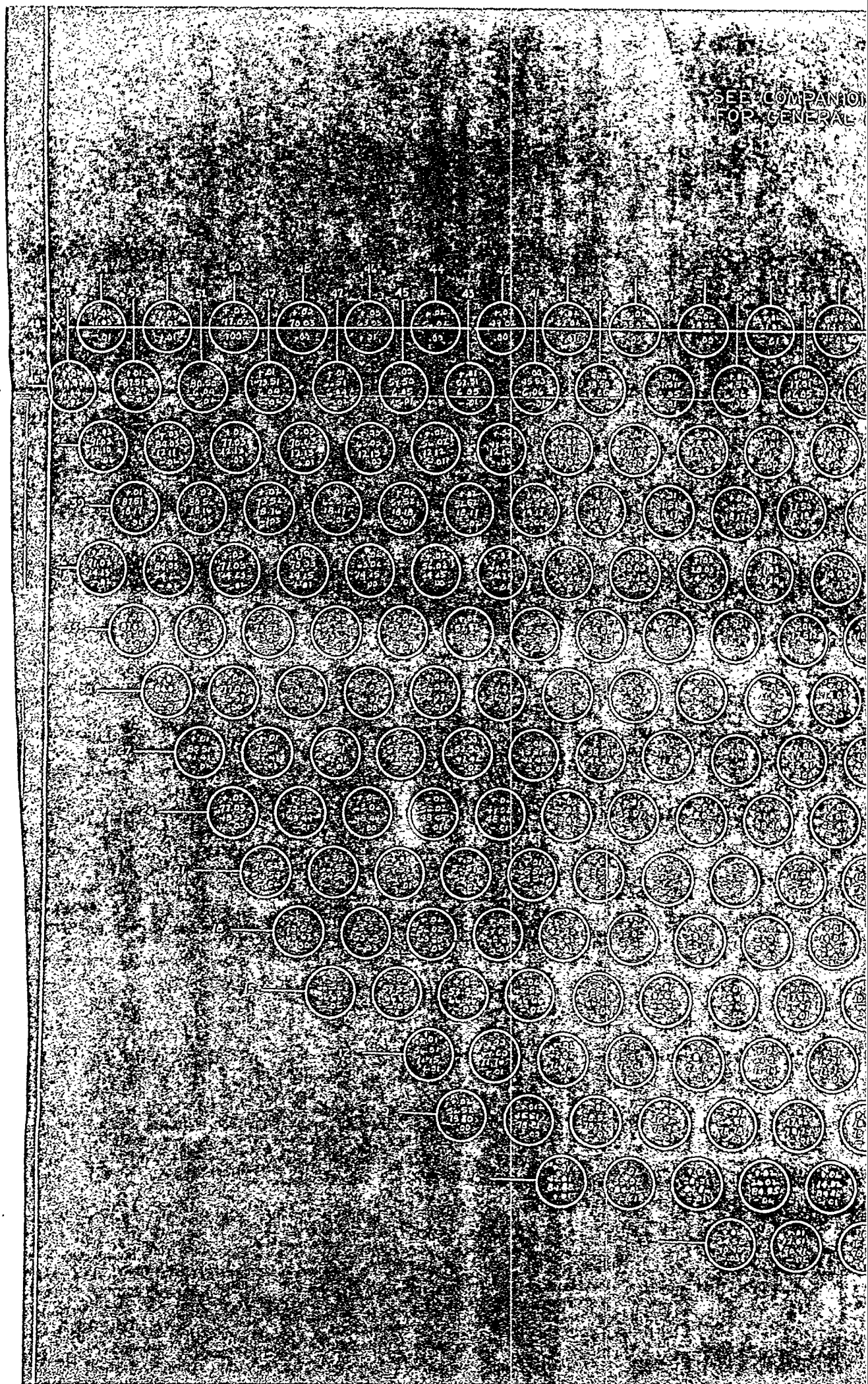
PLENUM CHAMBER
BOTTOM SIDE R UNIT
PATTERN COORDINATES

BY C. SADOWSKI
DATE 12-5-52

PROJECT 8980

EXHIBIT #17

PLENUM CHAMBER ROD TUBE LOCATIONS - TOP & BOTTOM SIDES


SEE COMPANION
FOR GENERAL

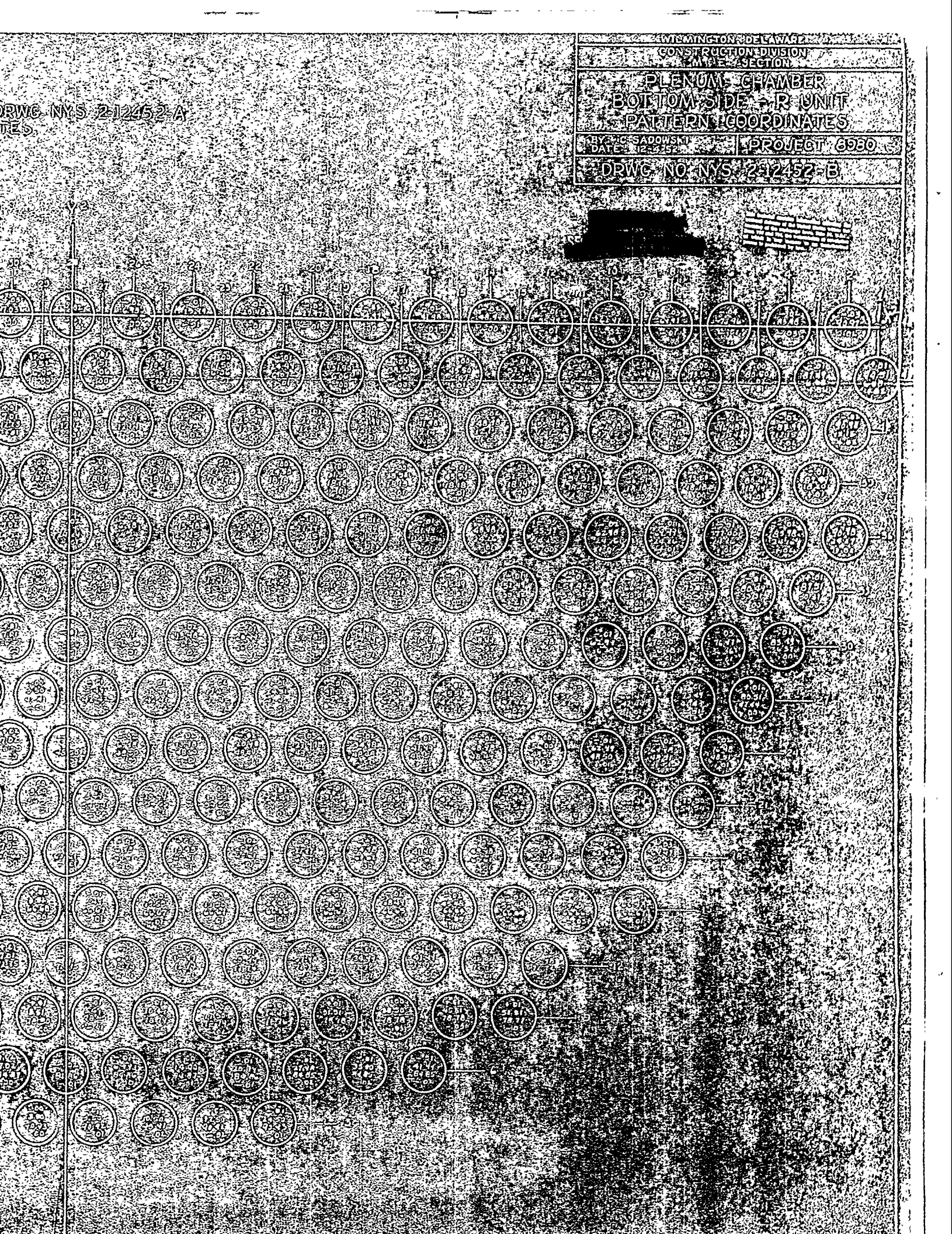
DRWG NYS 21245 2-A
TES

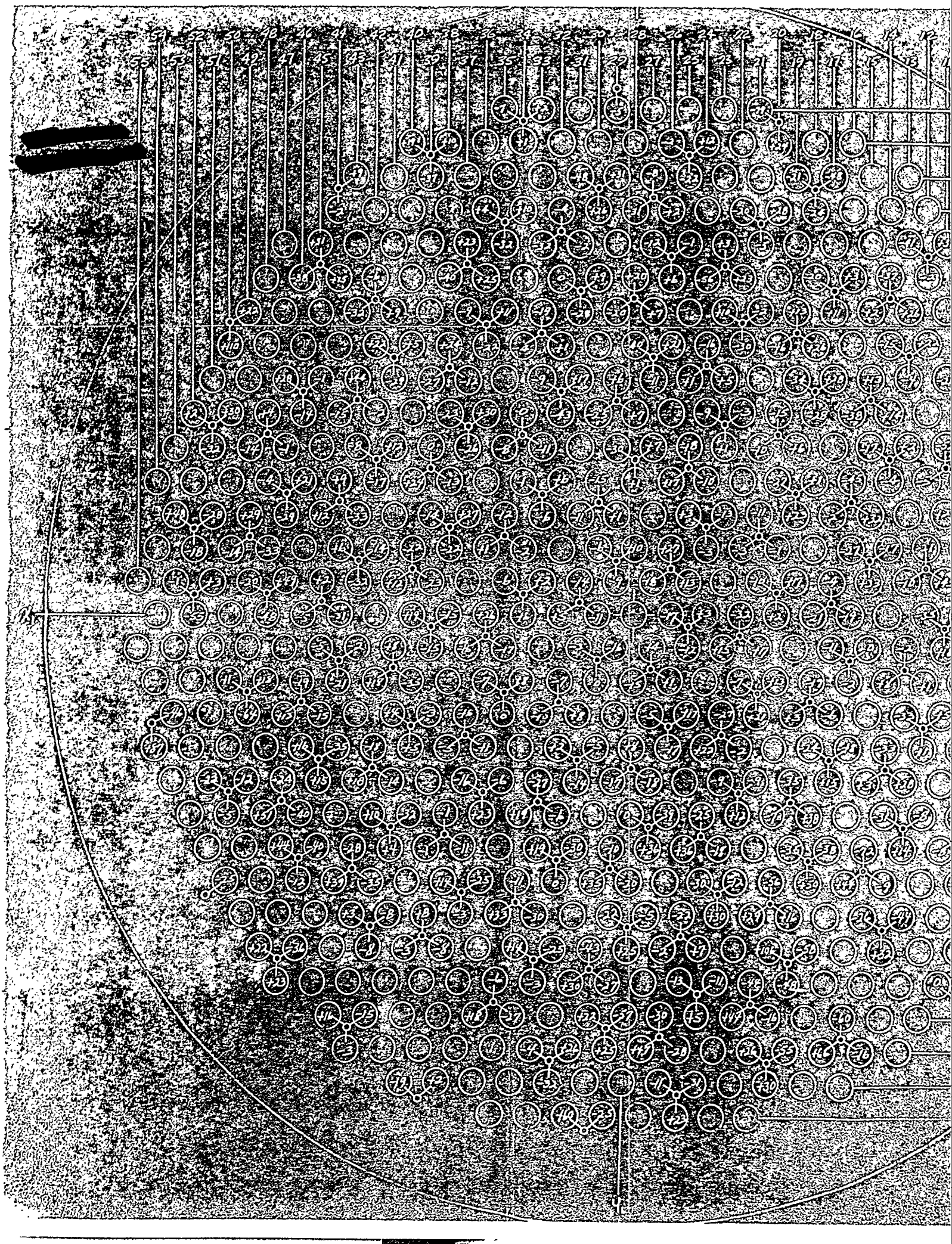
WILMINGTON, DELAWARE
CONSTRUCTION DIVISION
M. E. SECTION

PLENUM CHAMBER
BOTTOM SIDE - R UNIT
PATTERN COORDINATES

BY C. SADOWSKI | PROJECT 6530
DATE 12-7-55

DRWG. NO. NYS 2-12452-B





E. I. DU PONT DE NEMOURS & CO., INC.
WILMINGTON, DEL.
ROD TUBE LOCATIONS
PLENUM CHAMBER R-UNIT
BOTTOM SIDE
BY J. R. STEWART

(6) Plenum Template Inspection

The inspection of "R" unit template used for telescope actuator erection work at Savannah River is discussed in Part IV, section 6.

(7) Flange Facing

Using a portable horizontal boring mill, six nozzle flange faces (gasket seating area) were machined to a 125 RMS. Flange finish was checked with a profilometer after machining and found to be 125 RMS or less.

(8) Establishing Final Centerlines for Field Erection Purposes

As described in Part II-A, Section 13-a, a final set of X and Y centerlines were scribed on the NYX plenum chamber after line boring. In the case of the "R" plenum chamber, these lines were established on the top side after honing all large tubes to the required diameter. As stated before, pattern coordinates taken on the top side of the unit were later computed and referenced from the axes established on this side.

During the time that the units were being functional gaged as a final check before shipping, the X and Y axes previously established on the top side of the plenum chamber for pattern purposes were transferred to the bottom of the plenum chamber, top of the top tube sheet tubes and wrapper plates using the Wild T1 Theodolite. Part III, Section II-K describes how the Wild T1 Theodolite was used for transferring centerlines. Sketch #35 shows where the lines were transferred.

(9) Probe Pin Socket and Latch Stud Inspections

To the top side of the plenum chamber eight hundred and thirty-eight (838) probe pin sockets were welded at loactions specified on du Pont drawing W133194. Before welding sockets to the unit, they were visually and dimensionally inspected 100% and found satisfactory. For method used in gaging and dimensionally checking pre-welded probe pin sockets, see Part III, section II-C-1a. After this preliminary inspection, sockets were welded to the top side of the plenum chamber using the "Nelson" gun stud welding method.

After all probe pin sockets had been welded to the unit, the following inspections were made:

1. Location of "rod tube probe pin sockets" with respect to rod tubes. The gage used and the procedure followed during this inspection is discussed in detail in Part III, Section II-C.

2. Location of "large tube probe pin socket" with respect to large tubes. The gage used and the procedure followed during this inspection is discussed in detail in Part III, section II-C.

ENGINEERING SKETCH SHEET
E. I. DU PONT DE NEMOURS & CO.

PROJ. TITLE

SKETCH #35

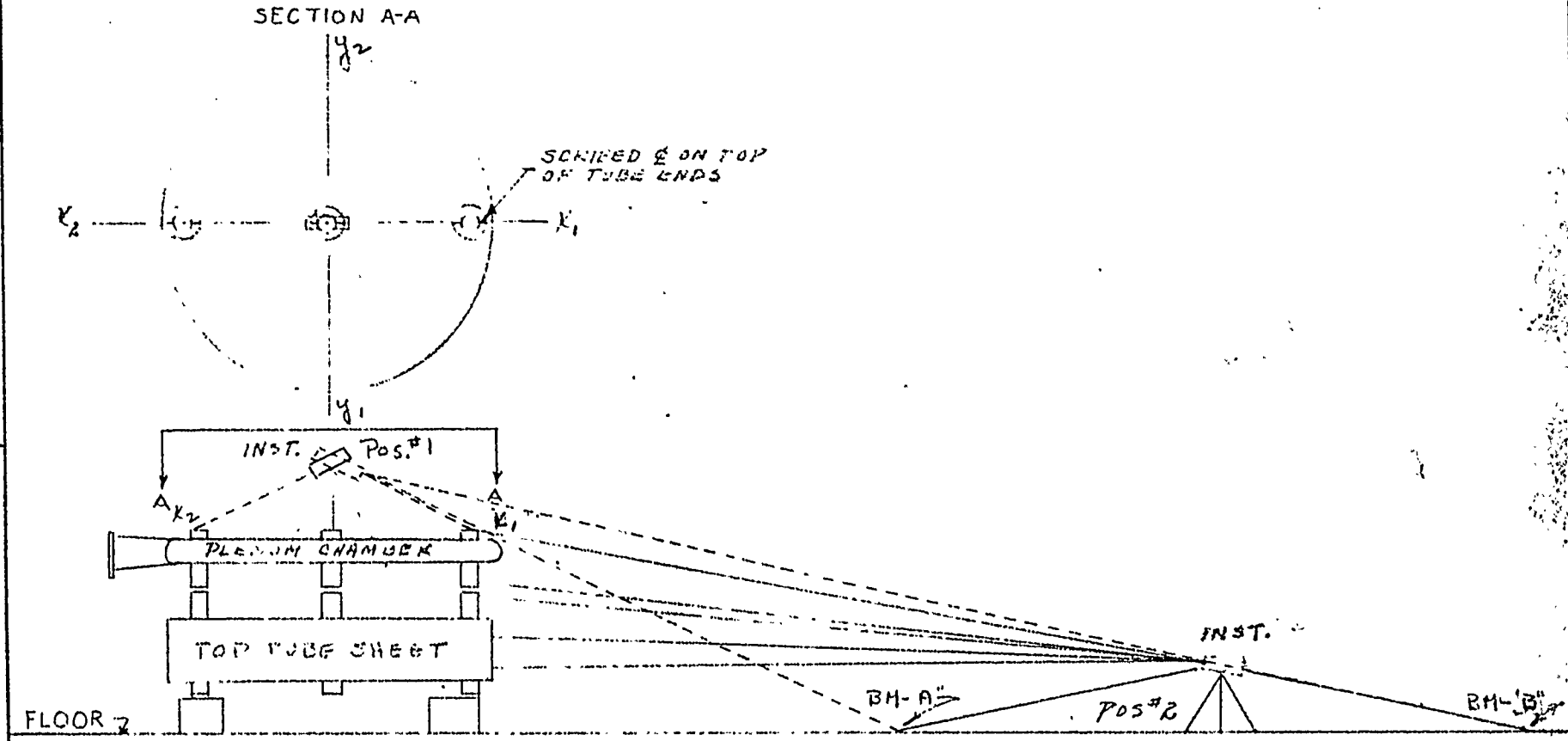
PROJ. No.

SIGNATURE:

DATE

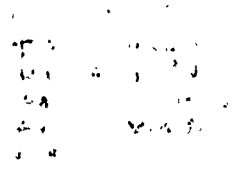
SUBJECT:

No. E-42436



PROCEDURE FOR TRANSFERRING AXES FROM TOP OF P.C. TO BOTTOM OF P.C. & TOP OF TOP TUBE SHEET

1. SET INST. ON TRIPOD IN CENTER OF P.C. (Pos.#1) WITH P.C. & T.T.S. LEVEL.
2. LEVEL INST. USING CROSS SLIDE BORE TO ADJUST LINE OF SIGHT OF TELESCOPE TO COINCIDE WITH "X" AXIS OF P.C.
3. REVOLVE INST. ON ITS VERTICAL AXIS & SIGHT ON FLOOR AT SUITABLE BENCH MARKS "A" & "B"
4. A CENTER PUNCH IS MOVED ACROSS BENCH MARK TO COINCIDE WITH TELESCOPES LINE OF SIGHT & A PUNCH MK. MADE. (A) ANOTHER BM IS USED APPROX. 40' FROM "A". THIS PROCEDURE IS REPEATED ON BOTH ENDS OF BOTH AXES.
5. INST. IS REMOVED FROM P.C. & SET UP ON FLOOR BETWEEN ANY TWO BM'S ON THE END OF AN AXIS.
6. THE LINE OF SIGHT IS AGAIN ADJUSTED TO LINE UP WITH THE BM (A & B), & THEN THE SCOPE IS SIGHTED ON P.C. & T.T.S. AT THE ENDS OF THE TUBES WHICH FALL ON THAT PARTICULAR AXIS
7. A PUNCH MARK IS MADE ON THE END OF THE TUBE & THE WHOLE PROCEDURE REPEATED AT THE ENDS OF BOTH AXES. THEN AFTER THE UNITS ARE SEPARATED, THESE PUNCH MARKS ARE CONNECTED BY A SCRIBED LINE ON THE TOPS OF ALL TUBES IN THE PATTERN WHICH FALL ON THE AXIS.



A B C D E F G H J K

3. Location of latch studs with respect to rod tubes. The gage used and the procedure followed during this inspection is discussed in detail in Part III, Section II-D.

4. Distance from the top surface of probe pin sockets (after machining to common plane) to top surface of large tubes. This distance was checked using a straight edge and 6" scale graduated in 1/64". (It will be noted on the drawing (W-133194) that this dimension is a substitution for the "effective length of probe pin socket after welding to dimension of 1 15/16" - 1/16" + .000"."

This substitution was made because of the unevenness in the top plate. The plane of the top ends of large tubes was then used as a reference for the dimensional check, since previous machining of tube ends established same in a plane.

Results of inspections indicated that all probe pin sockets and latch studs were located on the plenum chamber within the dimensional tolerances listed on drawing W-133194. Note, however, that tops of large tubes were used as reference plane, and in some cases, the dimension from the top surface of the tube plate to the top of the probe pin socket may differ from specified drawing dimension of $1\ 15/16" \pm \frac{.000"}{1/16"}$.

The above inspections were final and accepted as being satisfactory.

Next, five additional probe pin sockets were welded to the unit for the purpose of motion measurements. Du Pont drawing W-133194 shows where these "sockets" were located. Three of these sockets were located on brackets. They were checked for location and size using a 25 foot stainless steel tape and a 6-inch scale. There were no discrepancies.

(10) Dowell Cleaning (Final)

Final chemical cleaning was performed by Dowell, Inc., in an identical manner described in Section 15A-5 of this manual. The following was observed visually by the Inspection Department: "Hot detergent was forced into the assembly (under pressure) through one nozzle with the remaining nozzles sealed. (The unit was suspended over an open pit for the entire cleaning operation). One nozzle at a time was opened and the detergent was allowed to flow through this nozzle for approximately 15 minutes and then sealed up again. This procedure was repeated for each nozzle. After washing with Dowell detergent, the assembly was rinsed with distilled water. (Cold) Upon completion of this procedure, it was determined by visual inspection that the assembly was not clean, so it was decided to Dowell clean the interior again. The same procedure was followed as outlined above, except this time all nozzles were left open and the assembly tilted in order for all foreign material to be washed down and out the nozzles.

After the second Dowell chemical wash, it was visually inspected and accepted by the Inspection Department.

(11) Final Hydrostatic Test

Before the plenum chamber was shipped to the plant side, it was given a final hydrostatic test to determine the soundness of welding around 5¼" O.D. tubes, rod tubes, bulges and nozzles. This unit was prepared and tested in a similar manner described in section 13B-5 of this manual; however, the unit ("R") was not hammer tested. Tube welds, bulge and nozzle welding was visually inspected on both sides of the unit according to procedure and no leaks were found. The unit was accepted as being water tight. No other hydrostatic tests were performed on this unit prior to shipping.

(12) Final Freon Test

The plenum chamber was prepared for freon testing by sealing off all large tubes using O-ring plugs shown in photo serial number 240, section 13B-5 of this manual. Each of the six nozzle openings were closed off using temporary blind flanges and garlock gaskets. After closing up the unit, it was placed on six foot pedestals to allow access from underneath during the test. New York Ship then applied an air test and all leaking plugs and flanges were tightened until the assembly was air tight. After this eight (8) pounds of freon (by weight) was introduced into the unit and the pressure was raised to 55 psi. with air. This pressure was held for one hour before testing for leaks.

All 5¼" tube welding, rod tube, nozzle and bulge welding was tested for leaks using a General Electric Type "H" Halide Detector set on medium sensitivity. Photo serial number 240 mentioned above illustrates the use of the "detector". Leaks were detected in welds between bottom tube sheet plate and the following two tubes: X52-Y48 and X39-Y81. These two welds were chipped out and then the defective area was re-welded.

Again, the unit was subjected to another freon test performed in the manner discussed above. No leaks were detected in this final test and the unit was accepted.

(13) Photographing of Plenum Large Tube Pattern

Twelve photographs of the top side of the plenum were taken after the plenum had been Dowell cleaned and just prior to shipment. The photographs were taken with a semi-fixed focus camera equipped with a special aerotar lens designed to eliminate rectilineal distortion. The purpose of the photographs is to obtain a permanent record of the pattern on the top side of the plenum.

The camera was mounted on a special wooden stand approximately six feet in height and with a seven foot square base. The lens, while the camera was mounted, fell in the center of the top of the stand, and a vertical projection falls in the center of the 7' square base.

After leveling the plenum chamber using the Wild N111 precision level, the camera was then centered by means of a plumbob attached to

the lens over the necessary tube. The twelve points over which to center was specified in the report of F.F. White of the Engineering Research Laboratory, copies of which are available in the du Pont Inspection Office at New York Ship. General Electric 110 volt spot and flood lamps were inserted in the sockets on the camera stand. The illumination for eveness was checked by viewing the lighted tubes through combined red and green filters.

The camera was focused by placing a focusing card beneath the lens on the tubes and testing for sharpness of image on a blank plate. An eye piece was inserted in the back of the camera and when scratches on the plate, together with the focusing card image, were sharp the camera was in focus.

A six foot scale was then placed on the top of the tubes taking care not to cover those areas necessary for measurement. This scale was later used to compute the relative size of the photograph in relation to the actual size of the tubes.

Next, a photographic plate holder was inserted in the back of the camera with sensitized Kodalithic plates and the slides removed. The lens was set at a stop between 11 and 16. The vacuum pump was connected to the outlet on the camera housing. The pump (turned on) should register twenty pounds pressure.

The shutter was held open for approximately 8-10 seconds. In the past, 3 photographs were taken at each setting. Then the stand was moved to the next area and the procedure repeated. It was estimated that five hours was needed to take a complete pattern on the top side of a plenum chamber.

The plates when developed (Kodalithic fine line developer must be used) were measured under a toolmakers microscope and multiplied by a scale factor which must be computed for each plate.

(14) Re-grinding of All Tube Welding Prior to Shipping

Before shipping "R" plenum chamber, the 1" tube weld overlay on all large tubes was ground smooth and also rollovers due to lack of fusion. In addition to this, the weld rollover where rod tube and large tube weld joined were ground smooth. Some chipping was done on the tube welding and repairs made; however, these were few since all final hydrostatic and freon tests had been performed on the unit. This additional tube weld grinding came about as a result of preliminary hydrostatic and freon tests on "P" plenum chamber which was currently under fabrication at New York Ship. Inspection during these tests revealed that tube weld leakage occurred most frequestly at (1) large tube 1" weld overlay, (2) weld rollover where rod tube weld and large tube weld joined (3) rollovers on large tube welds due to lack of fusion. In view of these findings, it was thought that some improvement in tube welding would result by regrinding to remove the above listed conditions. However, since the shipping date was only a few days in advance when these conditions were discovered, the ultimate in tube welding repair could not be accomplished.

(15) Final Cleanliness Inspection

A final cleanliness inspection was performed on the interior of the plenum chamber just prior to shipping. The interior was inspected visually for foreign material by looking through all plenum tube weir slots. (The six nozzles were blanked off and ready for shipping, and therefore, inspection through these could not be done.) As a result of this final inspection, many small metal chips and one chisel were found on the interior. These were removed by New York Ship. After this it was visually inspected again and found satisfactory.

Next, the exterior was visually inspected for cleanliness. This inspection revealed that dirt, oil, and other substances were present on the exterior of the unit. At the Inspection Department's request, New York Ship steam cleaned both top and bottom sides of the unit in an effort to remove the contaminating material. After cleaning another visual inspection revealed a thin oily film had settled on the unit, apparently from the shop's atmosphere. This oil film was removed by swabbing the unit with F.O. 128 and wiping until clean. Again, the unit was visually inspected externally and internally as before and found satisfactory for shipping to the plant site.

The "R" plenum chamber was shipped by tug boat and barge from New York Ship on November 1, 1952, to the Savannah River Plant located in the sate of South Carolina.

B. "P" Unit

(1) Tube Weld Inspection

After all measurements had been taken on the line boring operation by the Inspection Department, the plenum chamber was removed from the boring and placed on low pedestals with the bottom side up. In this position, all tube welding and surface plate area were cleaned with F.O. 128 by New York Ship.

After cleaning the bottom side, all large and rod tube welds were visually inspected for rollovers, pin holes, cracks and other mechanical defects according to the rigid inspection procedure outlined in Section 6A-2f of this manual. Minor repairs were made and then they were re-inspected and accepted.

Next, the unit was turned top side up; cleaned with F. O. 128; welds inspected; repairs made; re-inspected and accepted. This work and inspection was performed in a similar manner as described above.

(2) Large Tube Honing

The plenum chamber was set up on four cast iron pedestals as shown in photo serial #220 in Part II. After this, honing of all large tube bores (top land only) was started. Tube bores were honed using a portable Sunnen hone attachment and rig. (See photo serial #220 in Part II; also see photo serial #60 in Section 14 of this manual). The top land was honed from 4.385" to 4.390". In some

cases, this tolerance was exceeded in an effort to remove scratches, gouges, tool marks, and other mechanical defects present in the top land; however, when honing of bore diameter exceeded the top limit of 4.390", it was reported to Design. In all cases, the reported oversize bores were acceptable.

The inspections made by the Inspection Department concurrent with the honing operation on the top side consisted of the following:

1. Using a standard dial indicator bore gage and ring gage, all tube bores were measured in the X and Y direction. This measurement was taken at a depth of 1 23/64" to 1 55/64" which was the O-ring seating area. Dwg. 1-2 (presented herewith) shows the location of the O-ring seating area in the top land referencing from the top end of the tube.

2. A profilometer was used to check the finish (RMS) in an axial direction of all large tube bores (top and bottom lands). Also, the finish was checked by "feel" using the hand. In all cases, finishes were less than the required 63 RMS.

3. Finally, a visual inspection using a portable lamp rig was made on the bores for the purpose of finding and removing all scratches, "steps", tool marks, and other mechanical defects, particularly in the O-ring seating area and piston ring seating area when inspecting the bottom land. Location of these areas is shown in Dwg. 1-2.

After honing large tubes on the top side, the unit was turned bottom side up. The bottom land (bore) was honed to the same diameter as the top land (4.385" to 4.390" I.D.). The same inspections discussed above were performed on the bottom side concurrent with the honing operation. Results were satisfactory and the top and bottom land bores were accepted subject to further inspection at a later date.

(3) Flange Facing

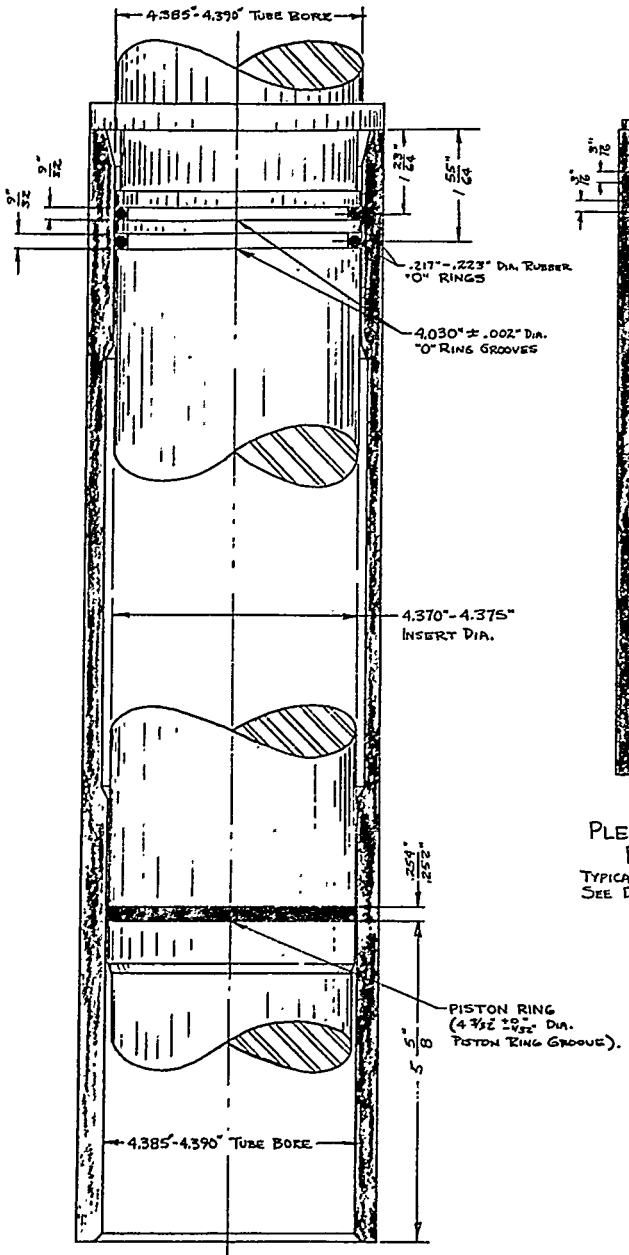
Concurrent with the tube honing operation, a portable horizontal mill was set-up for facing the nozzle flanges. For view of this machining operation, see photo serial #220 in the preceding section.

After each nozzle flange (total of 6) was machined, the finish was checked using a profilometer. In all cases, the finish was found to be 125 RMS or better as specified on du Pont drawing M-131156 and accepted.

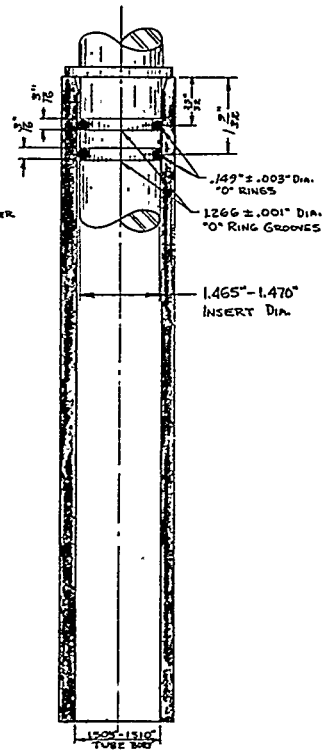
(4) Large Tube Repair as a Result of Honing

During the final inspection of large tube bore diameter, it was discovered that four tubes had been honed beyond tolerance in the top land. To bring the top land within acceptable tolerances, New

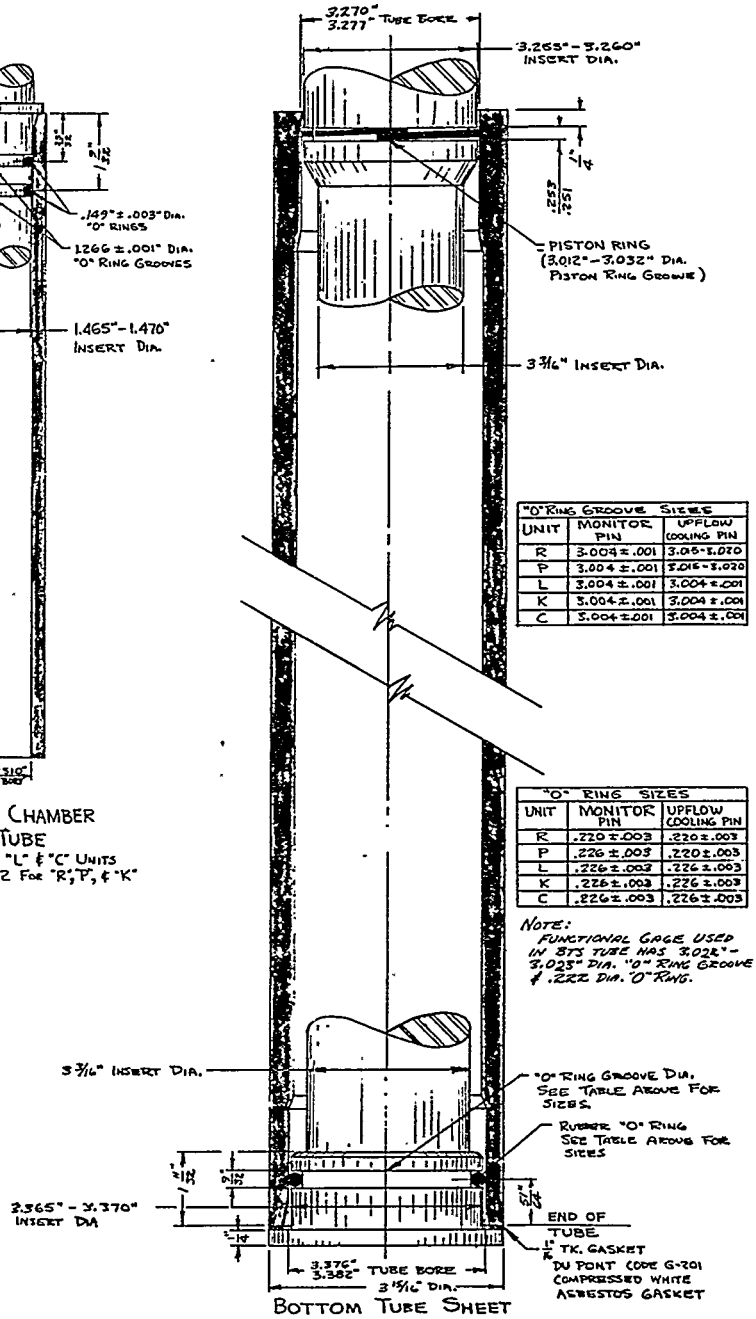
TUBE SEALING AREAS – P.C. & B.T.S.



PLENUM CHAMBER – LARGE TUBE
SEE DW'G 2-1



PLENUM CHAMBER
ROD TUBE
TYPICAL FOR "L" & "C" UNITS
SEE DW'G 2-2 FOR "R", "P", & "K"



"O" RING GROOVE SIZES		
UNIT	MONITOR PIN	UPFLOW COOLING PIN
R	3.004 ± .001	3.015-3.020
P	3.004 ± .001	3.015-3.020
L	3.004 ± .001	3.004 ± .001
K	3.004 ± .001	3.004 ± .001
C	3.004 ± .001	3.004 ± .001

"O" RING SIZES		
UNIT	MONITOR PIN	UPFLOW COOLING PIN
R	.220 ± .003	.220 ± .003
P	.226 ± .003	.220 ± .003
L	.226 ± .003	.226 ± .003
K	.226 ± .003	.226 ± .003
C	.226 ± .003	.226 ± .003

NOTE:
FUNCTIONAL GAGE USED IN BTS TUBE HAS 3.028"-3.025" DIA. "O" RING GROOVE & .222 DIA. "O" RING.

BOTTOM TUBE SHEET
LARGE TUBE
SEE DW'G 2-4

NOTE:
1. 63 RMS FINISH REQUIRED ON "O" RING & PISTON RING SEALS.

M & E SECTION
GOV'T CONTRACTS

DW'G. 1-2

[redacted]
BY: S.K. COCHRAN
JUNE 1953

York Ship "heli-arc shrunk" by depositing successive beads of weld metal on the O.D. of the tube. Numerous passes were made until the top land had shrunk enough to be re-honed. Two of these tube numbers and results of shrink welding were as follows: (No record of the other two can be found; however, these were inspected and found satisfactory after repairing as verified by entry in Inspection Department's Log Book.) Tube number X51-Y69 - bore diameter in X and Y direction at top was 4.392"; diameter (X & Y) 1-3/4" from top end was 4.393"; diameter of bottom of top land was 4.395 - 4.396". Tube number X52-Y36 - bore diameter in X and Y direction at top was 4.391" to 4.392"; diameter (X & Y) 1-3/4" from top end was 4.393"; diameter at bottom of top land was 4.397 - 4.398". Although the bore diameters in both cases exceeded the requirements, they were accepted "as-is" by the Inspection Department with Design's permission.

(5) Final Pattern Measurements

Pattern measurements were taken on the top and bottom sides of this unit in an identical manner described in section 15A-4 of this manual. For results of pattern measurements, see Exhibit #18.

(6) Sandblasting and Acid Washing

To prepare the unit for sandblasting and acid washing, the tube ends and nozzle flanges were blanked off in an identical manner described in Section 13B-5 of this manual.

After closing off all openings in the plenum chamber, it was placed on a railroad flatcar with the top side up and moved to the outside of Building 3. The top side was sandblasted throughly; then, the unit was pulled into Building 3 and turned bottom side up on the flatcar. The same procedure discussed above for the top side was followed for sandblasting the bottom side.

After sandblasting each side, the unit was visually inspected to determine if all areas had been "blasted" satisfactory. The unit was accepted and released for acid washing.

The top and bottom sides, including the plenum hood, nozzles, bulges, etc., were acid washed in an identical manner described in Section 13C-5 of this manual. Ferroxyl testing after cleaning proved satisfactory and the unit was accepted.

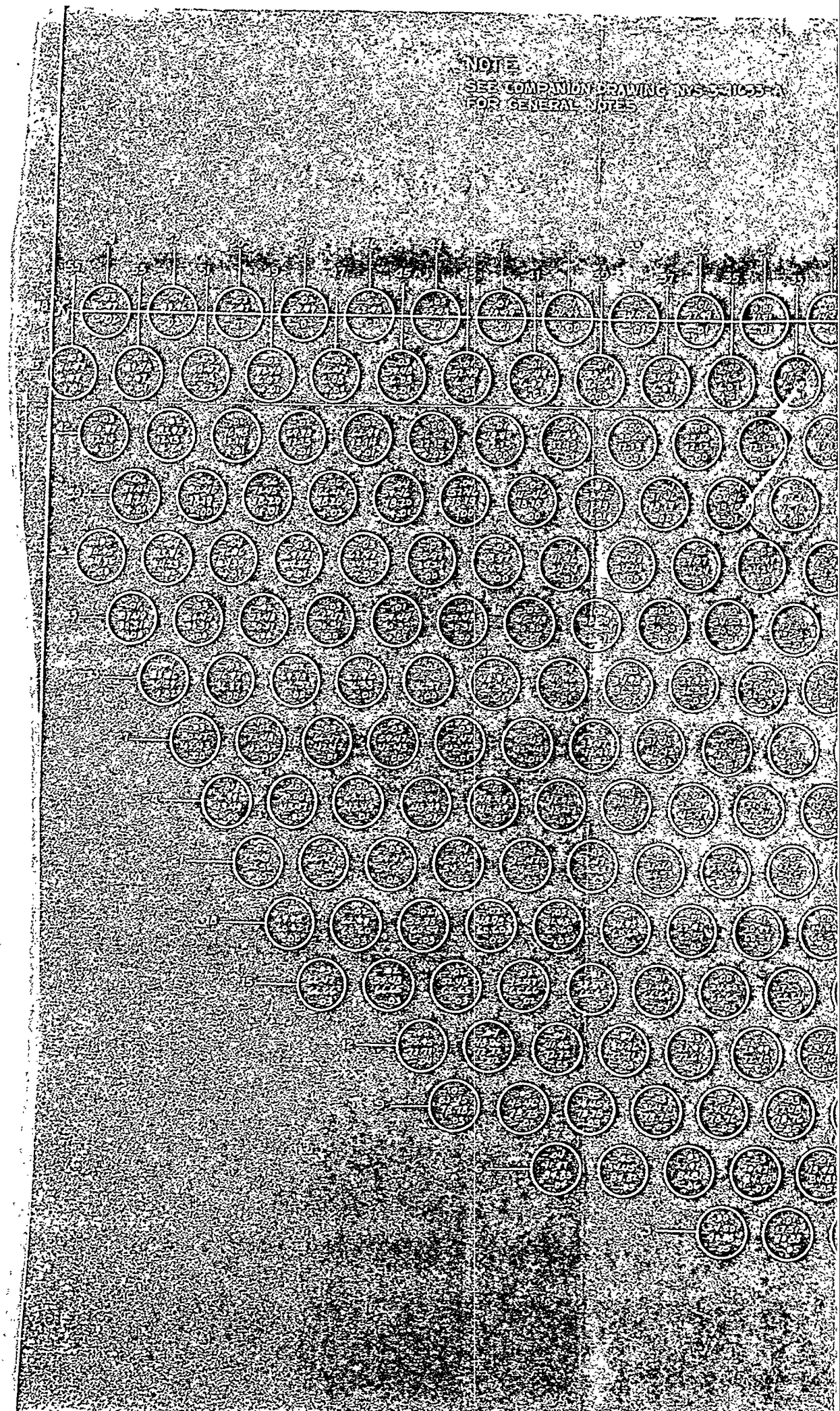
(7) Functional Gaging (After Honing)

The top tube sheet assembly ("P") was set up on cast iron pedestals approximately six feet off the shop floor and leveled. The unit was leveled using the Wild N111 Level and target. For use of instrument for leveling sub-assemblies, see Part III, Section II-J. Next, the plenum chamber was positioned on the top tube sheet in an operating position.

EXHIBIT #18

RESULTS OF PATTERN COORDINATES TAKEN ON TOP AND

BOTTOM PLATES OF "P" PLUTON CHAMBER

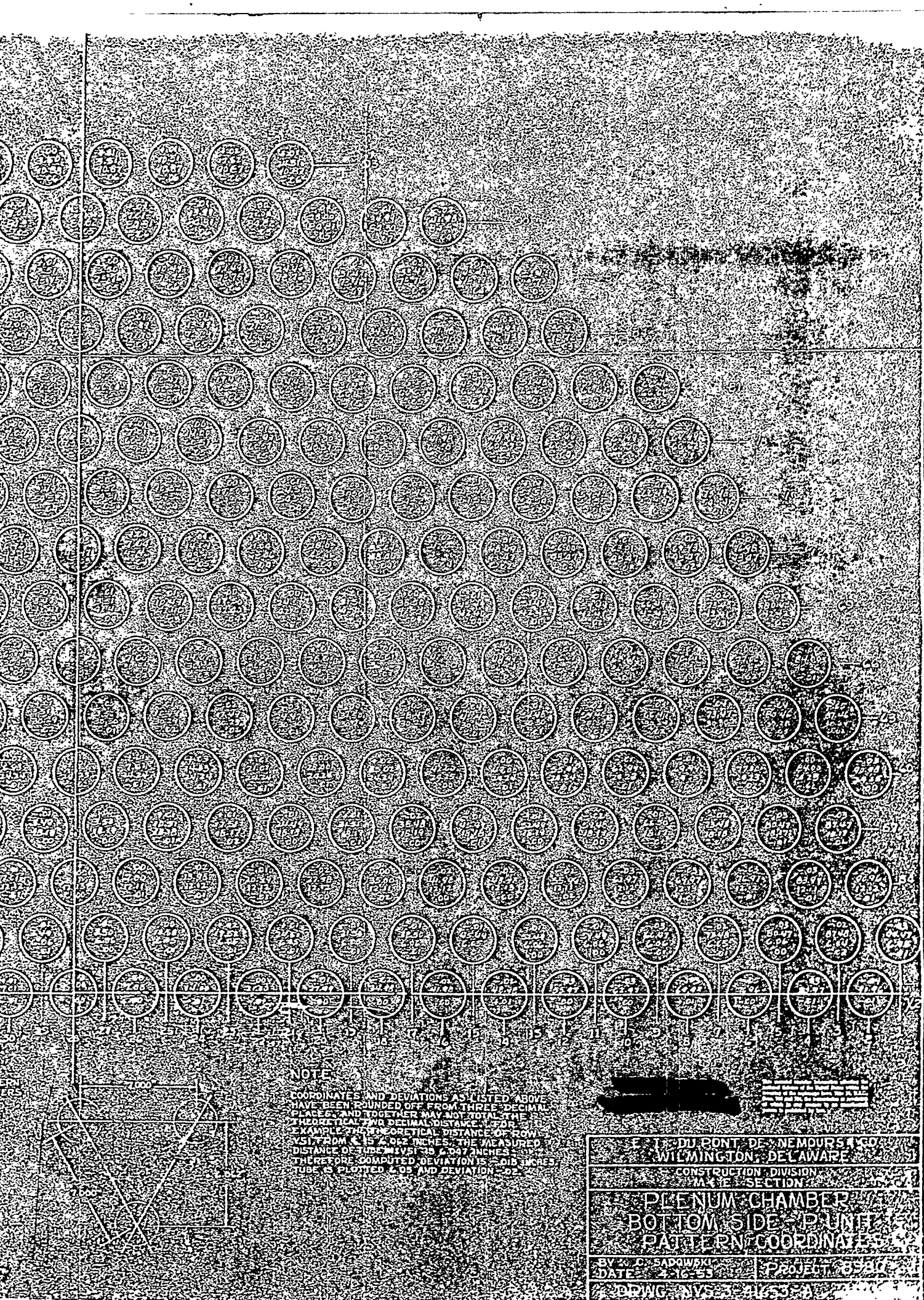

NOTE
SEE COMPANION DRAWING NYS-2-II.0-SF-1
FOR GENERAL NOTES

PLENUM CHAMBER
BOTTOM SIDE - P UNIT
PATTERN COORDINATES

BY: R.S. POWELL
DATE: 7-21-53

PROJECT 39-B

DRWG NO. NYS 3-41655-B



NOTE

COORDINATES AND DEVIATIONS AS LISTED ABOVE HAVE BEEN ROUNDED OFF FROM THREE DECIMAL PLACES AND TOGETHER MAY NOT TOTAL THE THEORETICAL 2 IN. DECIMAL DISTANCE. FOR EXAMPLE, THE THEORETICAL DISTANCE OF ROW V51 FROM ROW V15 IS 4.042 INCHES. THE MEASURED DISTANCE OF TUBE V51 IS 3.945 INCHES. THEREFORE COMPUTED DEVIATION IS -.018 INCHES. TUBE V51 IS PLOTTED -.95 AND DEVIATION -.02.

E. I. DU PONT DE NEMOURS & CO.
WILMINGTON, DELAWARE

CONSTRUCTION DIVISION
ENGINEERING SECTION

PLENUM CHAMBER
BOTTOM SIDE PLATE
PATTERN COORDINATES

BY C. SADOWSKI
DATE 2-6-55

PROJECT 8514

DRWG. NO. V51-6-3

SEE COMPANION DRWG NVS 8500-A
FOR GENERAL NOTES

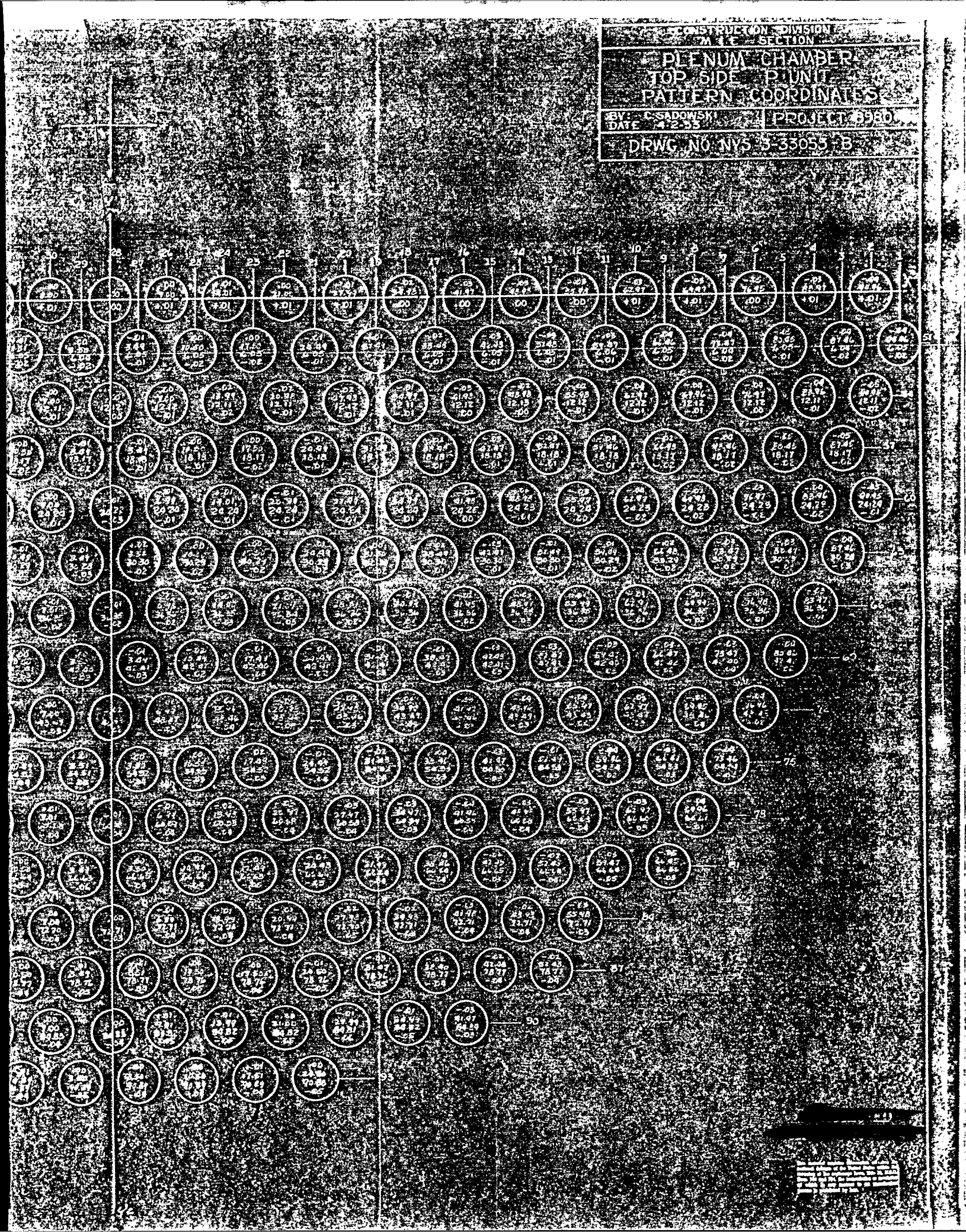
CONSTRUCTION DIVISION
ZMK SECTION

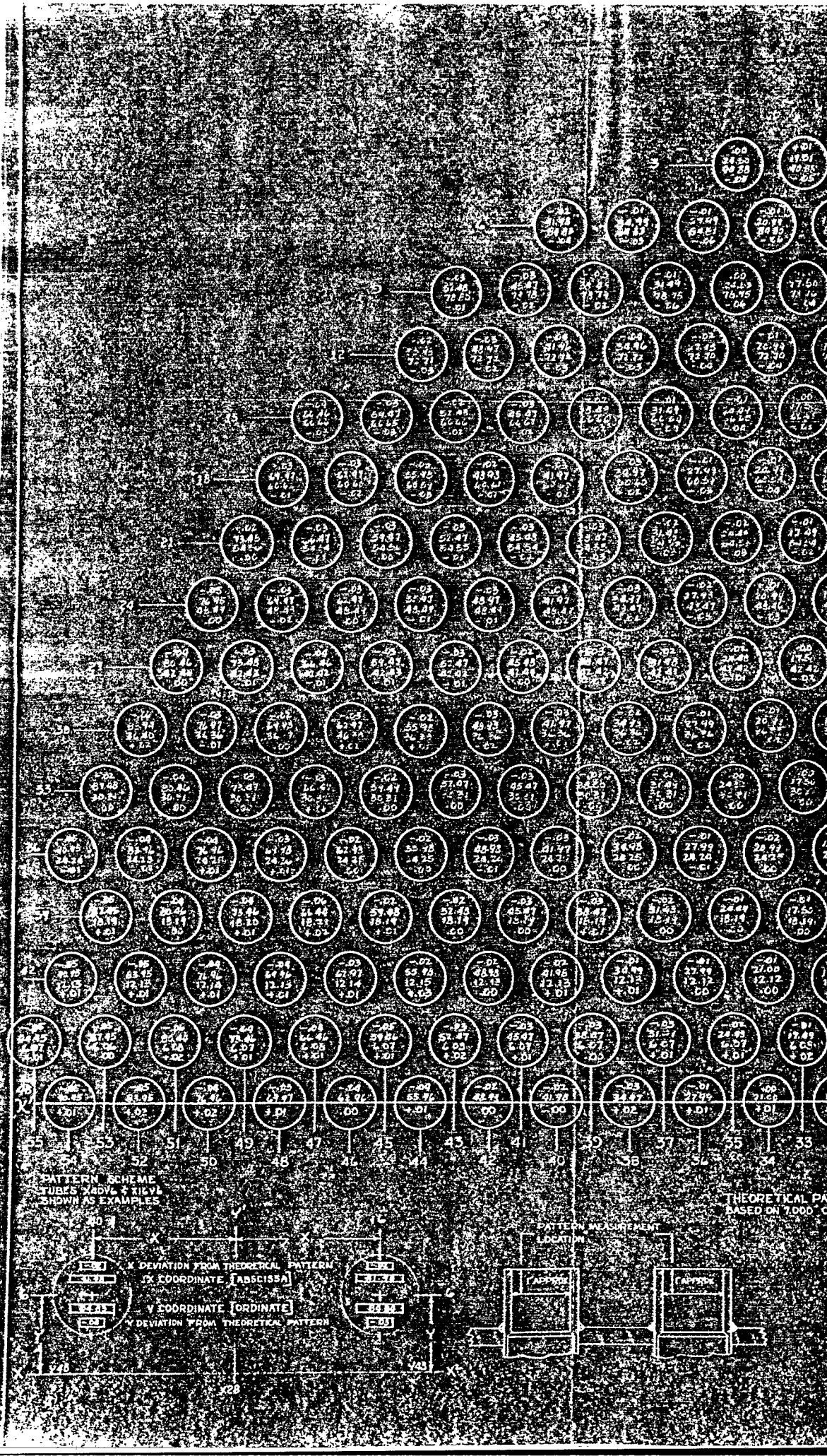
PLENUM CHAMBER
TOP SIDE P.U.N.I.T.
PATTERN COORDINATES

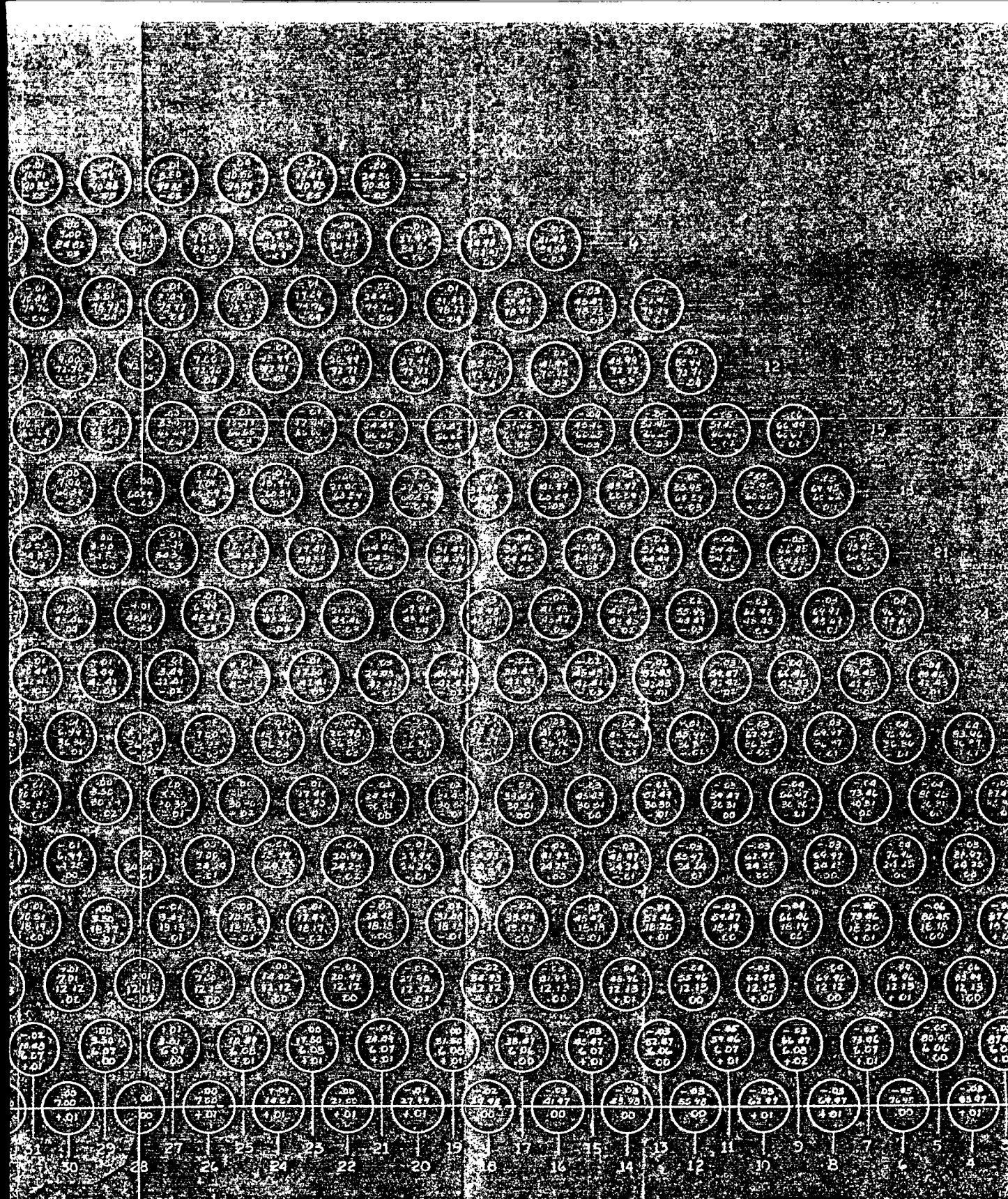
BY: C. SADOWSKI
DATE: 4-25-55

PROJECT 8980

DRWG. NO. NYS 3-33055-B




PATTERN SCHEME
TUBES ABOVE & BELOW
SHOWN AS EXAMPLES
X DEVIATION FROM THEORETICAL PATTERN
X COORDINATE [ABSCISSA]
Y COORDINATE [ORDINATE]
Y DEVIATION FROM THEORETICAL PATTERN
PATTERN MEASUREMENT LOCATION
THEORETICAL PA
BASED ON 7.000



NOTE

COORDINATES AND DEVIATIONS AS LISTED ABOVE HAVE BEEN ROUNDED OFF FROM THREE DECIMAL PLACES, AND TOGETHER MAY NOT TOTAL THE THEORETICAL TWO DECIMAL DISTANCE. FOR EXAMPLE THE THEORETICAL DISTANCE OF ROW X42 FROM X L IS 12.428 INCHES. THE MEASURED DISTANCE OF TUBE X42 IS 12.428 INCHES; THEREFORE COMPUTED DEVIATION IS .000 INCHES TUBE IS PLOTTED 12.13 AND DEVIATION .00 INCHES

E. I. DU PONT DE NEMOURS & CO.
WILMINGTON, DELAWARE
CONSTRUCTION DIVISION
M & E SECTION

PLENUM CHAMBER TOP SIDE P UNIT PATTERN COORDINATES

BY: S. C. SADOWSKI
DATE: 5-30-53

PROJECT 8980

When the two units were properly mated, a 4.375" diameter functional gage was inserted into the tubes. The following tubes would not functional gage: X44-Y12, X49-Y33, X51-Y69, X46-Y24, X54-Y54 and X50-Y72.

In order to make these tubes accept the 4.375" diameter functional gage, a Sunnen hone rig was used to smooth out the junction of the plenum and top tube sheet tubes. All tubes accepted the gage after this repairing. This repairing consisted of honing essentially the top 4" of the top tube sheet tube bore and the bottom 1" of the plenum chamber tube bore.

Note: Top tube sheet tubes meet the requirements of passing a 4.377" diameter plug gage and not having a bore size exceeding 4.410".

(8) Establishing Final Centerlines for Field Erection Purposes

After functional gaging and before dismantling the plenum chamber and top tube sheet, X and Y axes previously established on the top side of the plenum were transferred to the bottom side of the plenum, top of the top tube sheet and wrapper plates using the Wild T1 theodolite. Part III, section II-k describes how this instrument was used to transfer unit centerlines. Sketch #35 in Section 15A-8 of this manual illustrates pictorially where these centerlines or axis were established.

(9) Square Slot Milling Operation

Two square slots ($\frac{1}{2}$" x $\frac{1}{2}$") were milled in the bottom end of all large plenum along the "X" axis. Dwg. 2-1 in Section 16A-2 of this manual shows where the slots were milled.

After machining all slots were gaged using a "GO-NO GO" gage. The "GO" gage was 31/64" square and "NO GO" gage was 33/64" square. Both were approximately 6" long. During gaging of the slots, they were also visually checked for burrs and sharp corners. Final results indicated that all slots were within tolerance and no burrs or sharp corners were visible.

(10) Plenum Template Inspection

The inspection of "P" unit template that was used for telescope actuator erection work at Savannah River Plant was performed in an identical manner as described in Part IV, Section 6. All inspections proved satisfactory and the job was accepted for shipping to the plant site.

(11) "V" Slot Milling Operation

The inspection required during and after this machining operation is identical to that discussed in Section 16A-2A of this manual. All specifications pertaining to the "V" slotting is covered by du Pont drawing M-131107.

A final inspection report covering acceptances and discrepancies is presented herewith as Exhibit #19.

(12) Tangential Slot Inspections

All inspections performed dn tangential slots were performed concurrent with the machining operation.

First, the slots were visually inspected for burrs and sharp edges. Any found were removed by "hand filing". After this, the tangential slots were inspected for the following:

(a) Angular orientation of slot

(b) Radial distance from center of tube to base of slot

(c) Depth of slot referencing from tube O.D.

A specially designed tangential slot gage and master setting tube was used to check items "a" and "b". A special type depth gage was used to check item "c". For development, procurement, use, and application of the two gages, see Part III, Section II-A4.

All tangential slots were checked using the above two gages and found satisfactory.

(13) Photographing of Plenum Large Tube Pattern

After all tube repairs had been completed, the plenum chamber was set on 2½ ft. cast iron pedestals and leveled using the Wild N111 Level and precision target. Next, the exterior of the unit was jetted with high pressure air to remove oil, grit, filings and other foreign material. After this, the top side of the unit was wiped with F.O. 128 until clean, and then the plenum was released to the Inspection Department for photographing.

Photographing of the plenum large tube pattern top side was performed by the Inspection Department in an identical manner described in Section 16A-13 of this manual.

(14) Probe Pin Socket and Latch Stud Inspections

Inspections were performed identical to those described in Section 16A-9 of this manual, except as follows:

(a) The size and concentricity of the two reamed holes in probe pins shown in section "A-A", du Pont dwg. W-133305, Rev. 25 was checked using "GO-NO GO" gages shown on du Pont dwg. D-110286. The size of the two reamed holes were (1) 0.4688" to 0.4693", (2) 0.3750" to 0.3755".

(15) Tube Number Identification Tag Inspection

To the top side of the plenum chamber, large tube and rod tube identification tags were welded next to each of these tubes. Stenciled

EXHIBIT #19

FINAL REPORT ON "V" SLOT INSPECTION MADE ON "P"

PLENUM CHAMBER

E. I. DU PONT DE NEMOURS & CO., INC.

[redacted]struction Division

[redacted]ON

Report Number 436-P

CC: H. W. Gosney, F.P.M.
R. K. Mason - D. A. Hauser
Savannah River Plant (3)
R. K. Mason - E. M. Vass-SRP
H. L. Bunker - J. G. Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
J. B. Johnson - File

April 7, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

This material contains information affecting the national defense of the United States within the meaning of the espionage laws, Title 18, U.S.C., Secs. 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

TO C. J. VEITH - M & E FILE

FROM S. R. Cochran DATE March 25, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Plenum Chamber EQ.PC.NO. 155-P

DRAWING NOS. W-131407 R.5 JOB RATING

VENDOR New York Shipbuilding Corporation LOCATION Camden, N. J.

This is a final report on inspections made on V-notch slots on top ends of all plenum chamber tubes. Inspections were made concurrent with machining during period 3/19/53 to 3/25/53, by du Pont Inspection.

Inspection consisted of determining size and orientation of V-notch slots. Orientation was checked by use of a special gage shown on drawing no. D-112872. Size was checked by means of a special gage shown on drawing number D-112893.

Blueprint specifications for slots are:

Angular tolerance = $\pm$ 1/2°
Size of slot at top (width) = .530 $\pm$ .005 .000

S[redacted]ON

[redacted]

FIELD INSPECTOR'S REPORT
FROM: S. R. Cochran

Report Number 436-P
Page 2 of 2

During the course of inspection several slots were found to be oversize and several undersize. A. Arthur of Design gave clearance to W.F.Quillen of M & E, by telephone conversation on 3/24/53 to accept the following:

A. Undersize slots with the provision that the functional gage would properly fit the slots and that questionable slots were within angular tolerance.

B. Oversize slots up to a maximum width of .545" with the provision that the questionable slots were within angular tolerance.

All slots meet angular tolerance requirements and conditions of A. & B. listed above.

Range of Slot Widths

.515 to .519	.520 to .524	.525 to .529	.530 to .535	.536 to .540	.541 to .545
15	100	433	1008	396	67

Note: Slot number 3, on tube X45, Y51, was 3° out-of-tolerance but was welded and remilled and is now within tolerance.

Measurements of all slots are on file in this office.

lmw

[redacted]

on the top of each metal tag was the tube X and Y coordinates to make for easy tube location. Photo serial #234 in Part III, Section II-C, illustrates the use of a special induction welding unit for spot welding the tags to the top side of the unit.

After all tags were welded, a visual inspection was made to insure that tag coordinates corresponded to the unit X and Y coordinates; also, a visual inspection was made to insure that none of the tags obstructed the "V" slots. Both inspections proved satisfactory and the job was accepted.

(16) Inspection of Water Retaining Wall

a. Welding

The water retaining wall was fit and welded to the top side of the plenum chamber as specified on du Pont drawing W-134273. After all welding was completed, a visual inspection was made to determine if welding was free of porosity, pin holes, cracks, and other mechanical defects. Any defects noted were chipped or ground and re-welded (if necessary) using the metalic arc welding process. All weld inspections proved satisfactory according to drawing specifications and the job was accepted.

b. Dimensional

The height of the water retaining wall was checked dimensionally as discussed in Exhibit #20 presented herewith.

The drain pipe locations were checked for orientation using a 100 foot stainless steel tape. All measurements were made on the outer circumference of the dam and referenced from the X axis.

The above dimensional checks were satisfactory and the job was accepted.

(17) Rod Tube Elevations

The distance from the top ends of large tubes to top ends of rod tubes was measured using a combination square graduated in 1/64". The first inspection revealed that 63 of the 165 rod tubes measured were ranging from 1.6875" to 1.7187". Drawing specifications stated this distance to be 1.800" ± .062". These 63 rod tubes were re-faced by New York Ship and re-inspected. Final inspection revealed all rod tubes were within drawing tolerance with the exception of tube X28-Y62. This tube measured 1.875" and was accepted by Design.

(18) Functional Gaging After Welding Probe Pin Sockets, Latch Studs and Water Retaining Wall

The top tube sheet assembly was set up on cast iron pedestals approximately two feet high and leveled for mating with the plenum chamber. The top tube sheet was leveled using the Wild N111 precision level and target.

EXHIBIT #20

DIMENSIONAL CHECK ON HEIGHT OF WATER RETAINING WALL

E. I. DU PONT DE NEMOURS & CO., INC.

Construction Division

[redacted]

Report Number 454-P

CC: H. W. Gosney, F.P.M.
R. K. Mason - D. A. Hauser
Savannah River Plant (3)
R. K. Mason - E. M. Vass-SR
H. L. Bunker - J. G. Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
J. B. Johnson - File

April 15, 1953
New York Ship - Camden, N. J.

This material contains information affecting the national defense of the United States within the meaning of the espionage laws, Title 18, U.S.C., Secs. 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM A. A. Conn DATE April 6, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Plenum Chamber "P" Unit EQ.PC.NO. 155-P

DRAWING NOS. W-134273 R.0 JOB RATING

VENDOR New York Shipbuilding Corporation LOCATION Camden, N. J.

Scope: Height of water retaining wall.

Procedure: Dimensions were taken from top plate of plenum with a combination square and 6" rule. The 6" rule was laid across the top of the retaining wall and lined up with 2 marks on same plane on combination square. The combination square was flat on top plate.

Results: See attached sheet.

Measurements ranged from 1-31/32" to 2-3/8". Specified drawing dimension is 2".

Note: These dimensions are considered acceptable. (No tolerance is specified on drawing.)

lmw
attach.

[redacted]

W.S.P. A.A. Corin [redacted] DATE 4-6-53

HEIGHT OF WATER RETAINING WALL "P" UNIT - PLENUM CHAMBER.

Report #454-P

No.	DIMENSION	No.	DIMENSION	No.	DIMENSION	No.	DIMENSION
28	2 1/4 INCHES	55	2 11/32 INCHES	82	2 1/4 INCHES	109	2 5/16 INCHES
29	2 1/4 "	56	2 3/32 "	83	2 5/32 "	110	2 1/4 "
30	2 3/16 "	57	2 3/32 "	84	2 1/8 "	111	2 1/4 "
31	2 1/16 "	58	2 1/16 "	85	2 3/16 "	112	2 5/16 "
32	1 31/32 "	59	2 5/32 "	86	2 1/8 "	113	2 5/16 "
33	2 1/16 "	60	2 1/8 "	87	2 1/8 "	114	2 5/16 "
34	2 1/32 "	61	2 1/16 "	88	2 1/16 "	115	2 5/16 "
35	2 1/32 "	62	2 11/32 "	89	2 5/16 "	116	2 5/16 "
36	2 3/32 "	63	2 5/16 "	90	2 3/8 "	117	2 3/8 "
37	2 3/32 "	64	2 1/8 "	91	2 5/16 "	118	2 5/16 "
38	2 1/8 "	65	2 1/32 "	92	2 5/16 "	119	2 5/16 "
39	2 5/32 "	66	2 1/8 "	93	2 3/16 "	120	2 3/16 "
40	2 7/32 "	67	2 1/8 "	94	2 1/16 "	121	2 1/16 "
41	2 3/32 "	68	2 1/8 "	95	2 1/32 "	122	2 1/32 "
42	2 5/32 "	69	2 1/8 "	96	2 — "	123	2 — "
43	2 1/32 "	70	2 1/8 "	97	2 3/16 "	124	2 3/16 "
44	2 3/32 "	71	2 5/32 "	98	2 3/16 "	125	2 3/16 "
45	1 31/32 "	72	2 1/8 "	99	2 1/8 "	126	2 1/8 "
46	2 5/32 "	73	2 1/8 "	100	2 1/8 "	127	2 1/8 "
47	2 5/32 "	74	2 1/4 "	101	2 3/16 "	128	2 3/16 "
48	2 1/8 "	75	2 1/4 "	102	2 1/4 "	129	2 1/4 "
49	2 1/4 "	76	2 1/4 "	103	2 5/16 "	130	2 5/16 "
50	2 7/32 "	77	2 1/32 "	104	2 1/4 "	131	2 1/4 "
51	2 1/8 "	78	2 3/16 "	105	2 1/4 "	132	2 1/4 "
52	2 3/16 "	79	2 9/32 "	106	2 1/4 "		
53	2 1/16 "	80	2 3/16 "	107			
54	2 1/8 "	81	2 3/16 "	108			

DIMENSIONS WERE TAKEN EVERY 6" STARTING AT X' GOING IN A COUNTER CLOCKWISE DIRECTION.

LATEST DWG DIMENSION IS 1". DWG WAS RELEASED AFTER RETAINING WALL WAS COMPLETE. ORIGINAL RELEASE WAS 2" DIM.

[redacted]

After aligning the plenum chamber on the top tube sheet, all large and rod tubes were functional gaged. Large tubes were gaged using a 4.375" diameter functional gage. Results of this gaging revealed that the following large tubes would not properly receive the gage: X53-Y63, X49-Y21, X52-Y30, X53-Y39, X36-Y6. After some honing in the top tube sheet tubes, the above tubes accepted the functional gage. Also, all rod tubes were gaged using a 1.484" diameter functional gage. Results of this gaging revealed that the following rod tubes would not receive the gage: X41-Y29, X38-Y28, X27-Y29, X3-Y35, X36-Y46, X30-Y44, X48-X64, X17-Y77, X23-Y79. At this time, Design gave clearance to increase the bottom bores of the plenum chamber rod tubes to 1.3375" and increase the bores of the top tube sheet rod tubes to 1.320". The bores of these tubes were increased and the tubes again functional gaged. All above rod tubes accepted the 1.484" diameter functional gage for its entire length. The units were then separated and prepared for Dowell cleaning.

(19) Large Tube to Rod Tube Ligament Measurements

These measurements were taken in an identical manner. All results were satisfactory and accepted.

(20) Dowell Cleaning (Internally)

Field complaints issued by Operations Department, Savannah River, to the Inspection Department of New York Ship stated that the cleanliness of the "R" plenum chamber interior did not meet their cleaning specifications.

As a result of this complaint, the Inspection Group immediately made a careful study of the cleaning procedure used on the "R" plenum. From this study, a new cleaning procedure based on experience gained on cleaning of "R" plenum chamber, was drawn up and applied to the cleaning of "P" plenum chamber. For the procedure followed during cleaning of the plenum chamber, see Exhibit #21 presented herewith.

After the unit was cleaned internally, it was inspected, through the nozzles only, and accepted as being clean and acceptable per du Pont Specification No. 3056. Blind flanges were removed for inspection only after cleaning, and were immediately re-installed. Exhibit #22 presented herewith covers the inspection performed and the condition of the interior as observed visually by the Inspection Department.

(a) Field Complaint

On April 18, 1953, the "P" plenum chamber was shipped via tug or barge to the Savannah River Plant site. Upon receipt of same in the 100-P area, a visual inspection was made by Operations personnel on the interior of the unit. The latter reported to the Operations Department head that pools of oil were found in the plenum chamber nozzles. The Inspection Department of New York Ship was notified of this discrepancy immediately.

EXHIBIT #21

"p" UNIT PLENUM CHAMBER FINAL CLEANING PROCEDURE

DRAFT DRAFT

I. DU PONT DE NEMOURS & CO., INC.

[redacted]struction Division

Serial Number 216

CC: H. W. Gosney, F.P.M. (5)
S. R. Cochran (2)
B. Courtner - Dowell Corp (2)
J. B. Johnson - File

June 5, 1953
New York Ship - Camden, N. J.

MEMORANDUM

This material contains information affecting the national defense of the United States within the meaning of the espionage laws, Title 18, U.S.C., Secs. 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

TO: R. H. BARTO - J. REID (5)
NEW YORK SHIPBUILDING CORP.
CAMDEN, NEW JERSEY

FROM J. B. JOHNSON - R. V. GRAHAM R.V.G.

PROJECT 8980 - SAVANNAH RIVER PLANT - "P" UNIT
PROPOSED PLENUM CHAMBER FINAL CLEANING PROCEDURE

Cleaning Solution to be as follows:

0.1% Detergent (by weight)
1.0% Caustic
1.0% Trisodium Phosphate
Remainder - deionized or distilled water
Temp. 150° - 190°F.

I Jetting of plenum chamber in horizontal position slightly inclined.

A. No tube plugs installed.

B. Jet with stainless steel nozzle thru each nozzle for 10 minutes each.

II High pressure washing of plenum chamber in horizontal slightly inclined position.

A. Using special tube **plug and high pressure pump (2500 p.s.i.) spray cleaning solution thru the three slots in every tube for 1 minute each starting with tubes on the high side and working toward the low side.

B. Repeat step "A" using hot deionized or distilled water. Install each tube plug after tube is rinsed.

[redacted]

III - Washing of plenum chamber in vertical position, suspended by padded wire slings on two (2) nozzles 60° on either side of Y_1 nozzle. (Y_1-Y_2 axis vertical, Y_1 at top.)

A. Fill unit with cleaning solution thru bottom most nozzle and overflow thru top nozzle until full. Other four (4) nozzles blanked off.

B. Agitate with air simultaneously thru 2 bottom nozzles and eight (8) bottom tubes fitted with special *center tapped plugs. (1 hour) X9-Y81; X13-Y87; X16-Y90; X21-Y93; X35-Y93; X40-Y90; X43-Y87; X47-Y81.

C. Drain unit thru bottom most nozzle and tubes used in step "B".

IV - Rinsing of plenum chamber in vertical. (Y_1-Y_2 axis vertical, Y_1 on top.)

A. All tube plugs installed plus eight (8) special center tapped plugs* in bottom sector and ten (10) special center tapped plugs* in top sector. Location of these special plugs are as follows:

Top - X 6-Y24; X 9-Y15; X13-Y 9; X16-Y 6;
X21-Y 3; X35-Y 3; X40-Y 6; X43-Y 9;
X47-Y15; X50-Y24.

Bottom- X 9-Y81; X13-Y87; X16-Y90 X21-Y93;
X35-Y93; X40-Y90; X43-Y87; X47-Y81.

B. Fill unit with hot deionized or distilled water thru bottom nozzle, vent thru top nozzle until unit is full and overflow. for 5 minutes.

C. Agitate with air thru two bottom nozzles and eight special center tapped plugs* for 30 minutes while unit overflows at top nozzle.

D. Gradually drain unit thru bottom most nozzle and rinse thru ten special center tapped plugs* in top sector for 30 minutes, while air remains on two bottom nozzles and eight tubes in lower half.

* This special tube plug consists of a perforated tubular center plugged at one end and tapped for hose connection on opposite end. A flange on each end with "O" ring grooves is used to seal on the I.D. of the tubes.

[redacted]

** This special plug is an adaptation of a tube cap Detail 112519 originally used to seal off tubes during NYX tests. One of these caps has been altered by drilling and tapping a 1/2" hole in the top plug and three longitudinal rows of 9 - 1/16" holes each in the barrel. The rows of holes are spaced 120° apart and are orientated with the plenum tube slots by means of a key mounted on the shoulder of the cap. The plug is inserted in the tube with the key in any one of 3 "V" slots in the top of each plenum tube.

[redacted]

EXHIBIT #22

DOWELL CLEANING AND RESULTS

E. I. DU PONT DE NEMOURS & CO., INC.

Construction Division

[redacted]

Report Number 475-P

CC: H. W. Gosney, F.P.M.
R. K. Mason - D. A. Hauser
Savannah River Plant (3)
R. K. Mason - E.M.Vass-SRP
H. L. Bunker - J. G. Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
J. B. Johnson - File

April 24, 1953
New York Ship - Camden, N. J.

This material contains information affecting the national defense of the United States within the meaning of the espionage laws, Title 18, U.S.C., Secs. 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM A. J. Piatek DATE April 6, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Plenum Chamber EQ.PC.NO. 155-P

DRAWING NOS. W-131156 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Scope:

To clean inside of plenum - started 4/1/53 completed 4/2/53.

Procedure:

A solution of 0.1% detergent, 1.0% caustic and 1.0% trisodium phosphate was mixed with deionized water @ 150°-190°F. The plenum chamber was set in a horizontal position, slightly inclined, and the cleaning solution was jetted through each nozzle for approximately 10 minutes. After jetting through each nozzle was completed, a special tube plug was used to spray cleaning solution thru the three slots in each tube. The spraying was started on the high side of the inclined plenum chamber and worked toward low side. The cleaning solution was sprayed for approximately 1 minute in each tube at a pressure of 2300 psi.

After the spraying of each tube was completed, clean deionized water, with no cleaning chemicals added, was jetted through a stainless steel pipe into each nozzle for approximately 15 minutes per nozzle.

[redacted]

[redacted]

FIELD INSPECTOR'S REPORT
FROM: Piatek

Tube plugs were then installed in all tubes. Tube number X9-Y81; X13-Y87; X16-Y90; X21-Y93; X35-Y93; X40-Y90; X43-Y87 and X47-Y81 were fitted with special center tapped plugs. The plenum chamber was then lifted in a vertical position with Y_1 axis on top. Unit was filled with cleaning solution thru bottom nozzle and overflowed thru top nozzle. Other four nozzles were blanked off. When unit was filled with cleaning solution, the solution was agitated with air thru 3 bottom nozzles and the 8 bottom tubes fitted with special center tapped plugs for 1 hour. One hour later the unit was drained of the cleaning solution through the same nozzles and tubes through which the air had passed.

In rinsing the unit with clean deionized water, free of cleaning chemicals, the unit was set in a vertical position with Y_1 axis on top. The 8 tubes mentioned before and 10 other tubes X 6-Y24; X50-Y24; X9-Y15; X13-Y9; X16-Y6; X21-Y3; X35-Y3; X40-Y 6; X43-Y 9; X47-Y15 were fitted with special center tapped plugs. Unit was filled with hot deionized water thru bottom nozzle and vented thru top nozzle. After the unit was filled, the water was agitated with air for 30 minutes thru 3 bottom nozzles and 8 bottom tubes fitted with special center tapped plugs. Thirty minutes later the bottom nozzle was set on a jack and the bolts removed from the bottom nozzle cap. With bolts removed from the nozzle cap, the unit was raised off the jack and the bottom nozzle was then wide open for quick draining. During the draining process, rinse water was run thru top 3 nozzles and 10 top tubes that had special plugs for half hour. The unit was again rinsed using the same procedure. After the second rinse, the unit was lowered to a horizontal position and inside of unit inspected through all six nozzles for cleanliness.

Results:

Looking into the nozzles only, the unit looked very clean. Some weld smoke was noticed on the tack welds on the tubes and other welds on the inside. Other than this condition, the interior appeared to be clean and the cleanliness of the interior was considered acceptable.

lmw

[redacted]

In an effort to determine whether or not the unit was contaminated before it left New York Ship, a member of the Inspection Group (NYS) was sent to Savannah River Plant to investigate the complaint. A visual inspection performed by the inspector through three of the nozzles revealed no trace or evidence of oil on the bottom plates of the nozzles. Further investigation revealed that it was not oil as originally reported by Operations, but was detergent solution that had accumulated during Dowell cleaning in the void space between the bottom edge of the replaced vaned nozzle I.D. As time passed, the detergent became viscous and condensed out and formed small pools of what appeared to Operations (SRP) as oil on the uneven surfaces of the bottom nozzle plate. Detergent solution has an oily feel. In view of this physical property and an analysis on the substance removed from the nozzles, it was proved to be detergent and hot oil.

Additional rinsing at New York Ship may have avoided this complaint; however, no spots or pools of oil (as reported by SRP) were visable when the unit left New York Ship.

(21) Internal Drying of Plenum Chamber

For procedure and results of this inspection, see Part VII, Section II.

(22) Dimensional Inspection of Cooling Water Piping Holes With Respect to Lifting Lug Slots and Instrument Plate Slots

The location of cooling water piping holes with respect to the centerline of lifting lug slots and instrument plate slots was checked according to dimensions shown on du Pont drawing W-131407. As noted on the drawing, all slots were the same size and located in each skirt section (six) symmetrically with respect to the "Y" axis. Also, holes and slots were of the same size radially. A 6 ft. tape was used to measure the center-to-center distance of the holes in each section of the skirt referencing from the centerline of the skirts slot. An 18 ft. straight edge was placed across the unit and made to pass through the center of the center tube (X28-Y48) and the center of the two cutouts (180° apart) to serve as a base line from which measurements were referenced for locating holes. A 25 ft. tape was used to determine the average pitch radius referencing from the center tube. For results of this inspection, see Sketch #35as all measurements were considered acceptable.

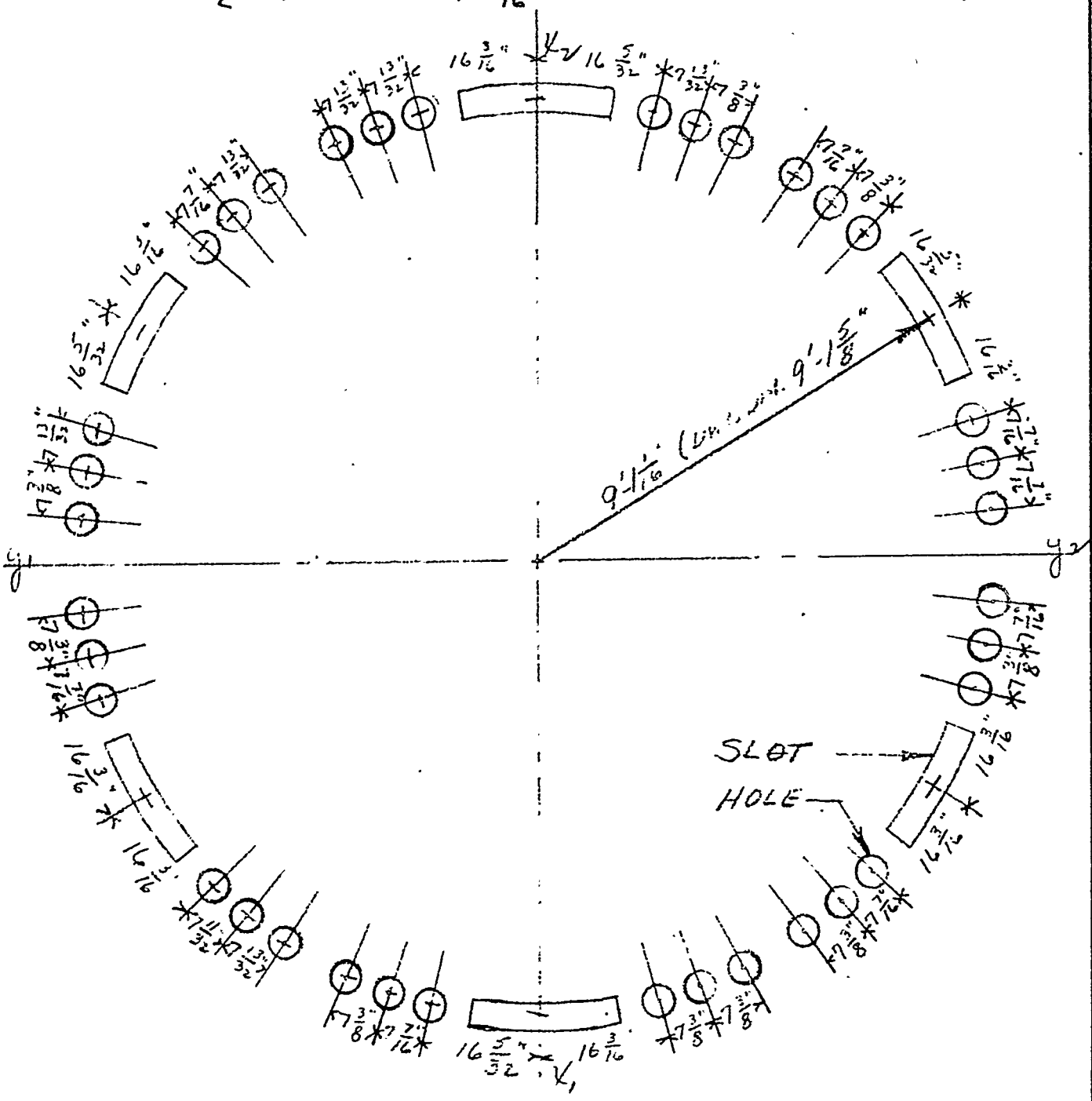
(23) Freon Test (Final)

The plenum chamber was prepared for freon testing by sealing off all large tubes using O-ring plugs shown in photo serial number 240, Section 14B-5 of this manual. Each of the six nozzle openings were closed off using temporary blind flanges and garlock gaskets. After closing up the unit, it was placed on six foot pedestals (top side up) to allow access from underneath during the test. New York Ship then applied an air test and all leaking plugs and flanges were tightened until the assembly was air tight. After this twenty (20) pounds of freon by weight was introduced into the unit and the pressure

SLOT TO HOLE LOCATION MEASUREMENTS

HOLE TO HOLE DWG SIZE - 7 3/8"
HOLE TO ℄ OF SLOT - 16 3/16"

RESULTS:
ALL DIM. SATISFACTORY



SKETCH # 35-A

~~ENGINEERING SKETCH SHEET~~ ~~E. I. DU PONT DE NEMOURS & CO.~~	~~PROJ. NO.~~	~~SIGNATURE:~~
~~PROJ. TITLE~~		~~DATE~~
~~SUBJECT:~~		~~No.~~ E-42430

was raised to 55 psi. with air. This pressure was held for one hour before testing for leaks.

All 5½" tube welding, rod tube, nozzle and bulge welding was tested for leaks using a General Electric Type "H" Halide Detector set on medium sensitivity. Photo serial number mentioned above illustrates the use of the "detector". Leaks were detected on the top side of the following tube locations: X21-Y15 - 2 pin holes at tube weld (large tube); X6-Y54 - large hole at tube weld (large tube); X10-Y72 - 2 pin holes adjacent to rod tube (large and rod tube); X10-Y70 - small pin hole in tube weld (large tube). Leaks were detected on the bottom side at the following tube locations: X34-Y18 and X19-Y57 - (both large tubes); leaks detected at overlap of large and rod tube welds. Cracks were visible, X17-Y87 - pin hole in tube weld (large tube).

Before and after all repair work, the bore sizes of leaking tubes and surrounding tubes were checked using a standard dial indicator bore gage and ring gage. Some of the tubes were out-of-round and some oversize due to weld repairing shrinkage. Oversize tubes were X21-Y15 and X6-Y54. These tubes were "heli-arc shrunk" by depositing successive beads of weld metal on the top O.D. of the tube. Numerous passes were made until the top land had shrunk enough to be re-honed. After honing, these tubes were inspected and found within tolerance. The other tubes that were out-of-round were honed, re-inspected and accepted.

After completion of repairs, shrink welding, and honing, another freon test was made. During this final check, it was necessary to raise the internal air pressure to 190 psi. to effectively seal all O-rings on plugs. The entire unit was rechecked using "detectors". No further leaks were detected and the unit was released for hydrostatic testing.

(24) Hydrostatic Test (Final)

The "P" plenum chamber was prepared and tested in an identical manner described in Section 13B-5 of this manual. One rod tube (X19-Y59) weld was found leaking on the bottom side and repaired. Before putting a final test on the unit, the top and bottom sides of the unit were cleaned with F.O. 128, especially around all tube welding to remove dirt, oil and other foreign material that had collected on the unit. The cleaning was satisfactory and the unit was subjected to a final test (referenced above) in which no leaks were detected. The unit was accepted and released for Dowell cleaning.

(25) Second Dowell Cleaning

During the time the "P" plenum was being fabricated, du Pont Operations personnel in Building 10 (NYS) were conducting experimental tests on the NYX unit. At their discretion and from time to time, various members of the Operations Department checked units being

fabricated for degree of cleanliness. Even though "P" plenum was in the final stage of fabrication, it was the opinion of the Operations Group (NYS) that the unit (internally) did not meet their cleaning specifications. Based on their observations, du Pont Construction requested that Parts III and IV of the final plenum chamber cleaning procedure be repeated. (See Section 15B-20). Internal cleaning was again done by Dowell in an identical manner as referenced above. After cleaning, the unit was visually inspected through the nozzles and accepted as being satisfactorily cleaned. No further cleaning was done internally prior to shipping.

(26) Functional Gaging of Plenum Chamber and Top Tube Sheet After Filling Top Tube Sheet with Raschig Rings and Tube Repair

a. Large Tube Functional Gaging and Tube Repair

After loading the top tube sheet with raschig rings and completion of all welding and machining on the plenum chamber, the two units were functional gaged and tube repairs made. The following paragraphs discuss the details and discrepancies encountered just prior to shipping the unit to the Field.

First, the top tube sheet was placed on five cast iron pedestals (approximately 5 ft. high) and leveled using a 18 ft. straight edge and 12" machinist level by New York Ship. Leveling was witnessed by the Inspection Department. After this the plenum chamber was placed on the top tube sheet, aligned and temporarily bolted to the latter with staybolts. These staybolts pass through both plenum large tubes and top tube sheet tubes and were capped and bolted on each end, thus clamping the two units together. Five staybolts were used; one in the middle (through tube X28-Y48) and the other four spaced symmetrically on the outer periphery of the tube pattern near the extremities of the X and Y axes. Some adjusting and rotational movement of the plenum chamber was necessary before optimum conditions (as determined by measuring tube overhang distances) and checking centering devices for clearance between tongue and groove were reached. Section 15A-6 of this manual explains how these measurements were taken and also how the readings were interpreted. Staybolts were then removed before proceeding with functional gaging, thereby, leaving the unit in an unstrained position.

After the units were properly mated all large tubes were gaged with a 4.375" diameter functional gage. The following tubes exhibited a tight fit: X44-Y12; X50-Y24; X51-Y27; X51-Y33; X49-Y45; X50-Y72; X46-Y24; X47-Y27; X48-Y30; X53-Y33; X55-Y45; X48-Y24; X49-Y27; X49-Y33; X54-Y36; X55-Y51. In order to make these tubes accept the gage, a hone was used to smooth out the junction of the plenum and top tube sheet tubes. This repairing consisted of honing essentially the top 4" of the top tube sheet tube bore and the bottom 1" of the plenum chamber tube bore.

After some honing in the top tube sheet tubes, the above tubes were functional gaged as before. The following functional gaged in a snug manner: X47-Y27; X48-Y30; X54-Y36; X51-Y69; X49-Y27; X51-Y33; X55-Y45; X50-Y72; X51-Y27; X53-Y33. Additional honing was done in these tubes after which all tubes accepted the gage.

Any changes in bore sizes of above listed plenum chamber tubes and corresponding top tube sheet tubes are listed in final line boring record which gives complete measurements of each plenum chamber tube and unusual top tube sheet tube. See Section 15B of this manual for these final results. NOTE: Top tube sheet tubes meet the requirements of passing a 4.377" diameter plug gage and not having a bore size exceeding 4.410".

b. Rod Tube Functional Gaging and Tube Repair

Next, a 1.484" diameter rod tube functional gage was inserted into all rod tubes. The following tubes exhibited a snug fit: X43-Y11; X41-Y29, X3-Y35; X39-Y89; X27-Y29; X37-Y37; X17-Y77. At this time a member of Design gave clearance to increase the bottom bores of the plenum chamber rod tubes to 1.320". After repairing the above tubes, they all accepted the functional gage.

The final bore sizes of bottom bores of above plenum chamber tubes were:

Tube		Bore Size	
X	Y	X	Y
37	37	1.334"	1.334"
3	35	1.328"	1.328"
17	17	1.325"	1.327"
27	29	1.335"	1.337"
41	29	1.335"	1.335"
43	11	1.345"	1.329"
39	89	1.332"	1.339"

These rod tube diameters were satisfactory and accepted by the Inspection Department per Design's approval.

In addition to close visual examination of rod tube bores in the plenum chamber the same was done on the corresponding top tube sheet rod tubes. Exhibit #23 presented herewith covers this inspection and the repairs made and the results.

During the gaging of large and rod tubes, the clearance between mating ports of centering devices welded to the plenum chamber and top tube sheet were checked. This was done to determine whether or not the tongues (welded to P.C.) were binding or riding on corresponding groove (welded to T.T.S.) faces. If this latter condition ever existed and was not discovered before leaving New York Ship, much trouble would probably result when the units were assembled in the Field in so far as functional gaging of tubes were concerned. However, this trouble has been avoided by checking tongue and groove alignment during final functional

EXHIBIT #23

FINAL INSPECTION OF TOP TUBE SHEET ROD TUBES IN CONJUNCTION WITH REPAIR OF PLENUM CHAMBER ROD TUBES.

E. I. DU PONT DE NEMOURS & CO., INC.

Construction Division

[redacted]

Report Number 466-P

CC: H. W. Gosney, F.P.M.
R. K. Mason - D. A. Hauser
Savannah River Plant (3)
R. K. Mason - E. M. Vass-SRP
H. L. Bunker - J. G. Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
J. B. Johnson - File

April 23, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

This material contains information affecting the national defense of the United States within the meaning of the espionage laws, Title 18, U.S.C., Secs. 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

TO C. J. VEITH - M & E FILE

FROM C. Heist, I. Louder DATE April 15, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Rod Tubes (Top Special Tube Sheet) EQ.PC.NO. 154-P

DRAWING NOS. W-131365 R. 27 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Scope: Visual inspection of rod tubes in "P" top special prior to shipping to field site. This inspection was completed 4/8/53.

Procedure:
Top special was about five feet from floor setting on pedestals and in a "top side up" position. With one man on top side shining a flashlight down the rod tubes, and another man underneath shining a flashlight up the rod tubes, the bores of the rod tubes were inspected for scratches, nicks, and undercuts.

Results:
The following rod tubes had undercuts that were caused while necking the tubes after welding:

X30-Y 2; X10-Y28; X29-Y11; X35-Y13; X19-Y17; X 4-Y26;
X 2-Y44; X 9-Y37; X11-Y47; X33-Y17; X32-Y26.

These rod tubes were repaired by blending in the undercut so that there were no sharp edges, and a rod tube liner was inserted in each tube to assure that they would not hang up.

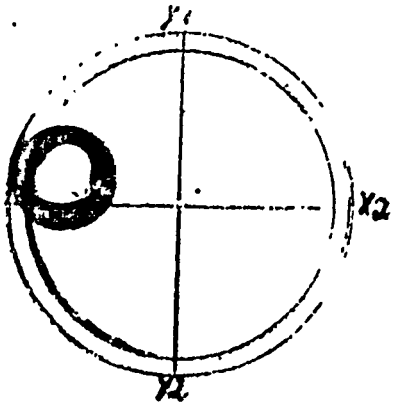
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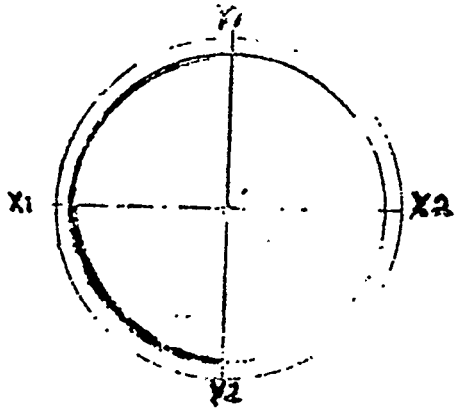
Two of these tubes, X2-Y44 and X29-Y11, were undercut as much as .049. These two tubes were accepted by Design, and a letter by Mr. H. L. Bunker - A. A. Arthur dated April 8, 1953, confirms this, provided the ledge was removed by "fairing-in" below the defect to produce a gradual transition to the true bore.

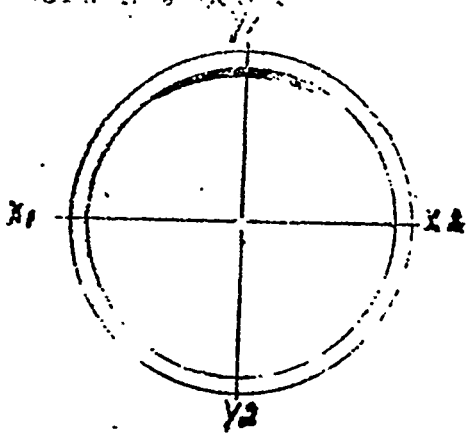
One rod tube X12-Y80 had a slag inclusion about 3" long starting 1" up from the bottom of tube on the Y_1 side. This slag inclusion was repaired by grinding .037 from the Y_1 side of tube.

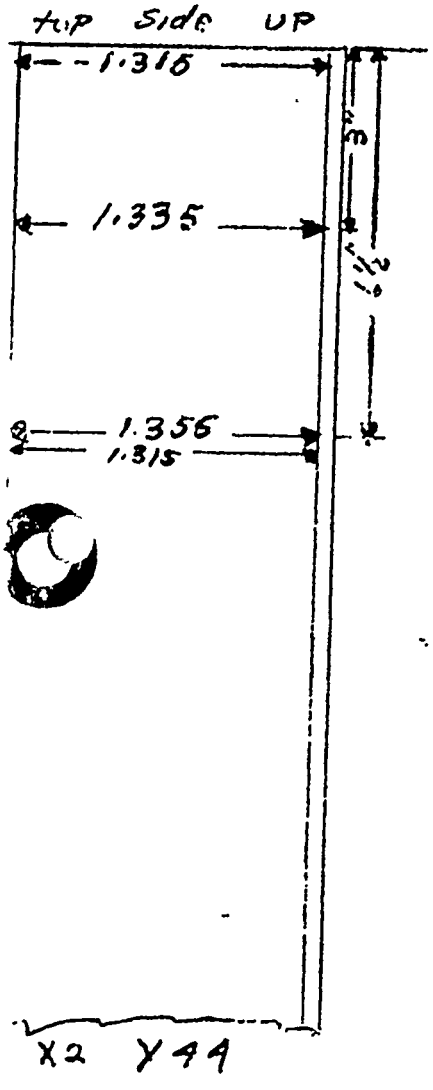
Note: See attached sketches for location and profile of these tubes. The condition of the bores of all other rod tubes was satisfactory.

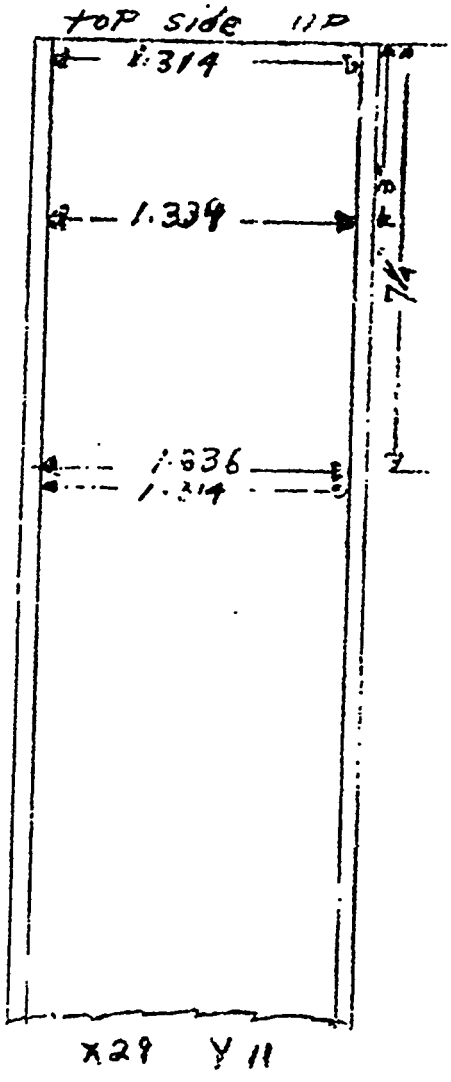
lmw
attach.

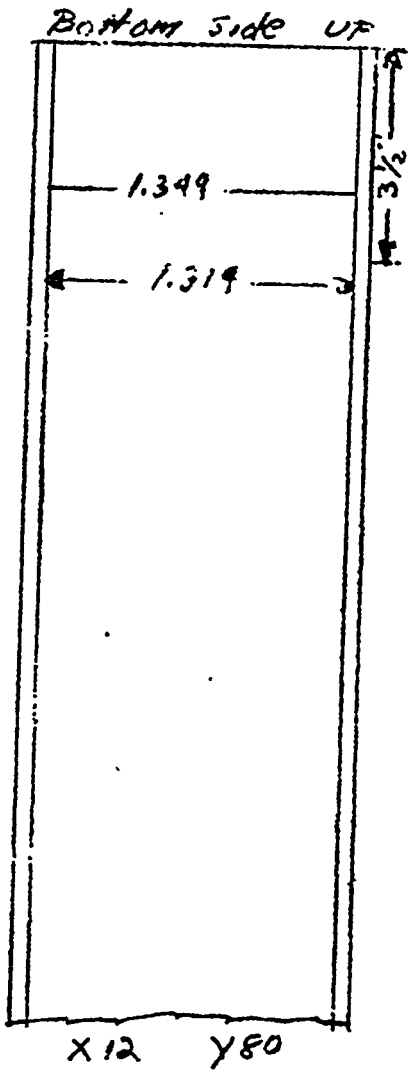












te: Rod tubes X2-Y44 and X29-Y11 are the rod tubes that were critical as far as the undercut from necking. Top view shows location by darken line in relation to X1 X2 and Y1 Y2 center lines. Bore sizes and profile of tubes are shown in front view.

Rod tube X12-Y80 shows location of slag inclusion. This was corrected by grinding out .037 from the Y1 side of tube. The bore size on this tube is 1.349 for about 3½" up from the bottom side of tube.

functional gaging, and at other times during fabricating of the units. Results of these measurements are presented herewith as Exhibit #24.

c. Cloverleafing of Large and Rod Tubes

During functional gaging of both large and rod tubes, special attention was given scratches, gouges, and other surface imperfections noted in the critical area of each tube. Dwg. 1-2, Section 16B-2 of this manual, illustrates pictorially where these critical areas were located. For any tube to be acceptable, all scratches, gouges, etc., were required to be removed that were in the O-ring or piston ring areas. Minor blemishes or scratches were removed from both large and rod tubes by "cloverleafing" or with crocus cloth. Major defects were removed either by honing or grinding with an abresive disc. For a detail discussion on the inspection procedure, and methods of tube repair incorporated, see Part VIII, Section A-49-A2. This referenced procedure was followed until all large and rod tube bores were satisfactorily repaired.

(27) Summary of Profiles to Ascertain Tube End Variation

During the final fabrication stages of "P" plenum chamber, a profile was taken first on the bottom side and then on the top side while the unit was in an operating position on the top tube sheet assembly. These final profiles were taken for reporting to Design the final condition of the tube end profile after all fabrication and welding had been completed.

In the first case (bottom side up) three profiles were taken with the unit supported on each of the nozzles near the outer periphery of the bulge weld but not supported in the middle. Results of these profiles taken symmetrically across the bottom side of the unit indicated that this side was convex. For results, see Exhibit #25.

Then the plenum chamber was placed on the top tube sheet assembly for final functional gaging. (See proceeding section) While the units were in this position, again three profiles were taken on the top side. Results of these profiles taken symmetrically across the top side of the unit indicated that this side was concave or "dished". For results see Exhibit #26.

As stated in Exhibit 25, the tube ends on the bottom side immediately after the facing operation were in a parallel plane within 0.005". The only welding done on this unit after this machining operation was stud welding of probe pin sockets and latch studs and aircomatic welding of the water retainer dam and minor tube weld repair. Further investigation revealed that the plenum chamber was not supported in the center during fabrication, particularly during hydrostatic testing, drying, and welding of probe pin sockets, latch studs and water retainer dam. It was the opinion of the du Pont inspectors that all future units should be supported in the middle at all times. This step was adopted strictly as a precautionary

EXHIBIT #24

DETERMINING CLEARANCE BETWEEN MATING PORTS OF CENTERING DEVICES WELDED TO PLENUM CHAMBER AND TOP TUBE SHEET

E. I. DU PONT DE NEMOURS & CO., INC.

Report Number 471-P 24-

Construction Division

[redacted]

CC: H. W. Gosney, F.P.M.
R. K. Mason - D. A. Hauser - Savannah River Plant (3)
R. K. Mason - E. M. Vass-SRP
H. L. Bunker - J. G. Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
J. B. Johnson - File

April 23, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

This material contains information affecting the national defense of the United States within the meaning of the espionage laws, Title 18, U.S.C., Secs. 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

TO C. J. VEITH - M & E FILE

FROM R. E. Chaney & C. H. Heist DATE April 17, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

Sheet

EQUIPMENT Plenum Chamber & Top Special Tube EQ.PC.NO. 154P & 155P

DRAWING NOS. W-131155 R.11 & W-131365 R. 27 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Inspection performed 4/15/53

Scope: To determine amount of clearance, if any, between mating ports of centering devices welded to the subject units while units were mated in operating position and not bolted together.

Procedure: Turbine type feeler gages were inserted between the tongue and groove of the mating parts from the front and on both sides of the tongue.

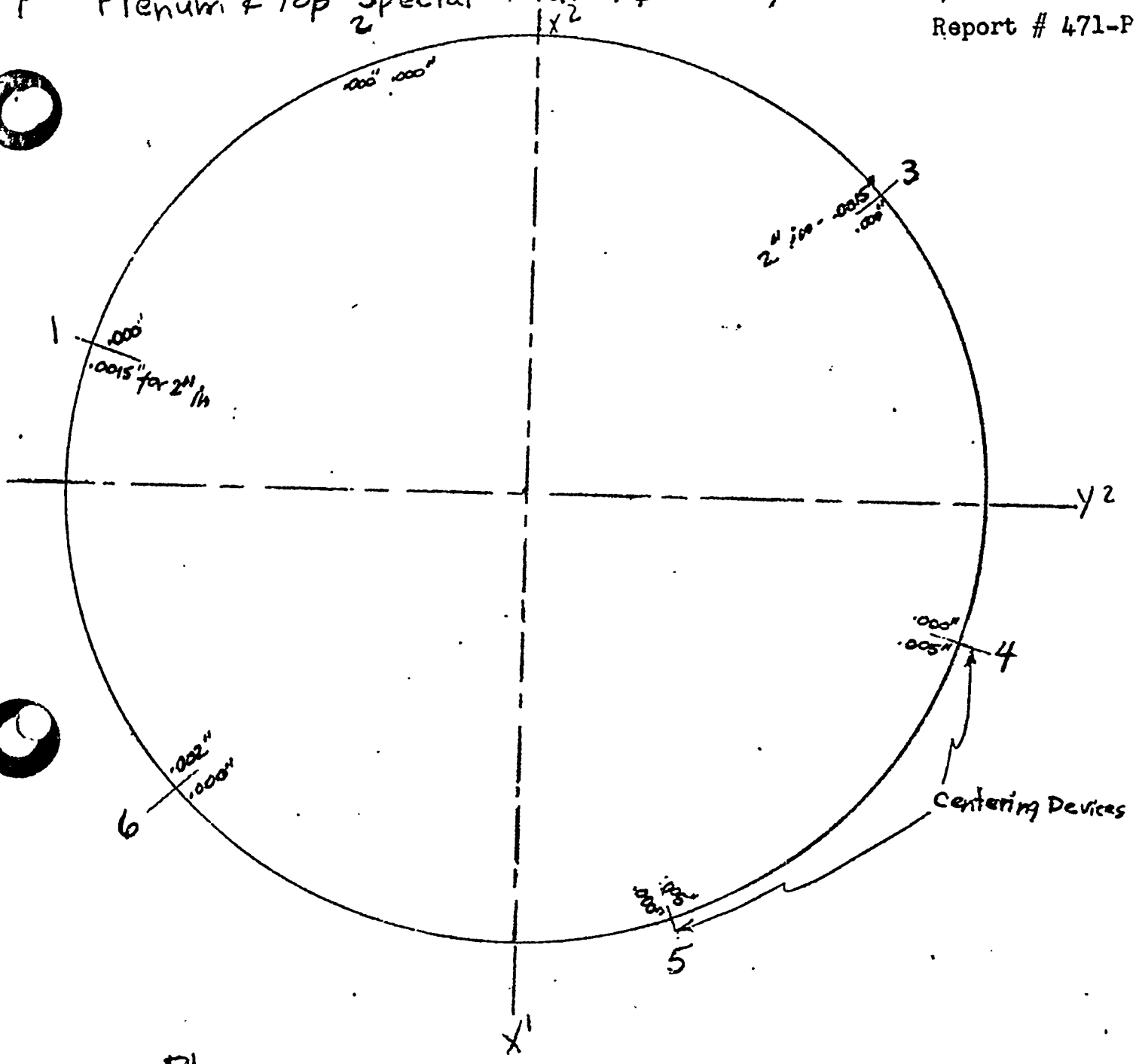
Results: See attached sketch.

lmw
attach.

[redacted]

"P" Plenum & Top Special Mated & Free of Bolts - 4/15/53

Report # 471-P



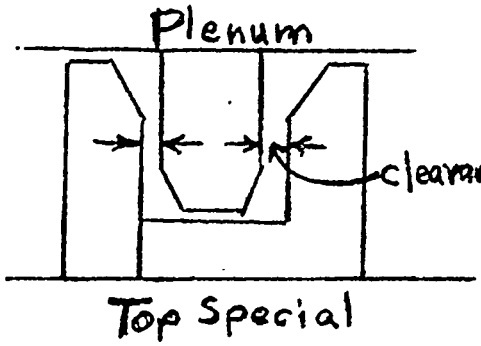


EXHIBIT #25

"P" PLENUM CHAMBER TUBE END PROFILE BOTTOM SIDE

E. I. DU PONT DE NEMOURS & CO.

Construction Division

Report Number 472-P

[redacted]

CC: H. W. Gosney, F.P.M.
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R. K. Mason - E.M. Vass-SRP
H. L. Bunker - J. G. Brewer
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J. B. Johnson - File

April 23, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

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TO C. J. VEITH - M & T FILE

FROM R. C. Chaney DATE April 17, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Plenum Chamber-Bottom Side EQ.PC.NO. 155-P

DRAWING NOS. W-131155 R. 11 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Inspection performed 4/14/53

Scope:
To determine the profile of the tubes while the unit was supported on six (6) blocks around the periphery of the tube sheet, but unsupported in the center.

Procedure:
An 18' straight edge was positioned, across the axis of each pair of the six (6) centering devices, directly on the tube tops. Feeler gages were used to determine the clearance at each end tube simultaneously in each position (no "rocking" motion of the straight edge).

Results:
See attached sketch.

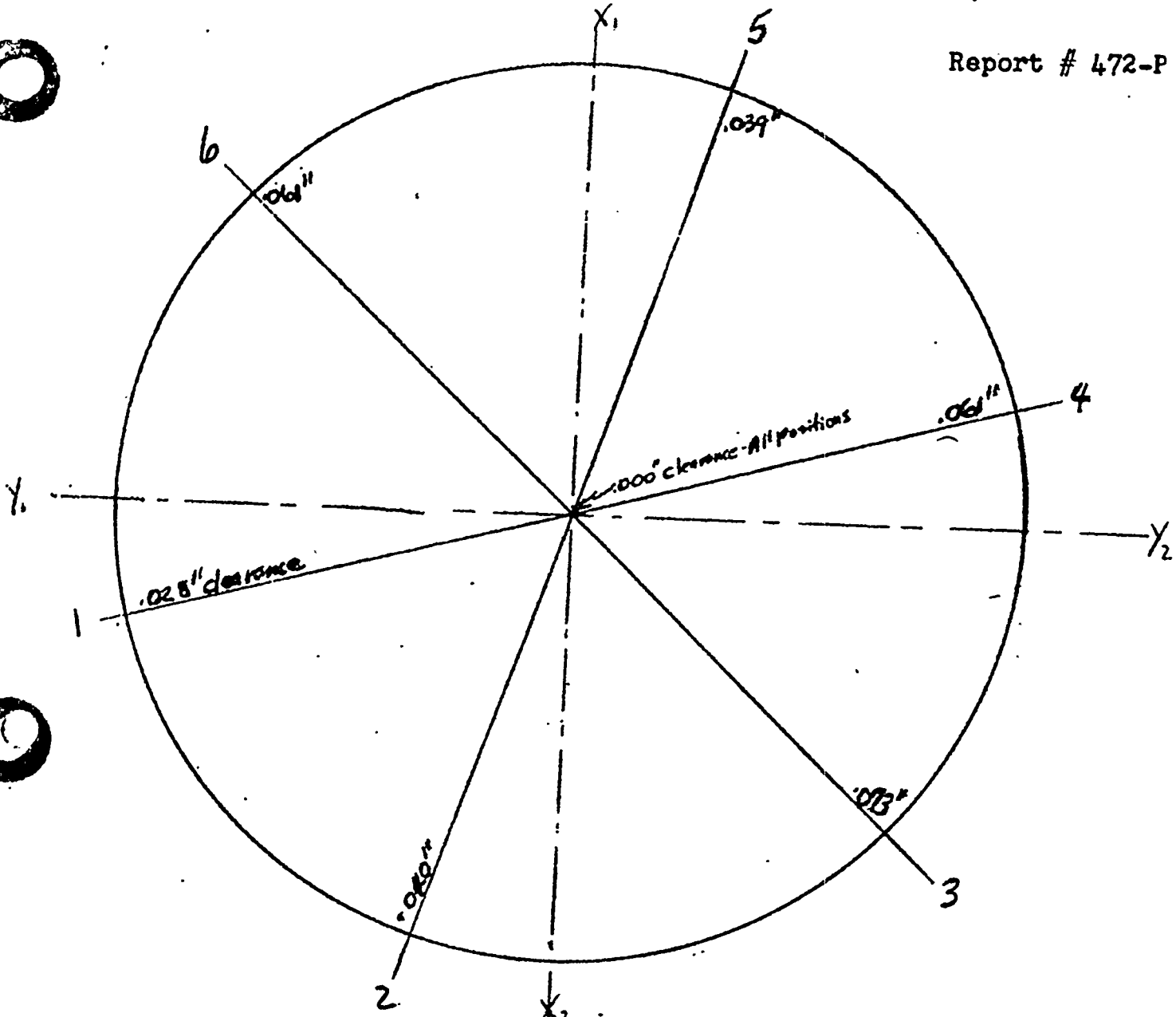
Note: The tube ends on the bottom side, immediately after the facing operation, were in a parallel plane within .005". The change in this condition is attributed to the welding of probe pin sockets, latch studs, and water retainer which was done after facing of the tubes had been completed.

lmw
attach.

[redacted]

"P" Plenum Chamber Profile - Bottom Side - 4/14/53

Report # 472-P



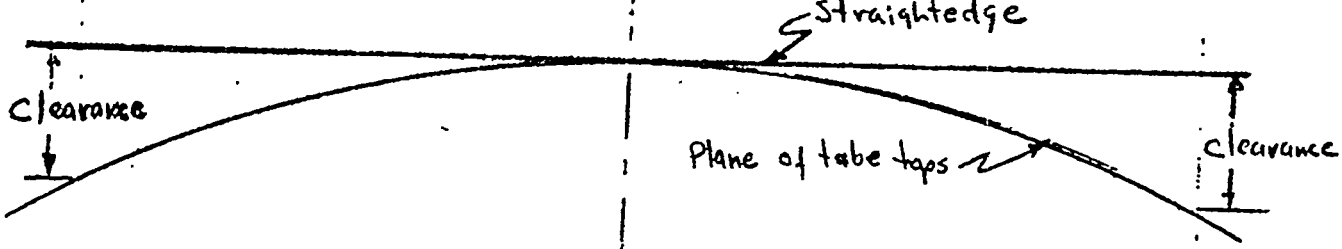


EXHIBIT #26

"P" PLENUM CHAMBER TUBE END PROFILE WHILE IN OPERATING POSITION ON TOP TUBE SHEET ASSEMBLY - TOP SIDE

E. I. DU PONT DE NEMOURS & CO., INC. Report Number 473-P

[redacted]nstruction Division

[redacted]

CC: H. W. Gosney, F.P.M.
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H. L. Bunker - J. G. Brewer
J. G. Brewer
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F. C. Breuninger
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R. H. Barto - NYS (3)
J. B. Johnson - File

April 24, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

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TO C. J. VEITH - M & E FILE

FROM R. E. Chaney DATE April 17, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Plenum Chamber - Top Side EQ.PC.NO. 155-P

[redacted]AWING NOS. W-131155 R. 11 JOB RATING

[redacted]NDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Inspection performed 4/15/53

Scope:
To determine profile of tube tops while subject unit was resting in operating position on "P" top special tube sheet.

Procedure:
An 18' steel straight edge was positioned, across the axis of each pair of the six (6) centering devices, on two machined blocks of equal size. A third machined block of the same size was inserted between the straight edge and the tube top of the center tube for each position. Feeler gages were used to determine the clearance between the straight edge and center machined block.

Results:
See attached sketch.

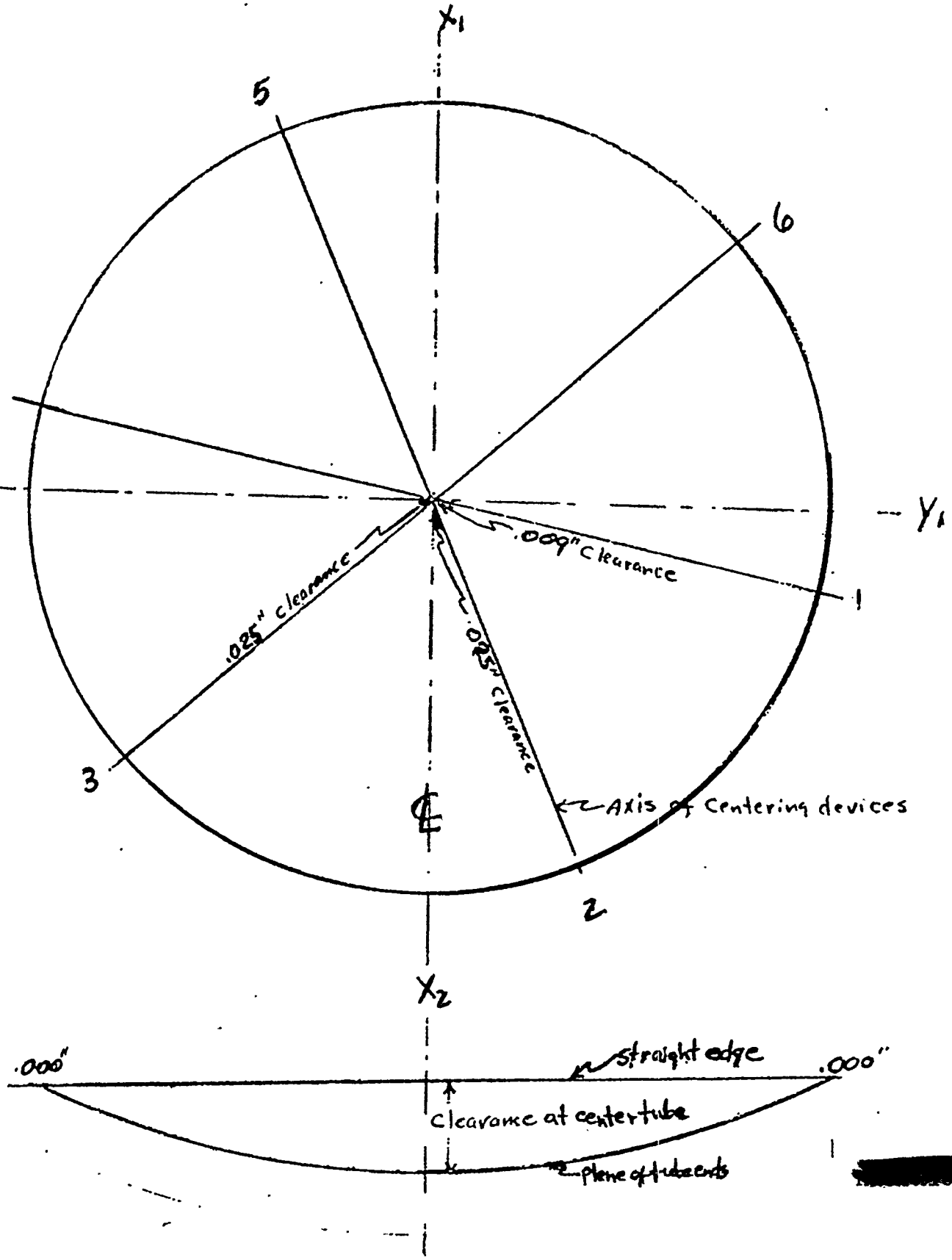
Note: The tube ends, immediately after the facing operation, were in a parallel plane within .005". The change in this condition (see attached sheet) is attributed to the welding of probe pin sockets, latch studs, and water retainer which was done after facing of the tube ends had been completed.

[redacted]ach.

[redacted]N

"P" Plenum Chamber Profile - Top Side 4/15/53

Report #473-P



measure with the belief that better units could be fabricated in the future.

(28) External Cleaning

The final cleaning of the plenum chamber was done after all freon, hydrostatic testing and functional gaging had been completed. This cleaning consisted first of detergent and 1% solium metasilicate washing along with hot deionized water rinsing on the opposite side of the unit. During this cleaning wooden O-ring plugs were installed in all tubes. After this all plugs were removed; each tube swabbed out with solvent (Fine Organics #128) and wipped with a clean cloth; inspected for cleanliness and new O-ring plugs installed. Exhibit #27 presented herewith covers this inspection.

(29) Final Inspection of Large and Rod Tube Bores for Mechanical Defects

Just prior to shipping the "P" plenum to SRF, large and rod tube bores were inspected visually and by feel in critical areas placing emphasis on O-ring seating areas. Where defects such as steps, poor finishes, or scratches were found, repairs were made to eliminate defective conditions. Results were as follows:

a. Rod Tubes

First, top bores of all rod tubes were inspected. All tubes were accepted after repairs were made to three tubes. Tube X17-Y77 exhibited a very poor finish. Honing of this tube to a bore size of 1.513", (0.003" over drawing size) improved the finish to 40 RMS; finish specifications was 63 RMS. Design gave clearance to improve finish of this tube by honing to above dimension of 1.513" diameter. After this, bottom bores were inspected; minor repairs made and accepted.

b. Large Tubes

All large tube bores (top and bottom) were inspected and accepted after repairs. It was impossible to remove scratches from bores of tubes X16-Y24 and X51-Y69 by honing as the bores were all ready 4.392" (drawing dimension: 4.385 to 4.390"). The scratches were at the O-ring seating area and were blended into the contour of the tube bore by "cloverleafing".

(30) Inspection of Shipping Plug Insertion and Shipping Gear Installation

After external cleaning, the "P" plenum chamber was prepared for shipping. A wooden plug with an O-ring fitted to its diameter was inserted into the bottom and top of all large tubes. Rubber stoppers were inserted into all rod tubes on the other periphery of the rod tube pattern. This was done on the top side only and was not deemed necessary on the bottom side. A visual inspection was made to determine if all necessary tubes were plugged. Then, an aluminum disc was bolted

EXHIBIT #27

VISUAL INSPECTION OF "P" PLENUM CHAMBER FOR

EXTERNAL CLEANLINESS PRIOR TO SHIPPING TO SRP

E. I. DU PONT DE NEMOURS & CO., INC. Report Number 467-P

Construction Division

[redacted]

CC: H. W. Gosney, F.P.M.
R. K. Mason - D. A. Hauser
Savannah River Plant (3)
R. K. Mason - E. M. Vass-SRP
H. L. Bunker - J. G. Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
J. B. Johnson - File

April 23, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

This material contains information affecting the national defense of the United States within the meaning of the espionage laws, Title 18, U.S.C., Secs. 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

TO C. J. VEITH - M & E FILE

FROM C. Heist - A.Piatek - R. Potts DATE April 23, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Plenum Chamber EQ.PC.NO. 155-P

DRAWING NOS. W-131155 Rev. 11 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Scope: Visual inspection of "P" plenum chamber for external cleanliness prior to shipping to field site.

Procedure:

Plenum chamber tubes were sealed with wooden plugs with an "O" ring seal. Outside surface was then washed with a solution of 1% sodium metasilicate and detergent, which was followed by a rinse with distilled water. Wooden plugs were then removed from tubes and they were wiped out with a rag saturated with FO 128, and wiped dry with rags. Wooden plugs were then put back into tubes. All personnel working on this operation wore white boots over their shoes. Plenum was then prepared for shipping.

Results:

Plenum chamber was in excellent condition as for cleanliness when covered for shipping to field site.

Note: This work was started on April 16 and completed April 17, 1953.

[redacted]

to each side of the plenum large tube pattern to serve as a protective covering for the tube ends. Next, all handling gear was secured to the unit. Finally, the entire plenum was "pillow cases" with canvas and laced on the outer periphery and made ready for shipping.

The "P" plenum chamber was shipped by tug boat and barge from New York Ship on April 18, 1953, to the Savannah River Plant located in the state of South Carolina.

C. "L" Unit

(1) Square Slot Milling Operation

This inspection was performed in an identical manner as described in Section 16B-9 of this manual except the following discrepancy was found: Those slots in row M90 were found to be milled 1/16" to 3/8" off center. This discrepancy was reported to Design and accepted by same. All other slots inspected were satisfactory and the job was accepted.

(2) "V" Slot Milling Operation

Inspection of the three machined "V" slots in the top ends of all large tubes was performed in an identical manner as described in Section 16A-(2)a of this manual. Approximately 600 slots checked for depth were found too shallow. Slots ranged from .001" to .014" undersize. These slots were repaired by filing and re-inspection of same proved satisfactory. See Exhibit #28 for details on final inspection results.

(3) Tangential Slot Inspections

This inspection was performed in an identical manner described in Section 16B-(12) of this manual. No discrepancies were found and the job was accepted.

(4) Large Tube Honing

All large tube bores in this unit were honed between 4.385" and 4.390". The inspection of tube bores after honing was identical to that described in Section 16B-(2) of this manual. Results of this inspection were satisfactory; however, all tube bores were subject to further visual inspection at a later date.

(5) Dimensional Check and squareness of Nozzle Flanges After Finish Machining

This inspection is covered in Report Number 622-L presented herewith. Also, the procedure for inspecting nozzle flanges after machining is outlined in Memorandum Serial Number 223-L. These two reports are presented as Exhibit #29. All inspections were satisfactory and the job was approved.

EXHIBIT #28

"V" SLOT INSPECTION

(FINAL)

E. I. DU PONT DE NEMOURS & CO., INC. Report Number 587-L

28

Construction Division

[redacted]

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CC: J. B. Johnson
R. K. Mason-D.A.Hauser-SRP (3)
R. K. Mason- W.P.Duncan-SRP
H. L. Bunker - J.G.Brewer
J.G.Brewer
H.B. Gage
F.C. Breuninger
S.R. Cochran (2)
R. H. Barto - NYS (3)
R. V. Graham - File

September 9, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM I. R. Louder DATE August 5, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC 167½

EQUIPMENT "L" Plenum Chamber EQ.PC.NO. 155-L

DRAWING NOS. W-132841 R3-Detail III JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, New Jersey

This is a final report on inspections made on V-Notch slots on top ends of all plenum chamber tubes. Inspections were made concurrent with machining during period 7-10-53 to 7-17-53 by du Pont inspectors.

Inspection consisted of determining size and orientation of V-notch slots. Orientation was checked by use of a special gage shown on drawing number D-112872 Rev. 1. Size was checked by means of a special gage shown on drawing number D-112893 Rev. 0.

Blueprint specifications for slots are:

Angular tolerance = $\pm$ 1/2°
Size of slot at top (width) = .530 $^{+\ .005}_{-\ .000}$

During the course of inspection one slot was found to be as follows: Tube X27 Y3; #3 slot - Angular deviation 2° cw; width .532. The above slot was welded and re-milled and is now within tolerance.

Mr. Arthur of Design gave clearance to R. V. Graham of M & E, by telephone conversation on 7/18/53, to accept the following:

[redacted]

[redacted]

FIELD INSPECTOR'S REPORT
FROM: I. R. Louder

1. V-slots listed below which are beyond blueprint tolerance angularity.

Tube # X	Y	Slot #1 Angular Deviation	Slot #1 Width	Slot #2 Angular Deviation	Slot #2 Width	Slot #3 Angular Deviation	Slot #3 Width
33	3			3/4° CW	.531		
26	6	1° CCW	.533	1° CCW	.531	1° CCW	.532
14	12	3/4° CW	.531				
35	9	3/4° CW	.532				
16	12	3/4° CW	.532				
18	12	3/4° CW	.532				
22	12	3/4° CW	.533				
34	12	3/4° CW	.533				
43	15	3/4° CW	.530				
21	27	3/4° CW	.531				
48	30	3/4° CW	.527				

2. All slot widths within the range of 0.536"-0.547" inclusive. (.001" to .012" oversize) provided orientation was within specified tolerances.

3. All slot widths within the range of 0.548" to 0.550" inclusive provided the orientation was within 1/4°.

All slots meet angular tolerance and width requirements as specified by Mr. A. Arthur.

Range of slot widths:

.530" to .535"	.536" to .540"	.541" to .545"
1764	242	13

Measurements of all slots are on file in M&E Office at New York Ship.

[redacted]

EXHIBIT #29

1. Dimensional Check and Squareness of Nozzle Flanges After Finish Machining.

2. Machining of "L" Unit plenum Chamber Nozzle Flange faces and Inspection Procedure

E. I. DU PONT DE NEMOURS & CO., INC.

Report Number 622-L

Construction Division

[redacted]

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CC: J. B. Johnson
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J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
R. V. Graham - File

September 30, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE
A.A.Conn - R.R.Baker - R.E.Chaney
FROM A. J. Piatek - H.E.Dahlke DATE September 22, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Plenum Chamber EQ.PC.NO. 155-L

DRAWING NOS. W-132842-Rev.4 & W-132843-Rev.11 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Scope: Dimensional check and squareness of nozzle flanges after finish machining.

Procedure: Squareness of nozzle flange faces was inspected as per memo. serial number 223-L issued on 7/29/53 by H. E. Dills.
Other dimensions taken with standardized steel tape and machinist rule ("6" inch).

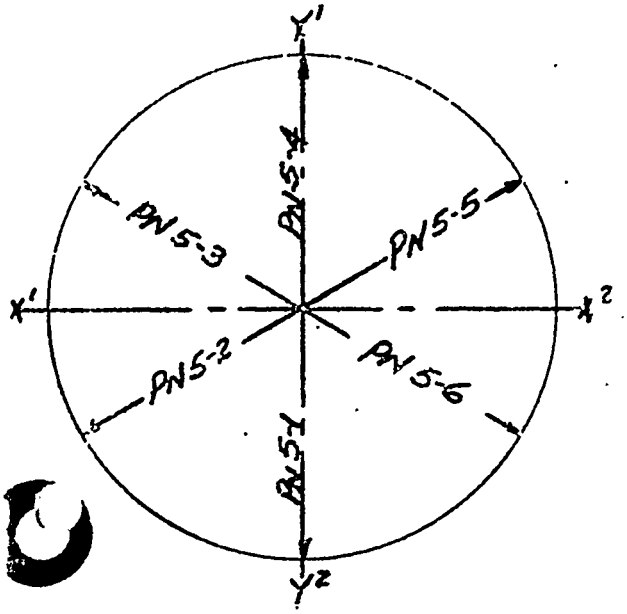
Results: All flange dimensions were found to be acceptable to above drawings. Final results are tabulated on attached sheet.

lmw

[redacted]

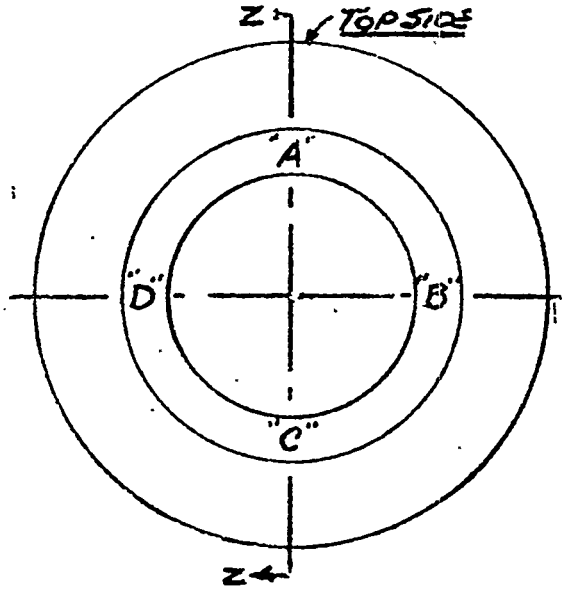
RESULTS [redacted] DATE 9-22-53

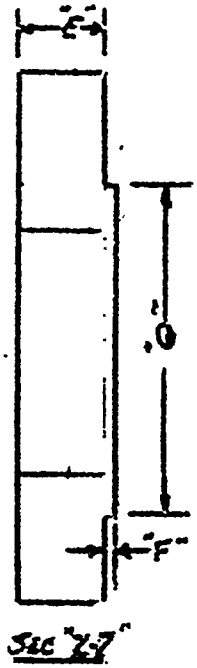
NOZZLE No.	INSP. DATE	INSPECTORS
PN-5-1	8-11-53	R. BAKER H.E. DAHLKE
PN-5-2	8-8-53	A.A. CONN
PN-5-3	8-5-53	A.J. PIATEK
PN-5-4	8-5-53	A.J PIATEK R.E. CHANEY
PN-5-6	8-10-53	A.A. CONN H.E. DAHLKE
PN-5-5	8-7-53	A.A. CONN



EACH FLANGE 60° APART

FLANGE LAYOUT TOP SIDE





FLANGE DIM. LAYOUT

FLANGE DIMENSIONS

	SQUARENESS OF GASKET FLANGE				O.C THICKNESS	GASKET FLANGE THICKNESS	DIA. GASKET FLANGE	SURFACE ROUGHNESS	BOTTOM END OF TUBES TO ℄ OF FLANGE
NOZZLE No.	"A"	"B"	"C"	"D"	"E"	"F"	"G"	R.M.S.	———
5-1	0	0	+.010	+.013	1 15/16"	3/64"	15"	100	11 29/64"
5-2	0	0	+.001	+.001	1 15/16"	3/64"	15 1/16"	90	11 25/32"
5-3	0	+.002	+.003	0	1 31/32"	3/64"	15 1/32"	75	11 15/16"
5-4	+.007	0	+.007	+.006	2 1/16"	3/64"	15 1/16"	80	11 53/64"
5-5	0	+.003	0	+.002	2"	1/58"	15 1/64"	100	11 57/64"
5-6	0	0	+.010	0	1 31/32"	1/32"	15"	100	11 1/16"
DWG. DIM	← 1/16" ACCUMULATED →				2"	1/32"	15"	125	11 3/4"

[redacted]

EXHIBIT #29

MACHINING OF PLENUM CHAMBER NOZZLE FLANGE FACES ("L" UNIT)

A member of Design verbally requested that the flange faces on this unit, and all subsequent units, be held perpendicular to the 60° centerlines and the plane of the tube ends within a tolerance of 0°15'±. or 1/16" over the raised face. To facilitate the checking of this dimension it was necessary for New York Ship to layout these 60° centerlines on each nozzle and on the bottom side based on X & Y axes established by du Pont Inspection Department.

Du Pont inspection checked flange faces by the following method:

1. A straight edge was placed along the 60° centerlines, resting on the tube faces, bottom side, and extending over the flange face.

2. A precision square was placed against the straight edge and resting against the raised face of the flange. Feeler gages were used to determine the squareness of flange face to plane of tubes.

3. The straight edge was then placed parallel to the 60° centerline with 12" to one side or the other by use of parallel bars.

4. Two machined blocks were clamped to the straight edge in such a manner that it extended down along side the flange face.

5. A precision square and feeler gages were used to determine squareness of flange face to centerline.

6. The distance from the center tube to the flange faces were checked with a steel tape.

7. The thickness of flange faces were measured.

8. The unit was leveled, using the Wild Level, to a plane within 0.010". No machining was done until the above inspections were made and the amount of material to be taken off determined. The machines were set up essentially the same way as the inspection was made so that the required squareness was reproduced. All of the above inspections were repeated after machining. Inspection then measured the distance from the plane of the tops of the tubes to the center of each nozzle. This information was reported to Design.

(6) Radial Measurements from Center Tube (X28-Y48) to face of Nozzle Flanges

This inspection was performed after machining the nozzle flanges. Using a 25 ft. stainless steel tape and measuring from the I.D. of the center tube (X28-Y48) to a straight edge across the face of the flanges and added ½ the I.D. of the center tube, the following measurements were obtained:

Nozzle #	Orientation	Measurement
1	Y2	12'-6 3/16"
2	Between Y2-Y1	12'-6 11/32"
3	Between X1-Y1	12'-6 7/32"
4	Y1	12'-6 3/8"
5	Between Y1-Y2	12'-6 27/64"
6	Between X2-Y2	12'-6 3/16"

Drawing dimension was 12'-6 5/8" ± 1/8". The above dimensions were considered satisfactory and the job was accepted.

(7) Dimensional Inspection of Cooling Water Holes with Respect to Lifting Lug Slots and Instrument Plate Slots

The orientation and size of cooling water holes was checked in a similar manner described in Section 16B-(22) of this manual. All measurements were satisfactory and the job was accepted.

(8) Final Pattern Measurements

Pattern measurements were taken on the top and bottom sides of this unit in an identical manner as described in Section 15A-(4) of this manual. For results of pattern measurements, see Exhibit #30.

(9) Establishing X and Y Centerlines on Top Side of Plenum Chamber

A final set of axes were scribed on the top side of the plenum chamber after honing all large tubes to the required diameter. Part IIA - section 13-a described how these axes were established. The final tube coordinate patterns were referenced from these axes.

(10) Large Tube to Rod Tube Ligament Measurements

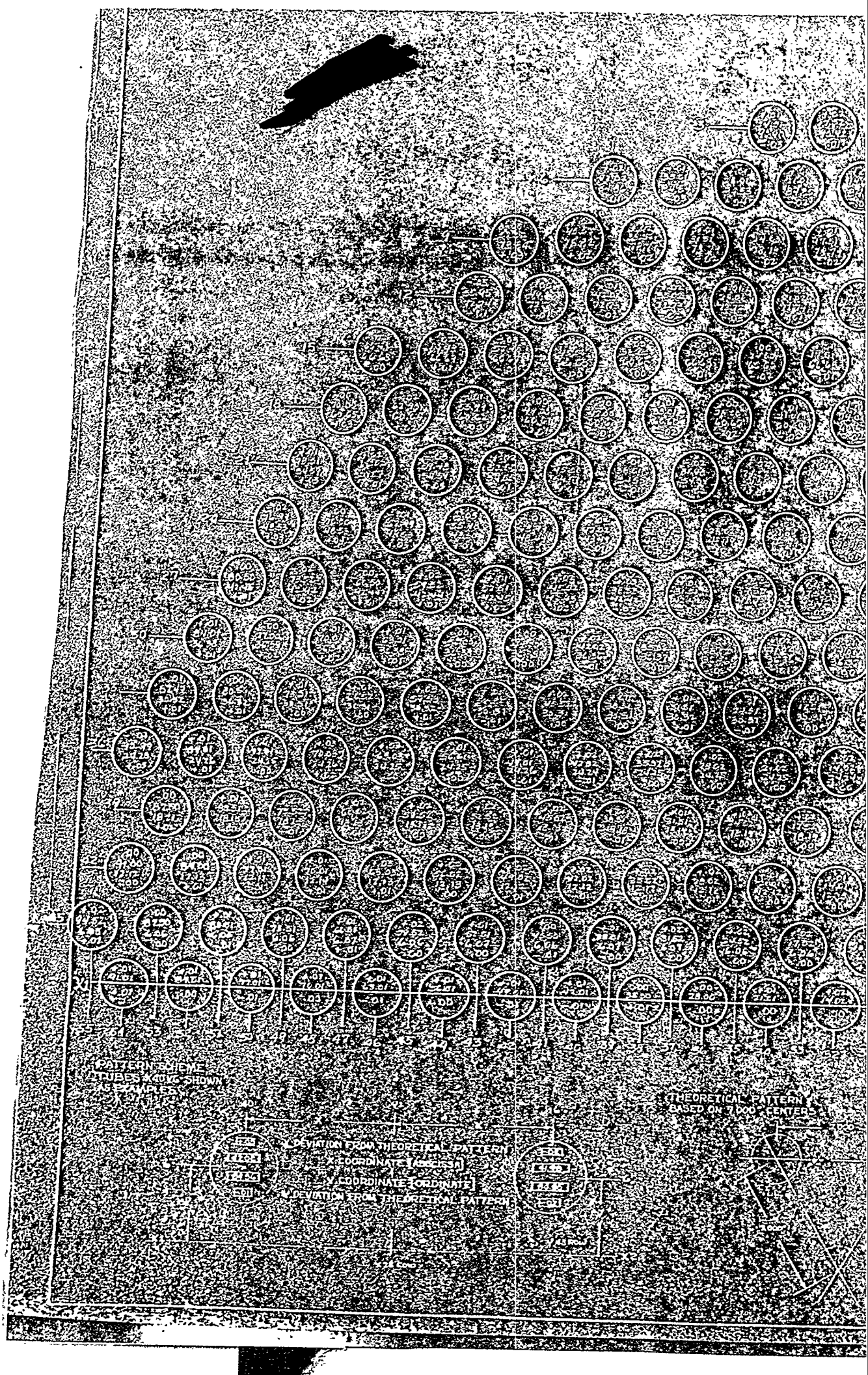
These measurements were taken in an identical manner described in Section 16A-(5) of this manual. All results were satisfactory and the job was accepted.

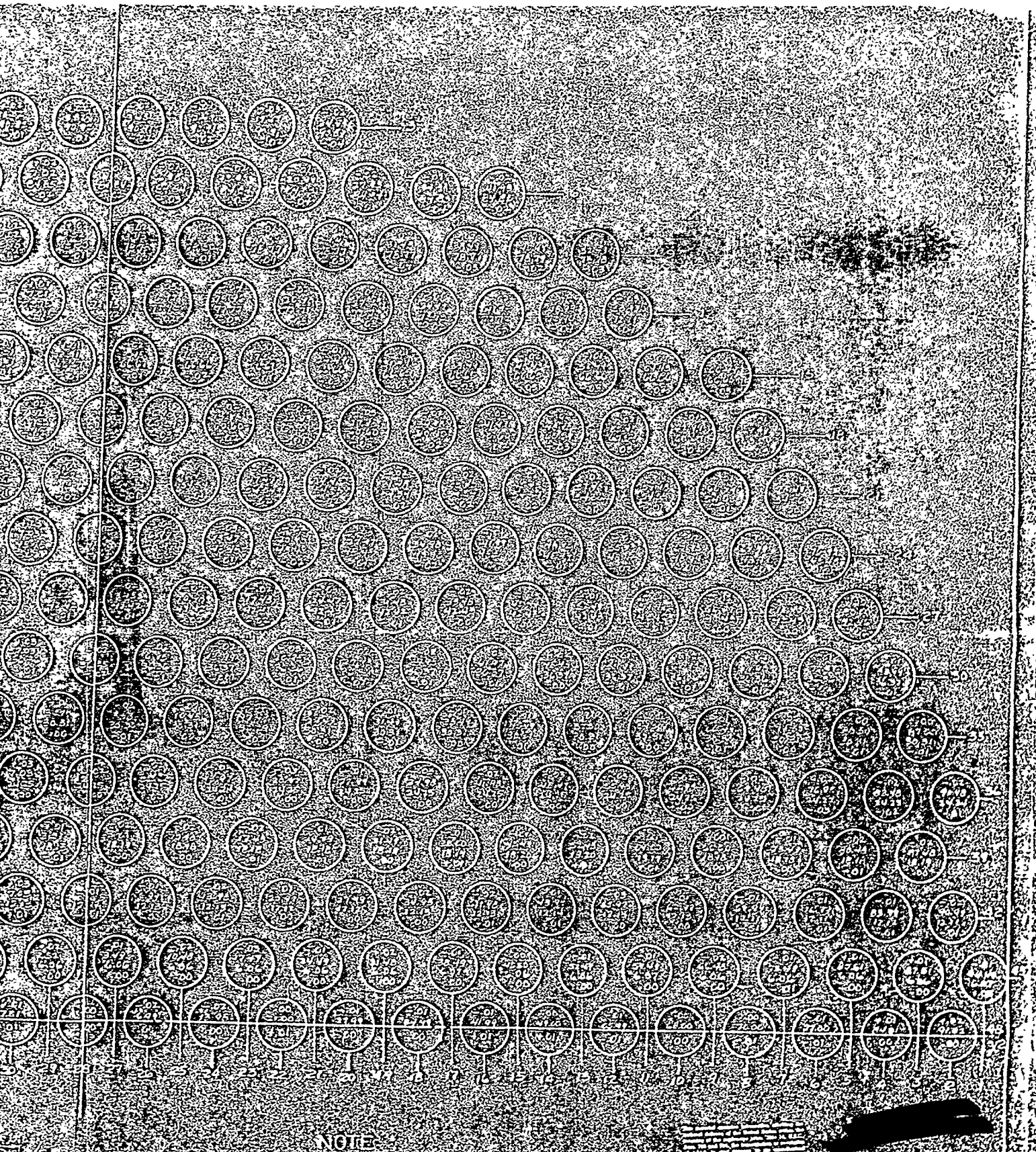
(11) Weir Slot Inspection

The requirement that all plenum tube weir slots, or elongated slots, be flush with the top side of the bottom tube plate necessitated a visual inspection of same to ascertain whether or not this specification was being complied with. It was required that these slots (3 tube) be flush with the bottom plate to prevent the accumulation of any liquid in the unit after shutdown. All slots were visually inspected and many were found to be "high". In order to comply with

EXHIBIT #30

RESULTS OF PATTERN COORDINATES TAKEN ON TOP AND BOTTOM SIDES OF THE "L" PLENUM CHAMBER


PATTERN AS GIVEN
TUBES MARKED THUS
EXAMPLES
THEORETICAL PATTERN
BASED ON 1.000" CENTERS
DEVIATION FROM THEORETICAL PATTERN
X COORDINATE (hundredths)
Y COORDINATE (hundredths)
DEVIATION FROM THEORETICAL PATTERN



NOTE

COORDINATES AND DEVIATIONS AS LISTED ABOVE HAVE BEEN ROUNDED OFF FROM THREE DECIMAL PLACES, AND TOGETHER MAY NOT TOTAL THE THEORETICAL TWO DECIMAL DISTANCE. FOR EXAMPLE, THE THEORETICAL DISTANCE FROM 33 TO 34 IS 10.84 INCHES. THE MEASURED DISTANCE OF TUBE 33V34 IS 10.843 INCHES. THEREFORE, COMPUTED DEVIATION IS .003 INCHES. TUBE 33 IS POINTED 15° AND DEVIATING 10°

ALL TUBE MEASUREMENTS WHEN TAKEN DOWN FROM TOP OF TUBE

E. I. DU PONT DE NEMOURS & CO.
WILMINGTON, DELAWARE
CONSTRUCTION DIVISION
ATLAS SECTION

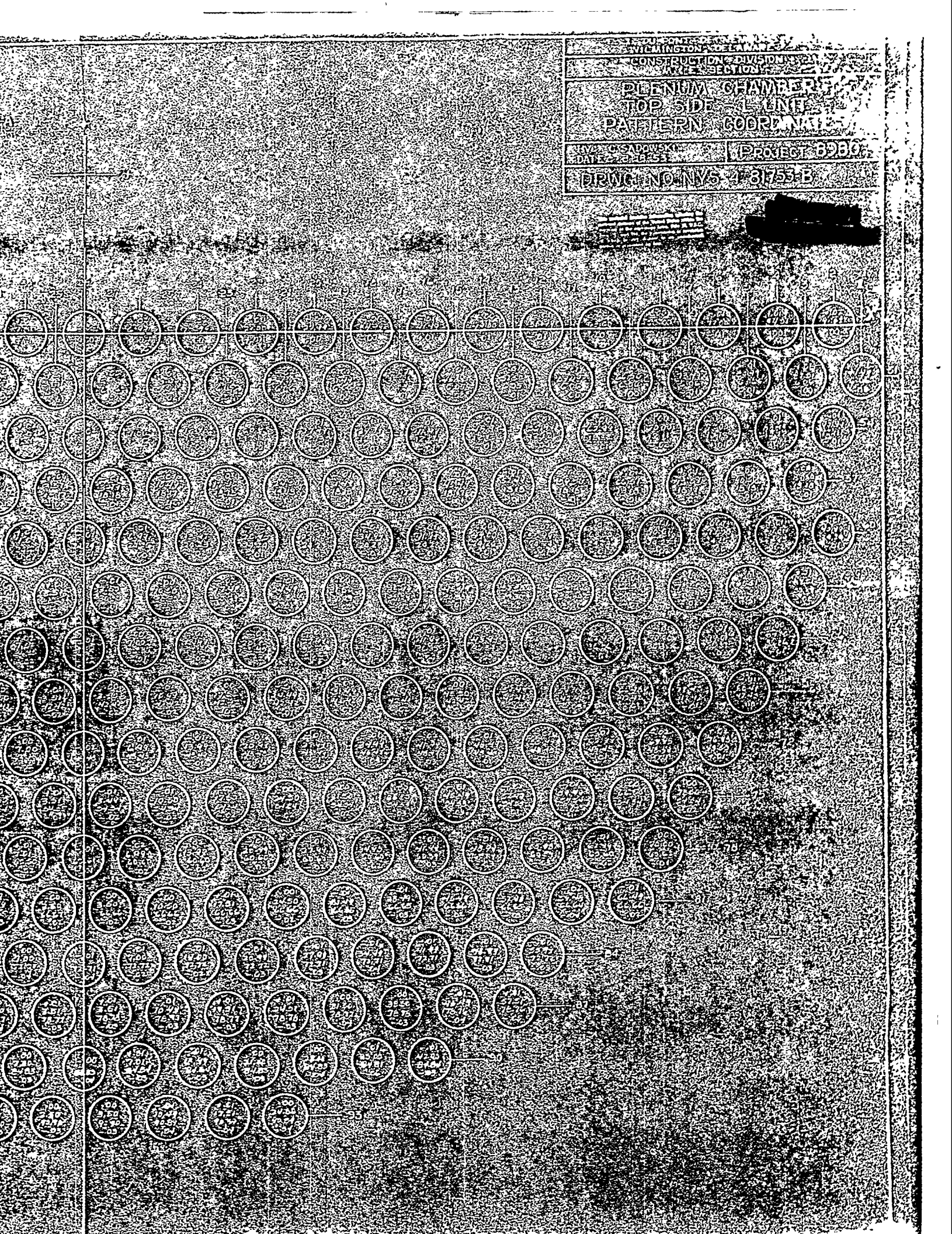
PLENUM CHAMBER
TOP SIDE - L UNIT
PATTERN COORDINATES

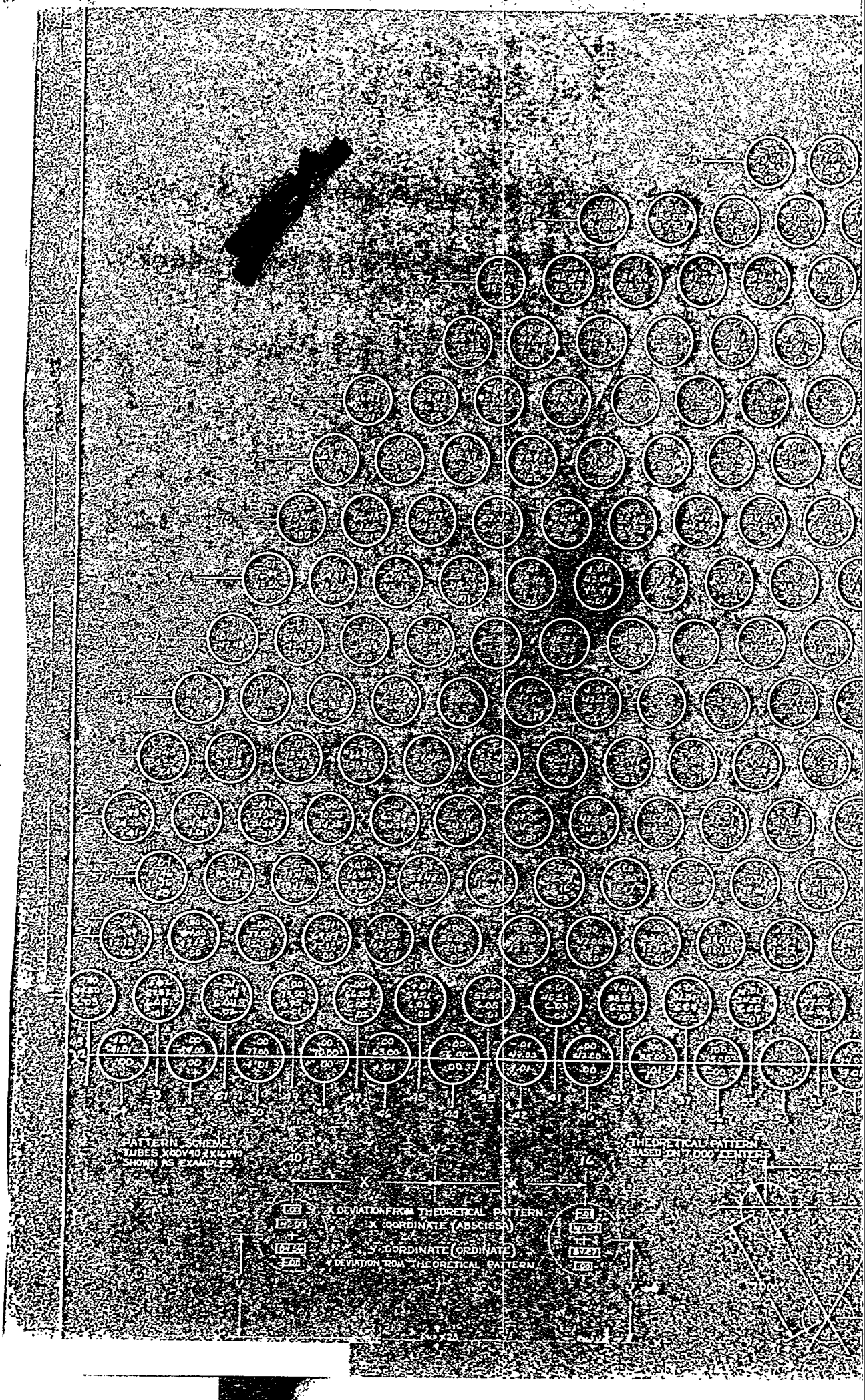
BY C. SADOWSKI
DATE 8-17-53

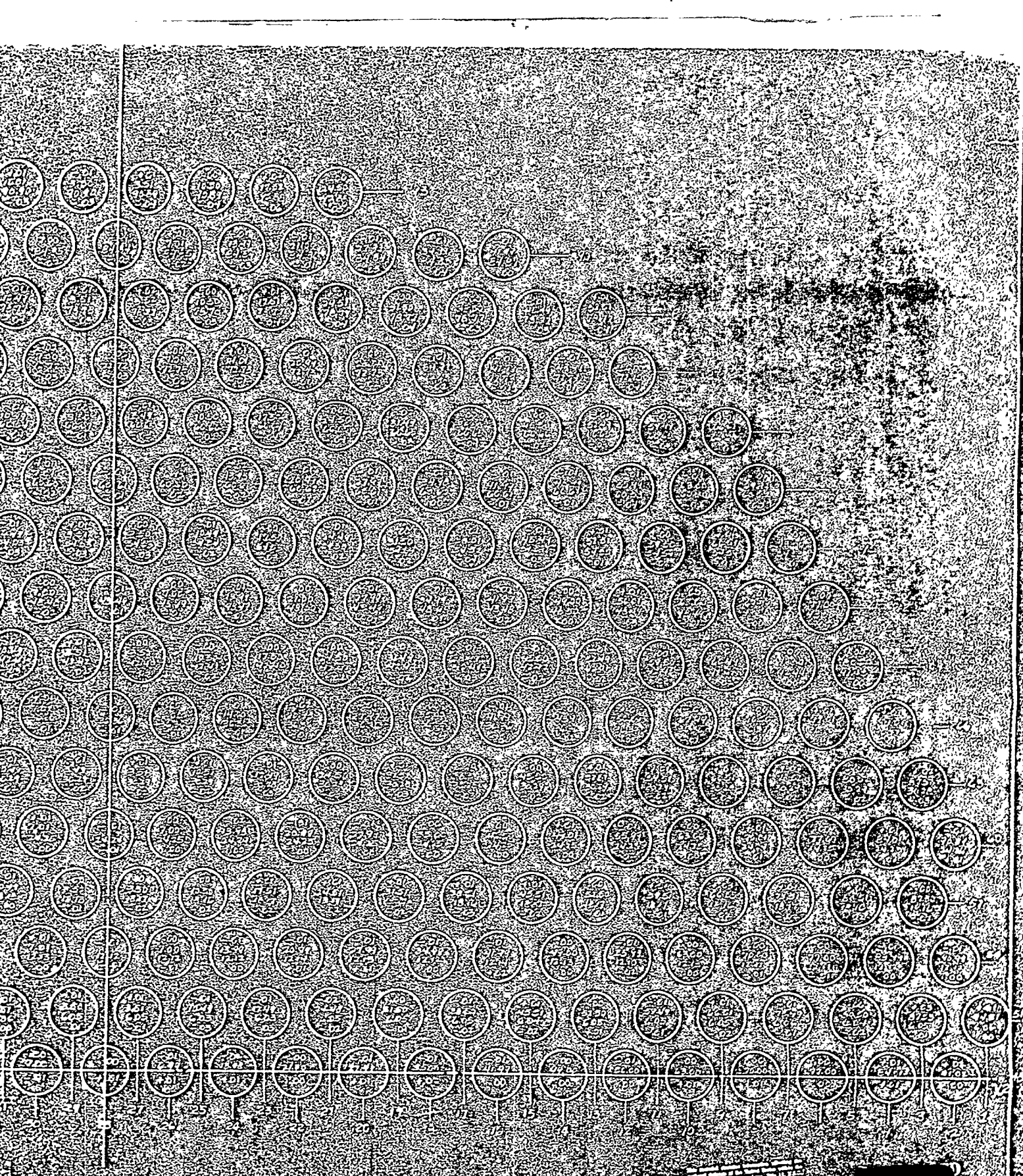
PROJECT 8980

DRWG. NO. NY54-8753-A

SEE COMPANION DRWG NO'S 4-3
FOR GENERAL NOTES


WILMINGTON, DELAWARE
CONSTRUCTION DIVISION (DB)
WYKE SECTION
PLENUM CHAMBER
TOP SIDE - L UNIT
PATTERN COORDINATES
PROJECT 8D80
DRWG. NO. NYS-1-81753-B


PATTERN SCHEME
TUBES X40Y40 & K40Y40
SHOWN AS EXAMPLES
THEORETICAL PATTERN
BASED ON 7.000 CENTERS
X DEVIATION FROM THEORETICAL PATTERN
X COORDINATE (ABSCISSA)
Y COORDINATE (ORDINATE)
Y DEVIATION FROM THEORETICAL PATTERN



NOTE

COORDINATES AND DEVIATIONS AS LISTED ABOVE HAVE BEEN ROUNDED OFF FROM THREE DECIMAL PLACES AND TOGETHER MAY NOT TOTAL THE THEORETICAL TWO DECIMAL DISTANCE. FOR EXAMPLE: THE THEORETICAL DISTANCE OF ROW A FROM B IS 1.75 INCHES. THE MEASURED DISTANCE OF TUBE X18 Y12 IS 13.73 INCHES. THEREFORE COMPUTED DEVIATION IS -.02 INCHES. TUBE IS PLOTTED AS 1.75 AND DEVIATION = .01

ALL TUBE MEASUREMENTS TAKEN ONE INCH DOWN FROM TOP OF TUBE

E. I. DU PONT DE NEMOURS & CO.
WILMINGTON, DELAWARE

CONSTRUCTION DIVISION
M. E. SECTION

PLENUM CHAMBER
BOTTOM SIDE - E UNIT
PATTERN COORDINATES

BY C. SADOWSKI
DATE 11-5-53

PROJECT E980

NOTE

SEE COMPANION DRWG NO. 5335-FA
FOR GENERAL NOTES

E. I. DU PONT DE NEMOURS & CO.
WILMINGTON, DELAWARE

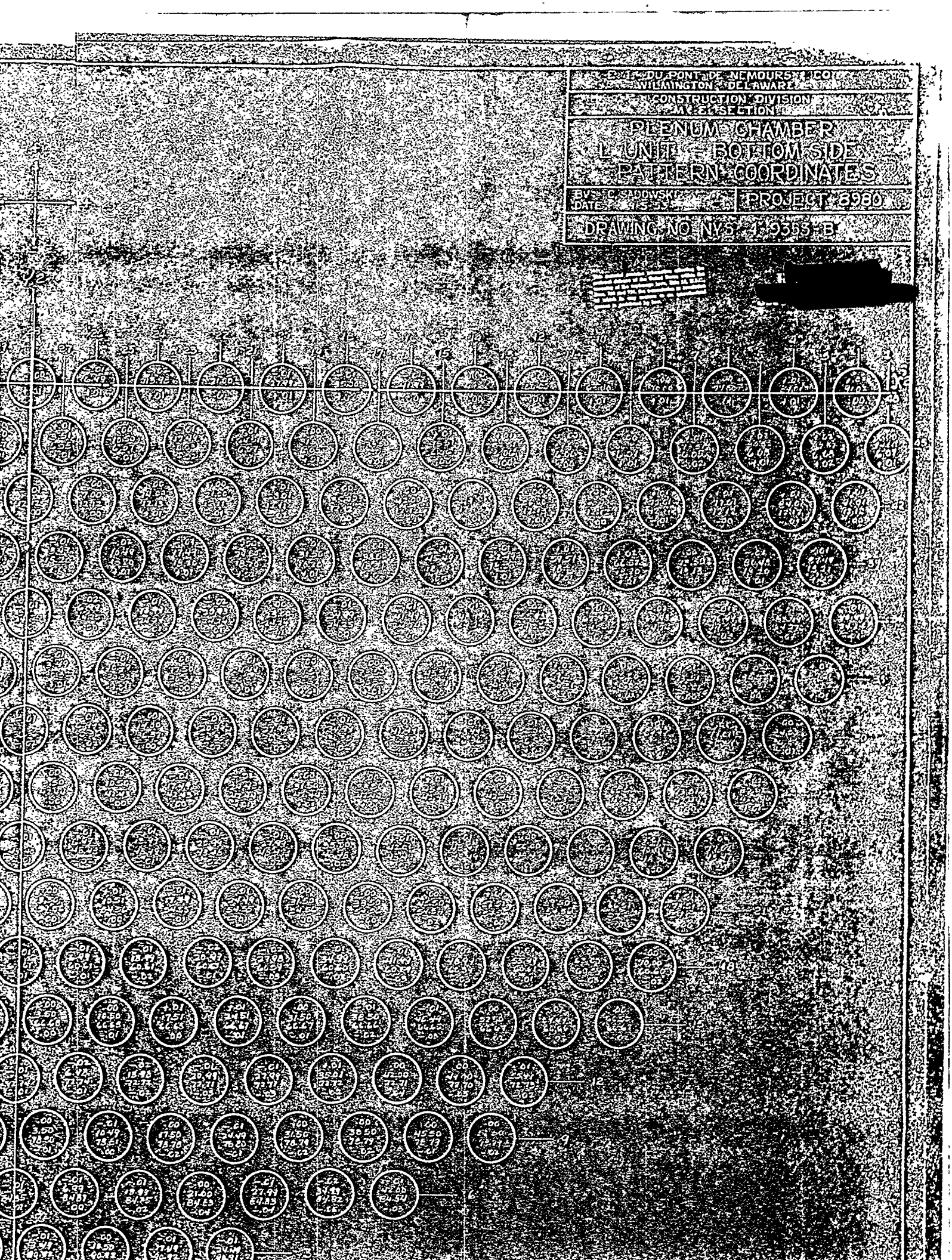
CONSTRUCTION DIVISION
MECH. SECTION

PLENUM CHAMBER
UNIT - BOTTOM SIDE
PATTERN COORDINATES

BY C. SADOWSKI | PROJECT 3980

DRAWING NO NV5-4-9353-B

[redacted]



the above specification, it was necessary for New York Ship to mill all weir slots too "high" flush with the top side of the bottom plate. A Thor #14 angle head air motor and a 5/16" end mill were used to mill the slots flush. Photo Serial #269 in Part VIII, Section A-12-b illustrates pictorially how this machining or milling operation was accomplished. A visual inspection by du Pont Inspectors was concurrent with the milling operation to insure no damage to finish honed bores resulted, and that no slots were elongated or milled into the bottom land of the plenum tube bore. During this inspection it was found that sharp edges and burrs were left on all slots as a result of milling. To remove this mechanical defect, slots were deburred by either filing or cloverleafing or by a combination of both. Upon re-inspection of all slots, they were found satisfactory and the job was accepted.

(12) Probe Pin Socket and Latch Stud Inspections

To the top side of the "L" plenum chamber eight hundred and thirty-eight (838) probe pin sockets were welded at locations specified on du Pont drawing W133609. The location of probe pin sockets that served rod tubes (one tube) on "P" unit was stud welded to the top plate on the X1 side of the rod tube it served. On "L" unit the probe pin socket was located and welded the same distance away from the rod tube as on "P", except on "L" the socket was located on the X2 side of the rod tube. This design change can be verified by referring to du Pont drawing W133305 ("P" unit) and W133609 ("L" unit).

Before welding sockets to the unit, they were visually and dimensionally inspected 100% and found satisfactory. For method used for gaging and dimensionally checking pre-welded probe pin sockets, see Part III, Section II-C-1a. After this preliminary inspection, sockets were welded to the top side of the plenum chamber using the "Nelson" gun stud welding method.

After all probe pin sockets had been welded to the unit, the following inspections were made:

a. Location of "rod tube probe pin socket" with respect to rod tube. The gage used and the procedure followed during this inspection is discussed in detail in Part III, section II-C. Inspection proved satisfactory and the job was accepted.

b. Location of "large tube probe pin socket" with respect to large tubes. The gage used and the procedure followed during this inspection is discussed in detail in Part III, Section II-C. Inspection proved satisfactory and the job was accepted.

c. Location of latch studs with respect to rod tubes. The gage used and procedure followed during this inspection is discussed in detail in Part III, Section II-D. Inspection proved satisfactory and the job was accepted.

d. Distance from top surface of finished machined probe pin socket to top surface of large tubes. Socket faces were spot faced 1/16" below the top ends of large tubes. Tolerance on this dimension was + .000 -.1/16". One hundred and twenty-three (123)

probe pin sockets were found out-of-tolerance. These were as follows: tubes-in-tolerance 550; tubes out-of-tolerance 0.001" to 0.015" - 72; tubes out-of-tolerance 0.016" to 0.047" - 45; tubes out-of-tolerance 0.048" and up - 6. Tubes out-of-tolerance 0.048" and up were:

Tube Number	Amount Out-of-Tolerance
X28-Y27	0.050"
X20-Y30	0.057"
X37-Y30	0.050"
X21-Y33	0.050"
X29-Y57	0.065"
X4-Y32	0.077"

The above discrepancies were reported to Design who later accepted them as satisfactory.

e. Thread Check of Probe Pin Sockets

Two thread gages were used:

(1) 7/16" - 20UNF Class 2B; Go-pitch dia. of 4.4050; No-Go Pitch dia. of .4104.
(2) 7/16" - 20 UNF Class 3B; Go-Pitch dia. of 0.4050; No-Go Pitch dia. of .4091.

Threads in probe pin sockets after welding to unit were checked as follows:

(1) Insert No-Go end of 3B gage in all threads, if loose fit exists then,
(2) Insert No-Go end of 2B gage in all 3B loose fits. Any that are a loose fit with a 2B gage is considered in 1B fit.

A permanent record was made of the number of sockets that were 3B, 2B and 1B fits, and information forwarded to Design for approval. Probe pin sockets with 2B threads by tube number were: X16-Y6; X18-Y6; X13-Y9, X21-Y9; X16-Y18; X34-Y18, X7-Y21, X9-Y21; X11-Y21; X15-Y21, X17-Y21; X21-Y21; X23-Y21; X31-Y21; X33-Y21; X26-Y24; X28-Y24; X21-Y27; X12-Y30; X22-Y30; X28-Y60; X28-Y78; X42-Y60. These discrepancies were accepted by Design.

(13) Plenum Template Inspection

The inspection of "L" unit template used for telescope actuator erection work at Savannah River Plant was performed in an identical manner as described in Part IV, Section 6. All inspections proved satisfactory and the job was accepted for shipping to the plant site.

(14) Motion Measurement and Motion Indicator Attachments

In addition to the probe pin sockets welded to the top side of "L" plenum chamber to serve rod tubes and large tubes, five more probe pin sockets were located and welded to the unit for the purpose of motion measurements. Du Pont drawing W133609 shows where these extra sockets

were located and welded. These probe pin sockets were checked for location using a 25 foot stainless steel tape and a 6" scale. Socket threads were checked in an identical manner described in the preceeding section. There were no discrepancies and the job was accepted.

(15) Tube Number Identification Tag Inspection

This inspection was performed in an identical manner described in Section 16B-(15) of this manual. Inspection proved satisfactory and the job was accepted.

(16) Dowell Cleaning (Internally)

Since the cleaning procedure written for "P" plenum chamber was followed in detail and satisfactory results were obtained, the du Pont Inspection Department adopted the same procedure for the "L" plenum chamber with minor modifications. These were:

a. Instead of rinsing each of the 673 large tubes ("P" unit) with hot distilled or de-ionized water using the special tube plug designed for this purpose, rinsing of the "L" plenum was done by jetting into each of the six nozzles with a S/S pipe using hot de-ionized or distilled water for 15 minutes, and then installing tube plugs. (Refer to Exhibit #21, Step II-B, Section 16B-(2) and Exhibit #31, Step II-B, of this section for changes in procedure.)

This change was effected in the "L" plenum chamber cleaning procedure because the length of time required in spraying the solution into each of the 673 tubes was too lengthy and time consuming.

b. Instead of gradually draining the unit as stated in the "P" plenum cleaning procedure, Step IV-D, the unit was rapidly drained on the "L" plenum chamber as noted in step IV-D, Exhibit #31. The change over from "gradually draining" to "rapidly draining" was adopted in order to provide a better cleansing action through an accelerated flow of liquid.

The procedure for internally cleaning the "L" plenum chamber was followed in detail as outlined in Exhibit #3/presented herewith. The operation was witnessed by a du Pont Inspector and the results of the visual inspection during and after cleaning is presented herewith as Exhibit #32.

(17) Hydrostatic Test (Final)

The plenum was placed on pedestals with the top side up in a horizontal position, and the unit was prepared for preliminary hammer and hydrostatic testing. First, all flanges were closed off using mild steel flange blanks and 1/8" thick Garlock #900 gaskets. Next, the tube ends were sealed off using mild steel tube cap flanges and 1/16" thick Garlock #900 Gaskets. (See photo serial #240, Section 16B-(5) of this manual). Pressure gages (two with 0-500 psi. range) were installed on one of the nozzle flange blanks. The assembly was then filled

EXHIBIT #31

"L" UNIT PLENUM CHAMBER FINAL CLEANING PROCEDURE

E. I. DU PONT DE NEMOURS & CO., INC.

Serial Number 229-L

Construction Division

CC: J. B. Johnson (2)
R. K. Mason-D.A.Hauser-SRP (3)
R. K. Mason-K.R.Brown-SRP (2)
H. L. Bunker-J.G.Brewer
H. B. Gage
J. A. Collins
C. J. Veith
L. H. Arning-F. C. Breuninger
J. F. Elliot
Dowell Corp. (2)
S. R. Cochran (2)
R. V. Graham - File

SE[redacted]ORMATION

August 21, 1953
New York Ship - Camden, N. J.

This material contains information affecting the national defense of the United States within the meaning of the espionage laws, Title 18, U.S.C., Secs. 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

MEMORANDUM

TO: R. H. BARTO - J. W. REID (5)
NEW YORK SHIPBUILDING CORP.
CAMDEN, NEW JERSEY

FROM R. V. Graham - H. E. Dills HEDills

PROJECT 8980 - SAVANNAH RIVER PLANT - "L" UNIT
PROPOSED PLENUM CHAMBER FINAL CLEANING PROCEDURE

Cleaning Solution to be as follows:

0.1% Detergent (by weight)
1.0% Caustic
1.0% Trisodium Phosphate
Remainder - deionized or distilled water
Temp. 150° - 190°F.

I. Jetting of plenum chamber in horizontal position slightly inclined.

A. No tube plugs installed. (Nozzle blind flanges removed)

B. Jet with stainless steel nozzle thru each nozzle for 10 minutes each.

II. High pressure washing of plenum chamber in horizontal slightly inclined position.

A. Using special tube **plug and high pressure pump [redacted] spray cleaning solution thru the three slots in every tube for 1 minute each starting with tubes on the high side and working toward the low side.

SE[redacted]

B. Jet into each nozzle with a S/S pipe using hot deionized or distilled water for 15 minutes and install tube plugs.

III. Washing of plenum chamber in vertical position, suspended by padded wire slings on two (2) nozzles 60° on either side of Y_1 nozzle. (Y_1-Y_2 axis vertical, Y_1 at top.) Use S/S blanks on all nozzles.

A. Fill unit with cleaning solution thru bottom most nozzle and overflow thru top nozzle until full. Other four (4) nozzles blanked off.

B. Agitate with air simultaneously thru 2 bottom nozzles and eight (8) bottom tubes fitted with special *center tapped plugs. (1 hour) X9-Y81; X13-Y87; X16-Y90; X21-Y93; X35-Y93; X40-Y90; X43-Y87; X47-Y81.

C. Drain unit thru bottom most nozzle and tubes used in step "B".

IV. Rinsing of plenum chamber in vertical. (Y_1-Y_2 axis vertical, Y_1 on top.)

A. All tube plugs installed plus eight (8) special center tapped plugs* in bottom sector and ten (10) special center tapped plugs* in top sector. Location of these special plugs are as follows:

Top - X 6-Y24; X 9-Y15; X13-Y 9; X16-Y 6;
X21-Y 3; X35-Y 3; X40-Y 6; X43-Y 9;
X47-Y15; X50-Y24.

Bottom - X 9-Y81; X13-Y87; X16-Y90; X21-Y93;
X35-Y93; X40-Y90; X43-Y87; X47-Y81.

B. Fill unit with hot deionized or distilled water thru bottom nozzle, vent thru top nozzle until unit is full and overflow for 5 minutes.

C. Agitate with air thru two bottom nozzles and eight special center tapped plugs* for 30 minutes while unit overflows at top nozzle.

D. Rapidly drain unit thru bottom most nozzle by completely removing flange and rinse thru ten special center tapped plugs* in top sector and three (3) top nozzles for 30 minutes, while air remains on two bottom nozzles and eight tubes in lower half

E. Check rinse water with PH paper for evidence of caustic (PH should be no higher than 7.2). If caustic is present, repeat complete rinsing operation described above.

* This special tube plug consists of a perforated tubular center plugged at one end and tapped for hose connection on opposite end. A flange on each end with "O" ring grooves is used to seal on the I. D. of the tubes.

** This special plug is an adaptation of a tube cap Detail 112519 originally used to seal off tubes during NYX tests. One of these caps has been altered by drilling and tapping a 1/2" hole in the top plug and three longitudinal rows of 9 - 1/16" holes each in the barrel. The rows of holes are spaced 120° apart and are orientated with the plenum tube slots by means of a key mounted on the shoulder of the cap. The plug is inserted in the tube with the key in any one of 3 "V" slots in the top of each plenum tube.

lmw

EXHIBIT #32

DOWELL CLEANING & RESULTS

E. I. DU PONT DE NEMOURS & CO. REPORT Number 594-L

Construction Division

[redacted]

This material contains information affecting the national defense of the United States within the meaning of the espionage laws, Title 18, U.S.C., Secs. 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

CC: J. B. Johnson
R. K. Mason-D.A. Hauser-SRP (3)
R. K. Mason-W.P.Duncan-SRP
H. L. Bunker - J. G. Brewer (6)
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
R. V. Graham - File

September 11, 1953
New York Ship - Camden, N. J.

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FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM R. R. Baker & A. H. Conn DATE 8/26/53

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Plenum Chamber EQ.PC.NO. 155-L

DRAWING NOS. W-132842 R3 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Scope: Final internal cleaning of plenum. (This cleaning was done by the Dowell Corporation)

Procedure: Using a cleaning solution of 0.1% detergent by weight, 1.0% caustic, 1.0% Trisodium Phosphate and the remainder deionized or distilled water with a temperature of 190° F, the six nozzles were jet washed with a stainless steel nozzle for 10 minutes each. After this was completed, high pressure washing (1500 to 1800 psi) with a special tube plug inserted in each large tube, working from the high side to the low side (the plenum slightly inclined), for 30 second each was accomplished.

Deionized water was then jetted into each nozzle with a stainless steel pipe for 15 min. each, after which each tube plug was installed.

The plenum was then placed in a vertical position, suspended by padded wire slings on two nozzles 60° on either side of Y^1 nozzle.

All nozzles were blanked off with S/S blanks. Eight special center tapped plugs were installed in the bottom sector and 10 plugs of the same type were installed in the top sector. This was done to obtain full coverage of air agitation. Air taps were also made into the two nozzles 30° each from Y^1 nozzle and into the two nozzles 30° each from Y^2 nozzle. The unit was then filled thru Y^2 (bottom) nozzle until it overflowed thru Y^1 (top) nozzle. The fill was then agitated with air thru the 4 nozzles mentioned above and thru the 8 special center tapped plugs in the bottom sector. This agitation was continued for 1 hour.

S[redacted]

[redacted]

FIELD INSPECTOR'S REPORT

FROM: Baker/Conn

The unit was then drained thru the bottom nozzle.

The unit was then filled with hot deionized water until the top nozzle overflowed for 5 min.

After the unit overflowed for 5 min., the valve on the bottom flange was opened slightly and deionized water pumped thru the 10 special plugs in the top sector. Air agitation was then carried on for 30 minutes thru the 4 nozzles and 8 special plugs previously mentioned.

The unit was then rapidly drained thru the bottom nozzle.

Results: Visual inspection proved the unit to be satisfactorily clean* and PH paper tests made while draining the unit showed no caustic to be present.

*Note: A few rust spots were observed in the nozzles, however, local passivation was used to remove these spots. Internal cleaning was satisfactory.

[redacted]

with deionized water pumped from a storage tank in the immediate area. The unit was vented through a ¼" tapped hole in the top end of each tube cap flange while pumping water into the unit. The unit was also vented through ½" pipe plugs in each of the nozzle flange blanks and two instrument tapped holes located in the top plate near the center of the unit. After the unit was filled with water, the venting holes were sealed off and the internal pressure was raised to 375 psi. using a Watson-Stillman hand pump. This pressure was held for one hour and then lowered to 315 psi. ($1\frac{1}{4}$ x 250# design pressure) for the hammer test. The top side of the unit was hammer tested using a special drop hammer with a 10# weight dropping a distance of 2 feet. The top side of the unit was hammered in the center of each triangle shaped tube cluster. This was done to test the tube fillet welding. All other welding on nozzles and bulges on the top side was hammered every 6". The vertical butt welds in the bulge and nozzle sections were hammered using a 3# hammer with a sharp swinging blow. (Hammer testing technique was taken from 1949 Edition of the ASME Boiler Code for Unfired Pressure Vessels, paragraph U-77.) Next, the pressure was released and the internal water level (in unit) was lowered approximately 1" below the top tube plate. Then the top plate of the assembly was hammered again in the same manner described above. The unit was again filled with water, venting as described above until the unit was completely full of water. Finally, the internal pressure was raised to 375 psi. ($1\frac{1}{2}$ x 250 design pressure) with the hand pump and all tube welds, bulge and nozzle welding on the top side was then visually inspected for leakage. None were found and the top side of the unit was accepted.

The internal pressure was then lowered to a nominal pressure and held in order that venting (when the unit was turned over) would not be necessary. This was imperative since venting from the bottom side was not possible using the equipment designed for sealing off the unit while hydrostatically testing the plenum in this position. After turning the unit (bottom side up) the same procedure discussed above was followed for testing and inspecting the bottom side. No leaks were found during this inspection and the entire assembly was accepted as being water tight.

(18) Gas Tube Chamfer Inspection

The bottom end of the six gas tubes for the NYX unit were chamfered on the inside diameter to 1/8" x 45°. This dimension was revised per design for "L", "K", and "C" to $\frac{3}{32}$" x 45°. The gas tube coordinate numbers were: X35-Y93; X9-Y81; X54-Y60; X2-Y36; X47-Y15; and X21-Y3.

A machinist's protractor and a 6" scale were used to dimensionally inspect the chamfer on all of the above listed tubes, and in addition, the chamfered surface was inspected visually for finish, particularly noting whether or not any "chatter" was evident. All inspections proved satisfactory and the job was accepted.

(19) Photographing of Plenum Large Tube Pattern

Next, the unit was prepared for photographing the large tube pattern. The unit was placed on 2½ foot cast iron pedestals with the top side up and then leveled within 0.003" using the Wild NIII precision level and target. After this the exterior of the unit was jetted with high pressure air to remove oil, grit, filings and other foreign material. New York Ship then wiped the top side of the unit with F.O. 128 (Fine Organics) until clean, and then the plenum was released to the du Pont Inspection Department for photographing.

Photographing of the top side of the unit was performed in an identical manner to that described in Section 16A-(13) of this manual.

(20) Internal Drying of Plenum Chamber

a. General

In January 1953, a du Pont Inspector from New York Ship visited the Savannah River Project to investigate reported tube weld leaks in sub-assemblies. The inspector witnessed the fields freon test on the "R" plenum chamber and "P" bottom tube sheet. Four leaks were found in the plenum; two at the junction of rod tube and large tube fillet weld overlap; one in a large tube 1" overlay, and the last between the large tube fillet welds and tube wall. In the bottom tube sheet assembly all three leaks were found in the fillet weld 1" overlay.

It was noted by the inspector that the field had internally dried each assembly before conducting their freon test. This internal drying was done to remove as much moisture as possible from the interior of the unit. Any moisture or water trapped in small cracks or pin holes on the inside tends to absorb and prevent the escaping of freon through cracks, pin holes and other imperfections in welding. As a result of this information, the du Pont Inspection Department at New York Ship revised their inspection procedure to include a drying step prior to freon testing to lessen the possibility of leakage after units were received at the plant site.

The fields method of drying was considered too costly to simulate at New York Ship since the NYX Program was nearing its completion; nevertheless, drying equipment on hand in New York Ship Yard was collected in Building #3 and was assembled into a drying unit. A drying procedure was written and adapted to this drying assembly. Basically, the plenum chamber, top tube sheet and bottom tube sheet were dried internally in a similar manner.

b. Drying Procedure for "P" and "L" sub-assemblies

1. "P" Top Tube Sheet

The first sub-assembly dried at New York Ship was the "P" top tube sheet assembly. The procedure set up for drying this unit was as follows:

(a) Set assembly over steam coil with top side down. The assembly is supported on pedestals placed under the outer edge of the tube plate.

(b) Place electric heaters around edge of assembly and connect up exhausters.

(c) Lower hood in place (See photo serial #229)

(d) Connect up blower with exhaust at top of hood.

(e) Run hot-air line from blower into hood, but do not connect with assembly at this time.

(f) Connect up electric heaters (including heaters in air line).

(g) Make sure all equipment functions properly and safely, and that electric heaters are located in the safest possible place in order to protect personnel. Notify Power House that operations are about to start.

(h) Turn on steam (if leaks appear in steam coil at any time during drying cycle, the steam is to be shut down immediately.)

(i) Turn on electric heaters in hood. Do not turn on heater for air line at this time.

(j) Allow temperature under hood to come up to 90° - 110° F., then turn on blower and electric heater on air duct. Circulate air until temperature evens out and blower is functioning correctly.

(k) Shut off blower and connect air line to top tube sheet assembly.

(l) Start exhaust blowers and hot air blower.

(m) Allow unit to dry out, keeping a continuous check on temperature at the three positions shown on Sketch #36.

(n) The humidity of air on the hood and that being exhausted from the assembly should be checked every two hours in order to establish the drying time necessary.

(o) When air being exhausted from assembly has shown a decrease in humidity from that over the air under the hood for a period of two hours, the blower and the electric heaters are to be shut off. On cool days or nights, some steam should be allowed to circulate so that the assembly does not cool down too quickly.

(p) After hood has cooled down to a reasonable working temperature, heater coils may be removed and dis-assembly connections started.

(q) Continue removing all connections and hood.

(r) Close off assembly to prevent entrance of surrounding air.

Serial Number 229

New York Shipbuilding Corp.
Camden, New Jersey
March 18, 1953

PROJECT 8980 - SAVANNAH RIVER PLANT

Drying Top Tube Sheet - "L" before loading with rachig rings. Warm air is collected at the top, filtered and blown through the flexible duct into the loading port. The blower and filter are on the platform at the right of the photo. Wet air is drawn out through the distribution pipes with the blower at the left of the photo.

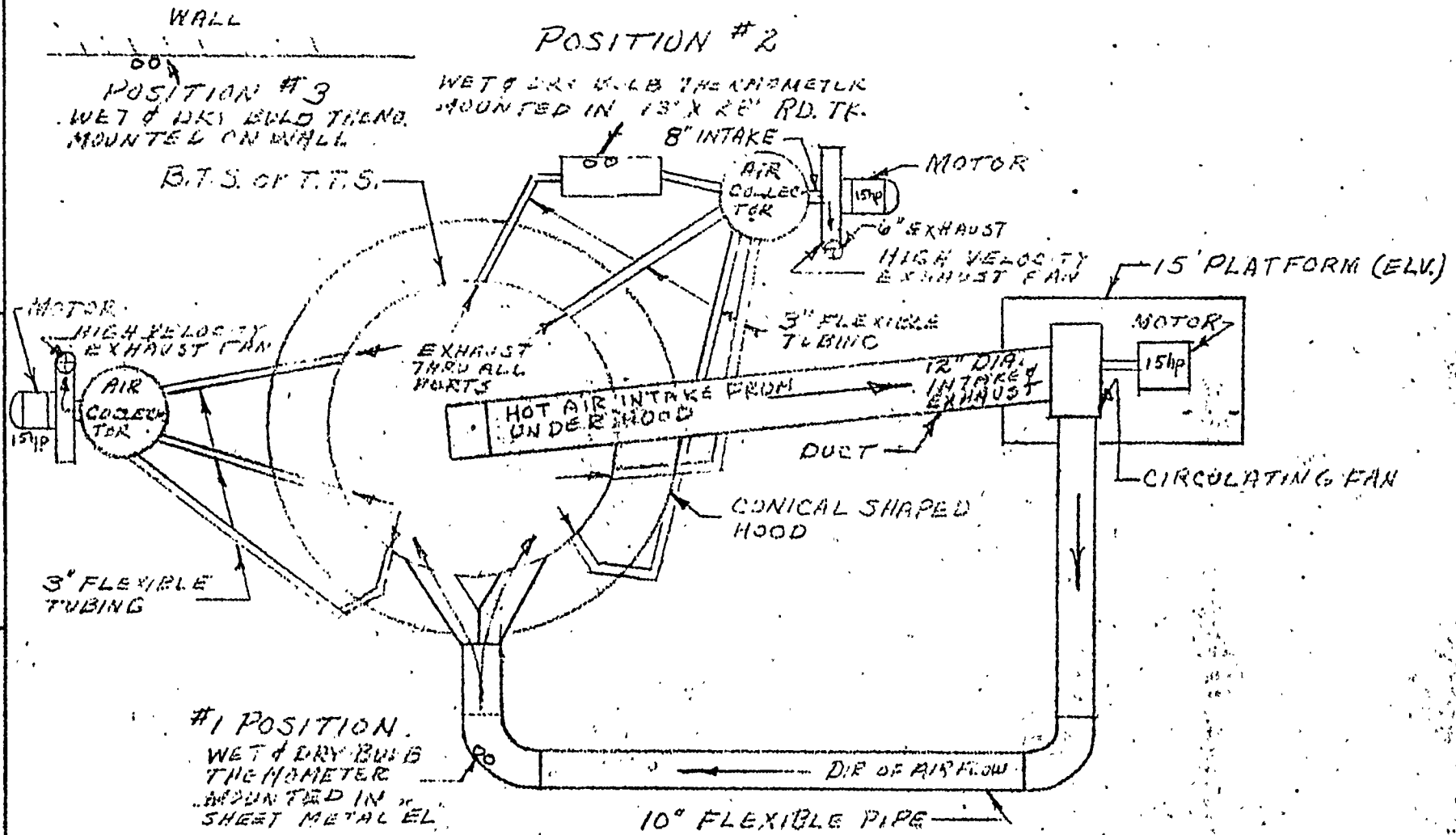
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ENGINEERING SKETCH SHEET
E. I. DU PONT DE NEMOURS & CO.

PROJ. TITLE | PROJ. NO. | SIGNATURES

SUBJECT | DATE | NO. E-4729

B.T.S. & T.T.S. BLOCK DIAGRAM FOR INTERNAL DRYING SET-UP



SKETCH # 36

A | B | C | D | E | F | G | H | J | K

The heat for drying was supplied with a return bend steam coil fabricated from 2" black iron pipe and laid on 1½" x 2" angle iron spaces suppo ted approximately 15" above the floor on wooden blocks having pitch for drainage into a steam trap (See step "a" and "h" in above procedure.) Fifteen banks of electric heaters were placed over the steam coils. The heaters were supported over the steam coils. The heaters were supported over the steam coils using steel stands in order that the heaters elevation was approximately 2" below the bottom end of the units tubes. (See steps "b", "f", "i", "j" and "o" in above procedure.) In addition, nine electric strip heaters were fastened to the outside surface of the hot air duct feeding the circulating fan to pre-heat the air before it entered the assembly.

The steam coils were left on throughout the drying process and electric heaters were manually turned on at 135° F. and off 140° F. Temperature was determined by a thermometer taped to the bottom end of a tube underneath the assembly.

All assemblies were supported on pedestals placed under the outer edge of the bottom tube plate. A conical steel hood supported by legs fabricated from "H" beams was placed over the assembly after all steam coils and heaters had been connected. (See photo serial #229.) (See Step "c" in above procedure.) Hot air was taken from the top of the conical hood by a duct into the intake of a blower, and then out the discharge through a filter to remove dirt and dust, and then back into the assembly through a 10" flexible pipe. Photo Serial #229 illustrates pictorially where these connections were made. The discharge was through 3" flexible tubing into two blowers with tanks and then discharged into the room.

Sketch #36 illustrates in block diagram the internal drying set-up. On the wrapper plates in both the top tube sheet and bottom tube sheet assemblies a total of thirty 3" flexible pipe connections were made to inspection ports in the unit. Fifteen of these 3" flexible pipes were connected to each of the two high velocity exhaust fans. This was not shown in the sketch since space would not permit a clear conception of the block diagram set-up for internal drying.

The room temperature, inlet and outlet temperatures (wet and dry bulb) were taken at positions #1, #2 and #3 as shown in Skotch #36. The temperature readings were taken every two hours and the percentage of humidity was determined by using a A.S.H.V.E. psychrometric chart.

The "P" top tube sheet was dried internally following the procedure described in this section. The drying was started on March 17 at 4:00 P.M. and was completed at 11:30 A.M. on March 19, 1953, a total of 43½ hours. Wet and dry bulb temperature readings were taken every two hours at the three positions shown in Sketch #36. At 4:00 P.M. on the starting day the exhaust wet bulb temperature was 72° and dry bulb temperature was 103° (Position #2 in sketch #36) Calculated relative humidity of exhaust air (using A.S.H.V.E. psychrometric chart) was approximately 22%. Calculated

relative humidity of inlet air taken at position #1 (Sketch #36) was calculated to be 12%. (Note: Room temperature position in #3 was not taken on this unit). The last readings taken at 10:00 A.M. on March 19, 1953 were: Exhaust (Position #2) wet bulb temperature 83° and dry bulb temperature 121°. Calculated humidity of exhaust air was approximately 21%. Calculated relative humidity of inlet air taken at Position #1 was calculated to be 20%. For the last six hours of the drying operation these readings remained constant and it was decided that the unit was dry on the inside and the drying operation was discontinued.

The remaining units ("P" P.C. and "L" P.C., TTS and BTS) were dried in a similar manner just described. The "P" plenum chamber was dried over a 96 hour period until the results indicated that the moisture in the air from the discharge (Position #2, Sketch #36) as determined by wet bulb - dry bulb reading remained constant when compared to inlet wet bulb - dry bulb temperature (comparison was actually made between inlet and outlet humidity percentages). After the first sixteen hours of drying this unit, it became necessary, in order to continue drying because of a three day plant shutdown, to attach a large pipe to a nozzle and extend the pipe approximately fifteen feet above the unit to produce a "flue effect" in lieu of the blowers until the drying operation was started up again. The drying of the "P" plenum chamber was started on April 2 and was completed on April 6, 1953. See Sketch #37 illustrating the manner in which a plenum chamber was set up for internal drying.

The "L" plenum chamber was dried in a similar manner as "P" top tube sheet assembly described in this section. This plenum chamber was dried for a period of 36 hours from August 29 to September 2, 1953. The final decision as to dryness reverted to the test that moisture content of inlet and exhaust air remained constant.

The "L" top tube sheet drying operation began on July 27 and was considered dry (internally) on July 28, 1953. In the drying of this unit two pans of water were used in an effort to determine how much "drying effect" was taking place under the conical shaped hood as compared to the inside of the unit. One pan was placed on top of the unit and the other was placed inside the unit through an inspecting port on the wrapper sheet. The water in the pans dried up in a relatively short time and proved nothing, except some drying was taking place inside the conical shaped hood and also in the unit itself. During the time the "pan method" was being used, wet and dry bulb temperature readings were discontinued; however, when all the water in the pans evaporated, it was decided to revert back to taking readings as previously described. The drying was continued over a period of 36 hours after which it was considered dry on the inside based on wet and dry bulb temperature readings.

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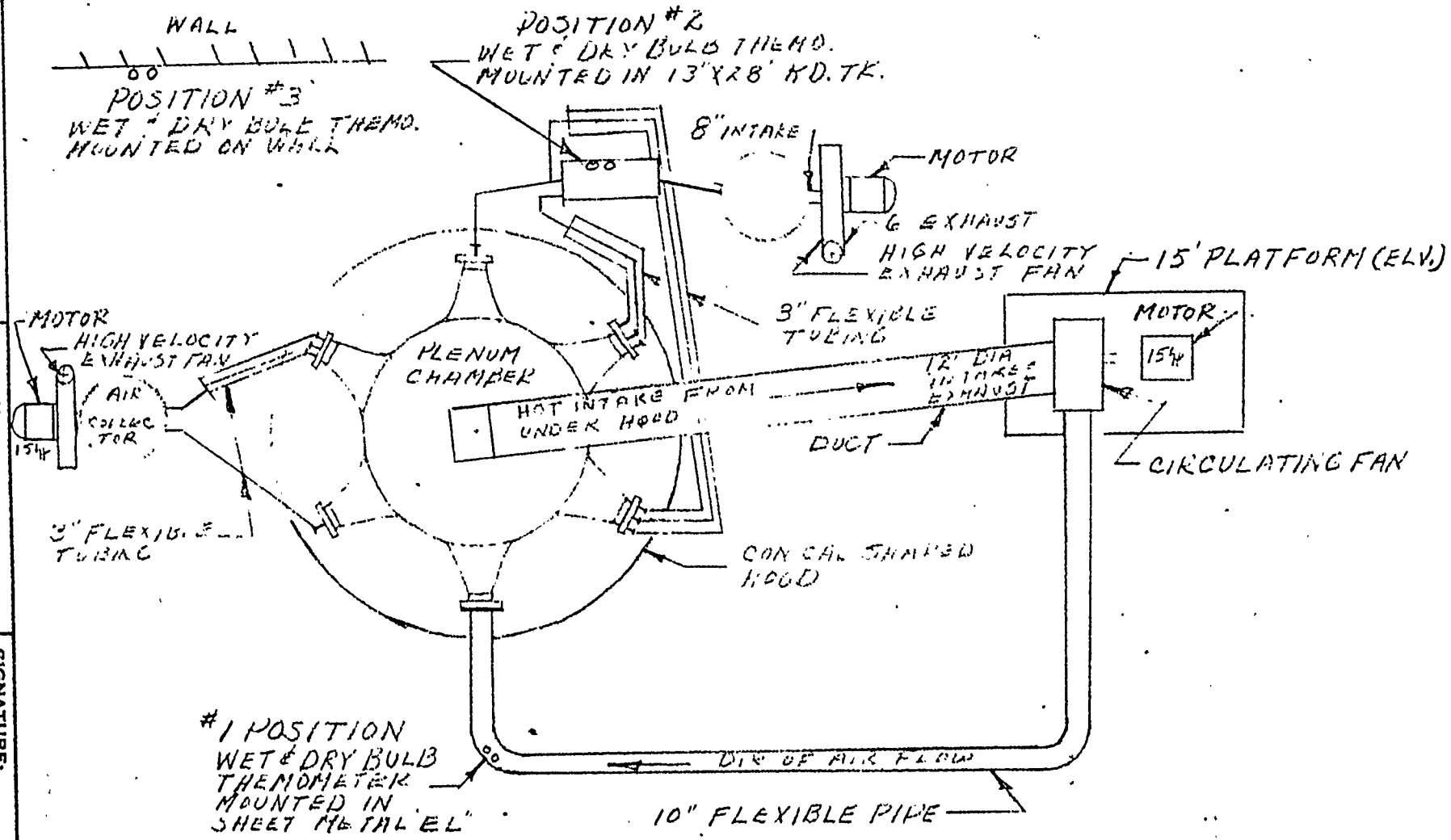
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No. E-42433

P.C. BLOCK DIAGRAM FOR INTERNAL DRYING SET-UP



SKETCH #37

A B C D E F G H J K

The "L" bottom tube sheet drying operation started on March 31 and was completed on April 1, 1953. In this case the drying was discontinued when the wet and dry bulb readings remained constant as compared to the moisture content in the air outside of the enclosure. The drying of this unit was interrupted on the midnight shift on April 1, 1953 when the blower system was inadvertently shut down, but was resumed on the following day shift. Just what credulity might be attached to the wet bulb-dry bulb method of determining moisture content of air in ascertaining whether the unit was sufficiently dry was a cause of concern. Readings at 5:00 P.M. on the last day at the inlet position indicated moisture content of 19% and at the discharge 28%. At 10:00 P.M. when drying stopped the in going air moisture content was 21% and discharge 34%. The moisture content unexpectently increased 6% at the time when drying discontinued. This same inconsistency was encountered during the drying of the "L" top tube sheet, "L" plenum chamber and on all three "K" unit sub-assemblied.

"K" unit sub-assemblies were dried and tested using the same procedure outlined in this section. The bottom tube sheet was dried for 48 hours from August 20 to August 22, 1953. The top tube sheet and plenum chamber were both dried for 36 hours, the former from September 17 to September 19, 1953, and the latter from September 25 to September 27, 1953.

(21) Freon Test (Final)

The plenum chamber was prepared for freon testing by sealing off all large tubes using O-ring plugs shown in photo serial number 240, Section 14B-(5) of this manual. Prior to insertion of O-ring plugs into all large tubes, they were visually inspected for any evidence of sharp edges or burrs which might scratch or gouge the finish of either the top or bottom land bore. Any mechanical defects found on the plugs were removed by hand filing. Also, a spot check was made on the O-rings to insure that new ones were being used and that they were clean. Before inserting a plug the bottom O-ring was lubricated with a small amount of "H" 660 (Ucon) oil to make for easy entry of the plug. This lubrication of O-rings also lessened the possibility of any O-rings from scratching the bore finish. Lubrication of the plugs top O-ring was not done since experience proved this not necessary. Each of the six nozzle openings were closed off using temporary blind flanges and appropriate size Garlock gaskets.

After closing up the unit, it was placed on six foot pedestals with the top side up to allow access from underneath during the test. New York Ship then applied an air test and all leaking plugs and flanges were tightened until the assembly was air tight. After this, ten (10) pounds of freon by weight was introduced into the unit and the pressure was raised to 53 psi. with air. This pressure was held for one hour before testing for leaks.

All 5¼" tube welding, rod tube, nozzle and bulge welding was tested for leaks using a General Electric Type "H" halide detector set on medium sensitivity. Photo serial number 240 mentioned above illustrates the use of the "detector". No leaks were found and the unit was accepted.

(22) Functional Gaging of Plenum Chamber and Top Tube Sheet After Filling Top Tube Sheet with Raschig Rings and Tube Repair

a. Large Tube Functional Gaging and Tube Repair

After loading the top tube sheet with raschig rings and completion of all welding and machining on the plenum chamber, the two units were functional gaged and tube repairs made. The following paragraphs discuss the details and discrepancies encountered just prior to shipping the unit to the plant site.

First, the top tube sheet was placed on cast iron pedestals approximately two feet high and leveled for mating with the plenum chamber. The top tube sheet was leveled by the du Pont Inspection Department using the Wild NIII precision level and target. After this the plenum chamber was placed on the top tube sheet aligned and temporarily bolted to the latter with staybolts. These staybolts pass through both plenum large tubes and top tube sheet tubes and were capped and bolted on each end, thus clamping the two units together. Five staybolts were used; one in the middle (thru tube X28-Y48) and the other four spaced symmetrically on the outer periphery of the tube pattern near the extremities of the X and Y axes. Some adjusting and rotational movement of the plenum chamber was necessary before optimum conditions (as determined by measuring tube overhang distances and checking centering devices for clearance between tongue and groove) were reached. Section 15A-(6) of this manual explains how these measurements were taken and also how the readings were interpreted. Staybolts were then removed before proceeding with functional gaging, thereby, leaving the unit in an unstrained position.

After aligning the plenum chamber on the top tube sheet, all large tubes were gaged using a 4.375" diameter functional gage. Results of this gaging revealed that the following tubes exhibited a tight fit and would not seat the functional gage properly. (All ranged between ½" and 2" from seating properly: X42-Y48, X47-Y63, X25-Y93, X22-Y90, X41-Y75; X49-Y69.) In order to make these tubes accept the gage, a hone was used to smooth out the junction of the plenum and top tube sheet tubes. This repairing consisted of honing essentially the top 4" of the top tube sheet tube bore and the bottom 1" of the plenum chamber tube bore. In some cases it was only necessary to cloverleaf the bottom bore of the plenum chamber for the functional gage to seat properly. The maximum plenum tube bore size during repair of these tubes did not exceed 4.393". In addition to the above, it was also necessary to grind the

corresponding top tube sheet tube at interference points (as determined by the functional gage) using a disc type grinder. If necessary the top tube sheet tubes were ground to a maximum of 1.410" in diameter.

After the above repairs were made, all tubes seated the functional gage properly and the gaging of large tubes was approved.

b. Rod Tube Functional Gaging and Tube Repair

Next, a 1.484" diameter rod tube functional gage was inserted into all rod tubes. All rod tubes seated the functional gage and the gaging of rod tubes was accepted.

Before the functional gaging of large and rod tubes, the clearance between mating ports of centering devices welded to the plenum chamber and top tube sheet were checked. This was done to determine whether or not the tongues (welded to P.C.) were binding or riding on corresponding groove faces (welded to T.T.S.) If this latter condition ever existed and was not discovered before leaving New York Ship much trouble would probably result when the units were assembled in the field insofar as functional gaging of tubes were concerned. However, this trouble has been avoided by checking tongue and groove (indexing devices) alignment before final functional gaging and at other times during fabrication when the units were in an operating position. Checking of the tongue and groove mating conditions before final functional gaging revealed that no binding or "riding" was present and the units were considered satisfactorily mated for resetting in the field, and then final functional gaging commenced.

c. Repair of Rod and Large Tube Bores to Remove Mechanical Defects Prior to Shipping

(1) Rod Tubes

During functional gaging of rod tubes, special attention was given scratches, gouges and other imperfections noted in the O-ring area. Dwg. 1-2, Section 16B-(2) of this manual illustrates pictorially where these critical areas were located. For any tube to be acceptable, all scratches, gouges, etc., were required to be removed from the O-ring seating area. Minor blemishes or scratches were removed from rod tube bores by either cloverleafing or using crocus cloth. Major defects were either removed by honing or grinding with an abrasive disc and then using crocus cloth to smooth out the reworked area. For a detail discussion on the inspection procedure and methods of tube repairs incorporated, see Part VIII, A-49-A2. This referenced

procedure was followed until all tube bore defects were satisfactorily repaired.

After all rod tubes had been visually inspected and accepted, shipping plugs were installed in both top and bottom ends to prevent possible damage to the tube bore from some outside cause while in transit to the field. Rod tubes were plugged on both ends using the following procedure:

1. After each rod tube was successfully functional gaged, the du Pont Inspection Department visually inspected the surface finish of the top end of tube for possible defects.

2. After surface finish was accepted, the top end of each tube was wiped with a clean, dry cloth.

3. Each rubber plug (used for sealing tube ends) was wiped with a clean dry cloth.

4. The plug was forced into the tube bore until it fitted snugly and would not fall out.

5. The above four steps were repeated on the bottom of each rod tube using the appropriate size plug.

6. The du Pont Inspection Department witnessed the insertion of each plug.

(2) Large Tubes

During functional gaging of large tubes, special attention was given scratches, gouges, and other surface imperfections noted in the critical area of each tube. Drawing 1-2, Section 16B-(2) of this manual, illustrates pictorially where these critical areas were located. For any tube to be acceptable, all scratches, gouges and other mechanical defects were required to be removed that were in the O-ring or piston ring areas. All large tubes were visually inspected for evidences of the above defects. Minor blemishes or scratches (when noted) were removed from the bores by cloverleafing or with a crocus cloth. Major defects were removed either by honing or grinding with an abrasive disc. However, Design Division specified that neither the top land nor the bottom land bore of a large tube was to exceed a maximum diameter of 4.393" when removing of defects in the O-ring area would not clean up the bore to the drawing dimension of 4.390". Opening up of large tube bores to 4.393" in diameter was resorted to only when defects in the O-ring or piston ring areas would not clean up. In most cases those defects not in the critical

areas were worked out by blending in of all sharp edges; however, in these cases no bore diameter was to exceed 4.390". All bore diameters honed, cloverleafed or ground to a diameter exceeding 4.390" were reported to the Design Division for their comments.

During the process of removing defects from large tubes in the "L" plenum chamber, a representative from the Operations Group at Savannah River visited New York Ship for the purpose of inspecting the O-ring and piston ring surfaces in the "L" plenum chamber prior to shipping. Also, he inspected the orientation notches or monitor pin grooves in the "K" bottom tube sheet. Results of this inspection is covered in "K" unit, Part VIII.

Fifty large tubes in the "L" plenum, noted as bad but corrected by New York Ship were re-inspected by the representative for their disposition. Fourteen of these tubes were found to be in need of more work due to vertical scratches in the O-ring seating zone. Later, seventy tubes were selected at random, and after re-inspecting, twenty were in need of additional work for similar reasons. At this point it was decided by the du Pont Inspection Department, and a member from the AED Process Section and also the SRP Operations representative, that a 100% re-inspection of all large tubes was necessary. In accordance with the SRP acceptance standard on O-ring sealing surfaces, a new visual inspection procedure was adopted, and in addition, the method used to remove scratches was re-defined to comply with final results desired. The new large tube visual inspection procedure adopted was as follows:

a. Lower inspection light into tube. This light should be padded with tape, cloth, or rubber to protect the inside surface of the tube (63 RMS). Scratches are quite apparent when viewed in the reflection of this light.

b. Any scratch or other imperfection noticed in step "a" should be tested by moving the sharp point of a fine line automatic lead pencil across the imperfection in all directions. If the pencil catches in the scratch, there is need for improvement.

c. The fingers should be pressed firmly to the side of the tube on the O-ring zone and moved about the tube circumference in vertical clockwise, and counter-clockwise directions. Any portion not feeling smooth to the touch should be further investigated by methods "a" and "b" and corrected if necessary.

d. Any scratches or imperfections above the O-ring zone should be quite smooth to the touch. This is to guard against the possibility of damaging the O-ring during insertion and removal.

The re-defined method to remove scratches was:

Remove most of scratch by use of cloverleafing.

Smooth out area with #1 emory cloth.

Restore original finish by use of crocus cloth.

Remove all dirt and emory dust by wiping entire tube with clean cloth.

Note: Tubes with more serious scratches were worked with cloverleaf discs attached to an air motor.

After complete re-inspection and repair of all large tubes using the above outlined procedures there was a total of one hundred and forty tubes that had scratches removed from the O-ring seating area. Only about ten percent of these tubes had scratches of a nature that required more than hand work to blend them into the tube without any sharp edges.

One tube (X31-Y9) had a deep (approximately 3/64") defect extending into the lower portion of the bottom O-ring area (actually below the O-ring). Since this defect was in such a low position it would not interfer with the O-ring seal and was acceptable. Five tubes (X29-Y57, X35-Y3, X7-Y33, X40-Y30) had gouges in the bottom lands. These were accepted after all sharp edges were removed and an O-ring test showed no damage to the O-rings when inserted through these tubes. An inspection tube X52-Y54 had an impression the size of a pin head about 0.002" deep 1 9/16" from the top end of the tube. This area was between the O-rings and acceptable per Design Division. Also, five tubes were honed oversize to 4.391" in diameter in order to remove scratches in the O-ring zone and were accepted per Design Division. These tubes were X11-Y15, X32-Y12, X49-Y21, X13-Y39, and X48-Y72.

As a result of final inspections, no defects were left in any tube in the O-ring zones.

Before leaving New York Ship, the SRP Operations representative was given platic impressions of tubes X31-Y9, X24-Y36, and X52-Y54 which had defects in the top land, but not in the O-ring zone. In addition an impression was taken of the entire bottom bore of tube X29-Y57. These impressions were taken for field study and analysis. (Note: Impressions were taken by mixing "surface replications - Polymer" (powder) with "surface replications monomer" (liquid) to form a "sticky mixture", and

then covering the surface with the mixture and letting it set for approximately one-half hour. The mixture hardens and reproduces the surface conditions present.)

(3) Procedure for Installing Shipping Plugs In "L" Plenum Chamber

While the "L" plenum chamber and top tube sheet were in an operating position during final functional gaging and tube repair, a procedure was developed and used for plugging all large tubes after they were accepted. This new procedure came about as a result of several things. First, field complaints received indicated that during the insertion of O-ring plugs in the counter-bore of the "P" unit bottom tube sheet tubes, short, shallow, vertical scratches were present when the plugs were removed in the field. This was caused by grinding dust or other dust being present when the O-ring wooden shipping plugs were installed and removed. On "L" bottom tube sheet and subsequent units the use of these plugs were discontinued; however, since similar plugs were used for plugging the "P" plenum and no discrepancies were encountered, it was decided to modify the shipping plugs and method of installation for "L" to such a degree that scratching of the high finish in plenum tubes would not occur.

The new procedure for installing shipping plugs in "L" plenum chamber tubes developed and used was as follows: Prior to the plugging operation the following operations were done:

a. The top side of the plenum chamber and the bore of each tube in the plenum chamber and top tube sheet was wiped clean with F.O. 128 (Fine Organics) before setting up for functional gaging.

b. The bore of each PC and TTS tube was swabbed clean with a dry cloth immediately before functional gaging.

c. Functional gage.

d. Prepare wooden plugs for large tubes by cutting off the threaded portion of the eye screw through the center of each plug so that only two threads extend beyond the nut when it is run up tight with the flat washer in place. This was done at a shop location far removed from the plenum.

e. Personnel at all times while on plenum chamber wear white canvas shoes to discourage contamination of unit.

For convenience the plugging operation will be divided into parts: a. large tubes - top side, b. large tubes - bottom side.

a. Large Tubes - Top Side

1. Immediately after each large tube was successfully functional gaged, du Pont Inspection visually inspected the surface finish of the top land.

2. After the finish of this land was accepted, the top land was wipped clean with a dry cloth just prior to insertion of the wooden plug.

3. Each wooden O-ring plug was inspected by a du Pont Inspector just prior to use as follows: The nut on each eye screw was tested (using fingers only) to see that it could not be completely run off the screw whose threads were burred as a result of the cutting operation. Then, the nut was tightened snugly on the screw with the fingers.

4. Each plug was wiped with a clean cloth until clean.

5. The plug was inserted with a 10" x 10" square of "polythene" into the top land bore in the following manner: The plug was placed (top side up) in the approximate center of the "polythene" square and the excess folded up around the entire outer periphery of the plug. Then, holding the "polythene" in place around the plug, both were inserted into the top plenum land until the top of the plug was approximately 1/2" below the top face of the tube. A special raised faced flange was used to force the plug to the desired distance into the bore (See Sketch No. 38)

6. Finally, the excess "polythene" was folded over the tube top and a rubber band placed around the circumference of the tube to hold the "polythene" in place.

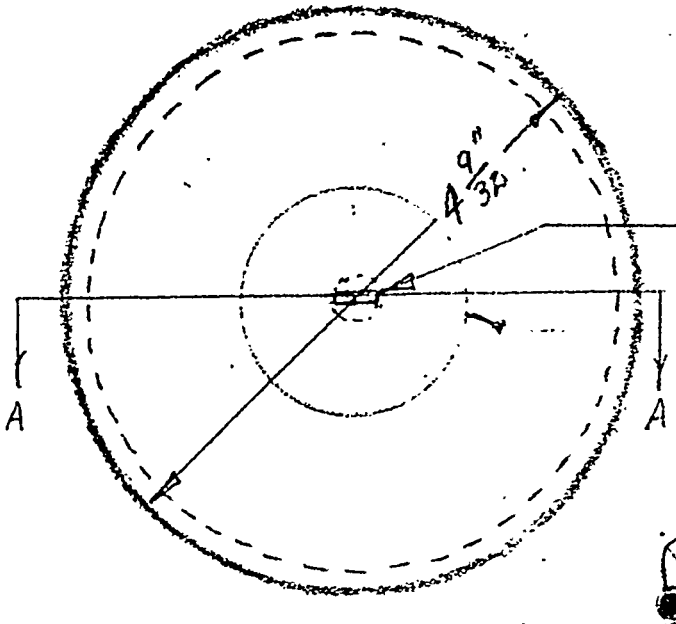
7. The above steps were performed by New York Ship personnel and witnessed by a du Pont Inspector.

b. Large Tubes - Bottom Side

1. When the bottom side was available after repairs, the above procedure was repeated, except the plug in this case was inserted into the bottom land. Only until it was flush with the bottom face of the tube.

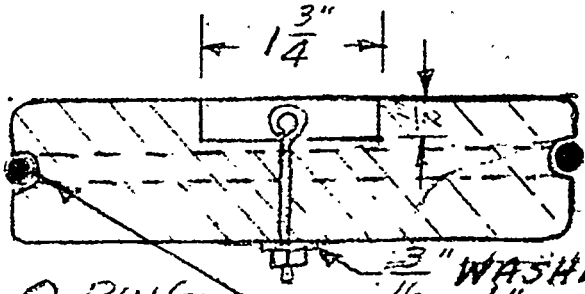
2. The forty-eight (48) tubes that required through bolts for holding shipping gear to unit was supplied with wooden dowels through which the bolts passed. These dowells were covered with "polythene" in the

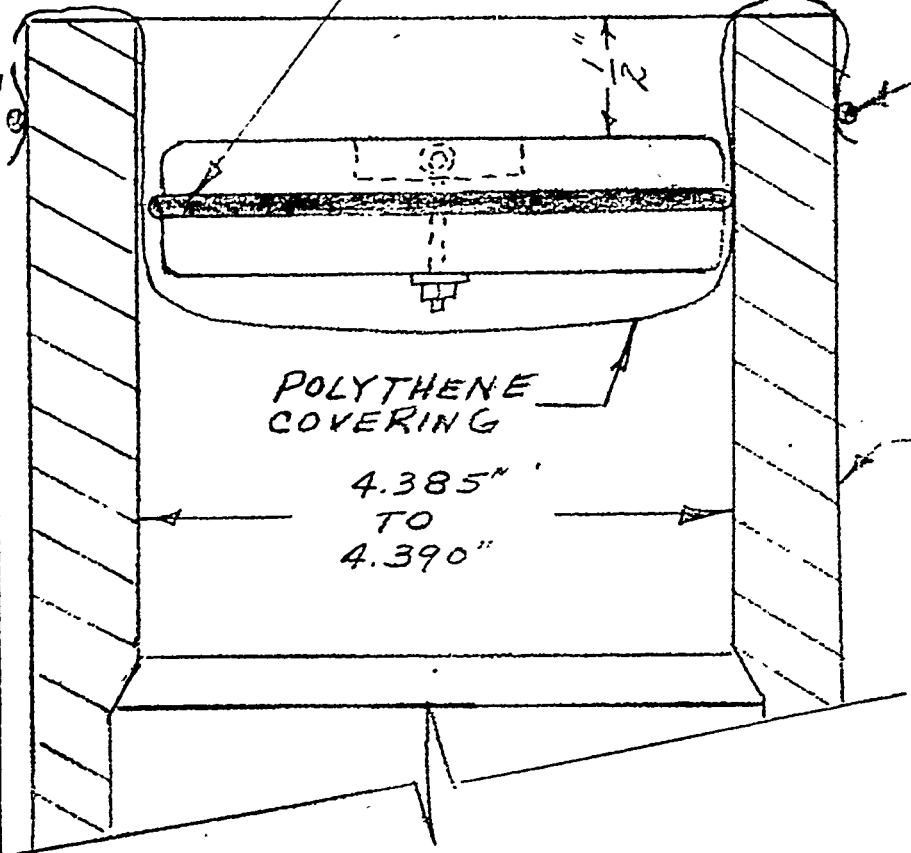
SHIPPING PLUG FOR "L" PLENUM TUBES



PLUG

SECTION A-A





NOTE: SKETCH IS:
1. NOT TO SCALE
2. DIM ARE APPROX.
3. DO NOT USE FOR FAB. PURPOSES

SKETCH #38

~~ENGINEERING SKETCH SHEET~~ E. I. DU PONT DE NEMOURS & CO.	~~PROJ. No.~~	SIGNATURE:
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following manner: Each dowell was wrapped 1½ times around with polythene and then the excess "polythene" was flared at the top and bottom ends and the C.D. of the dowell was scotch taped.

During the plugging operation the du Pont Inspection Department visually checked all external surfaces surfaces of the unit for evidence of weld splatter. Where weld splatter was found, New York Ship personnel removed it by either chipping or grinding or a combination of both. Before plugging tubes, the entire unit was vacuum cleaned to remove all dust particals, and other foreign material. In the process of vacuum cleaning particular attention was given to removing dust, grit, grime, etc. from each large tubes weir slots and to the crevice under the plenum skirt.

After all tubes were plugged in the manner just described, a visual inspection was made by the du Pont Inspection Department to determine if all plugs were properly in place and for evidence of any dirt or grime that may have collected on the unit. A few spots on the unit were re-cleaned using F.O. 128 (Fine Organics) to remove foreign material, and then a aluminum disc was bolted to each side of the plenum large tube pattern to serve as a protective covering for the tube ends. Next, all shipping gear was secured to the unit. Finally, the entire plenum was "pillow cased" with canvas and laced on the outer periphery and made ready for shipping and then the unit was identified by appropriate lettering painted on the shipping gear lifting eyes. This was necessary for ready identification in the field.

The "L" plenum chamber was shipped by tug boat and barge from New York Ship on October 2, 1953, to the Savannah River Plant located in the state of South Carolina.

REPORT

OF

MATERIAL & EQUIPMENT

SECTION'S

ACTIVITIES

AT

NEW YORK SHIPBUILDING CORP.
DURING FABRICATION

OF

AXC 167 1/2

STARTING MAY 18, 1951
PART VII - SECTION II

BY: JAMES RAY STEWART

MAY 11, 1954

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"R", "P" AND "L" UNIT DRAWING LIST BY SUB-ASSEMBLY

The following list covers all du Pont prints pertaining to fabrication released to the M & E Group located at New York Ship.

This list was prepared from existing drawing files at the latter location on January 14, 1954. For reference purposes and convenience, drawings are listed by sub-assembly, drawing number, title and revision number.

A. "R" Unit

1. Top Tube Sheet

Drawing No.	Title	Revision #
W-130671-A	Sections and Details Sheet #2 - Arrangement for Ordering Material	0
W-130942	Sections and Details Sheet #2 - Arrangement	1
W-130943	Plan and Cross Section Arrangement	31
W-130944	Sections and Details Sheet #1 Arrangement	11
W-131090	Sections and Details Sheet #3 Arrangement	10
W-131109	Sections and Details Sheet #4 Arrangement	15
W-132354	Chimes Plan - Sections and Details	0
D-110135	Pre-machined finish of rod Tube	1
D-110139	Indexing Device	7
D-112633	3" Inlet and Outlet Pipes	1
D-112649	Pre-machined Finish of Bearing Tube	1
D-112650	Pre-machined Finish of Non-bearing Tube	1
D-112665	Top Tube Sheet Collars	5
D-114898	Baffle and Deflector Plates	11

B. "P" Unit

1. Top Tube Sheet

Drawing No.	Title	Revision #
W-131365	Plan and Cross Section Arrangement	27
W-131370	Sections and Details Sheet #1 Arrangement	11
W-131393	Sections and Details Sheet #2 Arrangement	3
W-131394	Sections and Details Sheet #3 Arrangement	12
W-131417	Sections and Details Sheet #4 Arrangement	15

Drawing No.	Title	Revision #
W-132823	Chimes, Plans, Sections and Details	1
D-110144	Indexing Device	6
D-112673	Pre-machined Finish of Bearing Tube	3
D-112674	Pre-machined Finish of Non-Bearing Tube	5
D-112679	Collars	1
D-112685	3" Inlet and Outlet Pipes	0
D-114935	Baffle and Deflector Plates	6

C. "L" UNit

1. Top Tube Sheet

Drawing No.	Title	Revision #
W-133141	Sections and Details Sheet #1 Arrangement	4
W-133142	Chimes Plan, Sections and Details	0
W-133143	Plan and Cross Section Arrangement	8
W-133144	Sections and Details Sheet #2 Arrangement	0
W-133145	Sections and Details Sheet #3 Arrangement	5
W-133146	Sections and Details Sheet #4 Arrangement	2
D-110233	Pre-machined Finish of Rod Tube	1
D-110271	Indexing Device	3
D-110272	Instrument Well	0
D-112764	Pre-machined Finish of the Bearing Tube	2
D-112765	Pre-machined finish of the Non-bearing Tube	4
D-112854	Collars	1
D-112856	3" Inlet and Outlet Pipes	0
D-114635	Baffle and Deflector Plates	3
D-114689	Deflector Plate Thermocouple Lead Chip Drilling Detail	28

PART VII - SECTION II * TOP TUBE SHEET INSPECTIONS PERFORMED BY DU PONT ON "R", "P" AND "L" UNITS

1. Plate Preparation

A. "R" Unit

(1) Plate Inspection

The Type 304 stainless steel material for the top, bottom and baffle tube sheets was inspected in a similar manner to that discussed in Part II-A, Section 1-a. All inspections were satisfactory.

(2) Plate Fit-up, Welding and Radiograph Inspections

These inspections were performed in a similar manner to those performed on the "R" bottom tube sheet discussed in Part VII, Section II, item 1A-(2). All inspections were satisfactory.

B. "P" Unit

(1) Plate Inspection

Same as 1A-(1) above.

(2) Plate Fit-up Welding and Radiograph Inspections

Same as 1A-(2) above.

C. "L" Unit

(1) Plate Inspection

Same as 1A-(1) above.

(2) Plate Fit-up, Welding and Radiograph Inspections

Same as 1A-(2) above.

2. Tube Inspection (Pre-assembly)

A. "R" Unit

Pre-assembly inspection of large tubes and rod tubes for assembling into the "R" top tube sheet is discussed in Part II-A, Section 2 and Part VII, Section I, item 2A.

B. "P" Unit

Pre-assembly inspection of large tubes and rod tubes for assembling into the "P" top tube sheet is discussed in Part II-A Section 2 and Part VII, Section I, item 2A and 2B.

C. "L" Unit

Pre-assembly inspection of large tubes and rod tubes for assembling into the "L" top tube sheet is discussed in Part II-A, Section 2 and Part VII, Section I, item 2C.

3. Revised Drill Jigs for "R", "P" and "L" Units

The discussion for "R" plenum chamber drill jigs included the "R" top tube sheet. Refer to Part VII, Section I, item 3A for a detailed analysis of the problems confronted with and the steps taken to solve the problems.

4. Trepanned Top Tube Sheet Inspections

A. "R" Unit

The method used for inspecting the top and bottom plates and baffle plates for the "R" top tube sheet assembly has been discussed in Part VII, Section I, item 4A. Sketches #4 and #5 shown the ligament measurements for both the top and bottom tube sheets of the "R" top tube sheet. The baffle plate was also measured in an identical manner.

B. "P" Unit

Same as "A" above, except see Part VII, Section I, item 4A, Sketches #10 and #11.

C. "L" Unit

Same as "A" above, except see Part VII, Section I, item 4A, Sketches #16 and #17.

5. Dimensional Check of Tube Ligaments and Bores

A. "R" Unit

(1) Top Tube Sheets (top, bottom and baffle)

Ligament measurements on the top, bottom and baffle plates were obtained in a similar manner to that described in Part VII, Section I, item 5A-(1).

B. "P" Unit

(1) Top Tube Sheets (top, bottom and baffle)

Same as "A" above, except see Part VII, Section I, Item 4B.

C. "L" Unit

(1) Top Tube Sheets (top, bottom and baffle)

Same as "A" above, except see Part VII, Section I, Item 4C.

6. Inspection of Tube Sheets After Grinding and Acid Washing

A. "R" Unit

This inspection was performed in a similar manner to that discussed in Part II-A, Section 3-C.

B. "P" Unit

This inspection was performed in a similar manner to that discussed in Part VII, Section I, Item 6B.

C. "L" Unit

Same as "B" above.

7. Assembling of "R", "P" and "L" Top Tube Sheets

A. "R" Unit

(1) Gusset Plate Pre-Assembly Inspections

The pre-assembly gusset plate inspections performed on the "R" top tube sheet were similar to those discussed in Part VII, Section III, item 7A-(1) for the "R" bottom tube sheet. Also, see Part II-B, Section 4a, photo serial #129 and 130.

(2) Inspections Performed During Assembling of Gusset Plates Into Unit

These inspections were performed in a similar manner to those discussed in Part VII, Section III, item 7A-(2) for the "R" bottom tube sheet. For location of gusset plates (or web plates), see Dwg. 4-2 presented herewith.

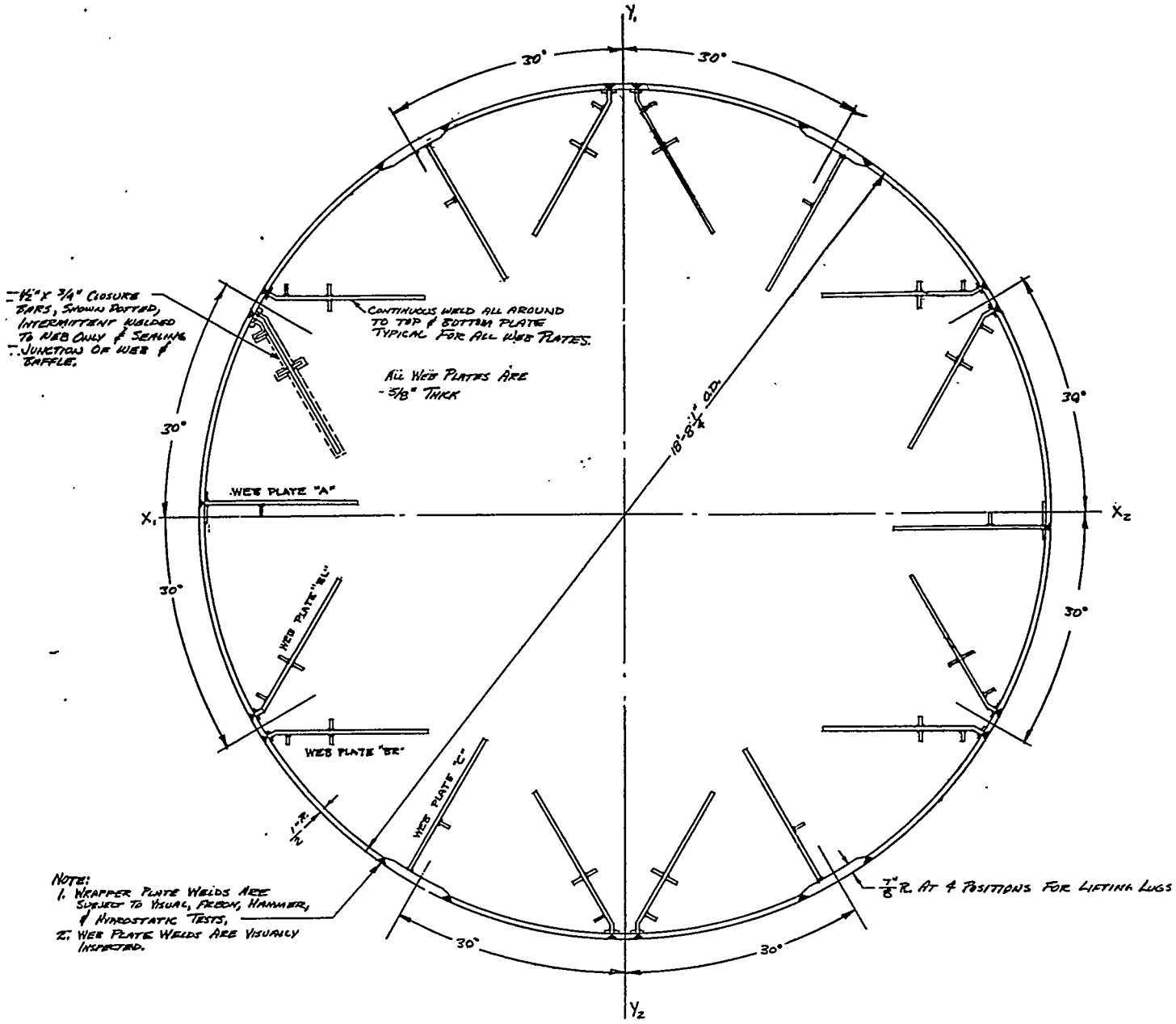
(3) Baffle Plate Spacers, Sandblasting, Acid Washing and Ferroxyl Testing

All of these operations and inspections were performed in a similar manner to that described in Part VII, Section III, item 7A-(3).

(4) Collar Inspection

The large tube and rod tube collars for spacing the baffle plate on the inside of the "R" top tube sheet assembly were checked for thickness only. This was necessary to insure that a level plane would be maintained when the baffle plate was bolted in place. The required thickness of all type tube collars was 1". This was measured using a 0"-1" outside micrometer. All inspections were satisfactory. See du Pont drawing D112665 for top tube sheet collar specifications.

TOP TUBE SHEET WEB PLATE LAYOUT



M & E SECTION
GOV'T. CONTRACTS

DWG. 4-2

RESTRICTED

BY: S.R. COCHRAN
FEB. 1953

Next, large tube and rod tube collars were acid washed and then ferroxyl tested. Photo serial #84 in Part II illustrates pictorially acid washing of large tube collars.

The large tube collars were then fit and tack welded to the bottom side of the top tube plate. Since shoulder tubes hold their collars firm against the tube plate, they were not fitted at this time. Shoulder tube collars were later set in place with shoulder tubes holding them firmly in position during preliminary assembly operations. Rod tube collars were fit and tack welded in a similar manner. All of the above operations were witnessed by du Pont inspectors.

(5) Verticality Check After Placing Tube Sheets in Circumferential Handling Jig

This inspection was performed in a similar manner to that described in Part VII, Section I, item 7A-(1).

(6) Gusset Plate Welding Inspections

Inspections performed after gusset plates had been fully welded in the "R" top tube sheet were similar to those performed on the "R" bottom tube sheet discussed in Part VII, Section III, item 7A-(6). No problems were encountered.

(7) Rod Tube Assembly and Welding Inspection

After the tube sheets in the circumferential handling jig had been leveled and mated for best verticality and concurrent with gusset plate welding, 168 pre-machined rod tubes were cleaned with CCl_4 on the outside inserted into the unit and tack welded. After tack welding all rod tubes, they were fully welded using three Aircomatic Automatic Tube Welders working 120° apart. Tubes were welded in accordance with a sequence set up for keeping distortion to a minimum and unit turned as required to balance welding. Refer to Part VII, Section I, item 7A-(2)a for rod tube welding sequence.

All rod tube welding was visually inspected for cracks, porosity, undercutting and necessary repairs made. The 5.005" trepanned holes in the vicinity of the rod tubes were distorted due to rod tube welding and hence would not pass top tube sheet straight tubes. Portable drill presses were set up and all distorted holes were again reamed to original size.

(8) Instrument Wells

Just prior to installing large tubes, the Design Division requested that twelve instrument wells be fabricated and welded into the unit. Since at this time drawings of the new instrument

wells were not available, preliminary sketches were furnished by Design in order not to hold up fabrication of the top tube sheet assembly.

As shown on Dwg. 4-3 presented herewith, twelve instrument wells and stabilizer plates were fabricated for this unit. Stabilizer plates (Section A-A) were cut from 1/8" thick S/S plate to suit a template made to fit the 7" tube pattern. The plates were then laid out and drilled for 1/4" pipe. Next, the center section of the instrument well (1/4" pipe) was cut to proper length and beveled on each end for welding. (See Dimension "X", Dwg. 4-3). Twelve pieces for the bottom 3" section of each instrument well were machined from solid S/S bar stock and beveled for welding on the open end. Twelve pieces for the top 3" section of each instrument well were made in a similar manner, beveled on the lower end for welding and with a 1/8" pipe tap on the upper end.

The three pieces that make up one instrument well were welded together to form the completed well. During the process of butt welding the pipe together, weld metal melted through to the inside. With the consent of the du Pont Inspection Department, New York Ship reamed the top and bottom weld lines on the I.D. of each well to 5/16" diameter.

The twelve instrument wells were then hydrostatically tested at 2000 psi. for 10 minutes and then visually inspected for leaks. None were found and the 12 instrument wells were released for assembling into the top tube sheet assembly.

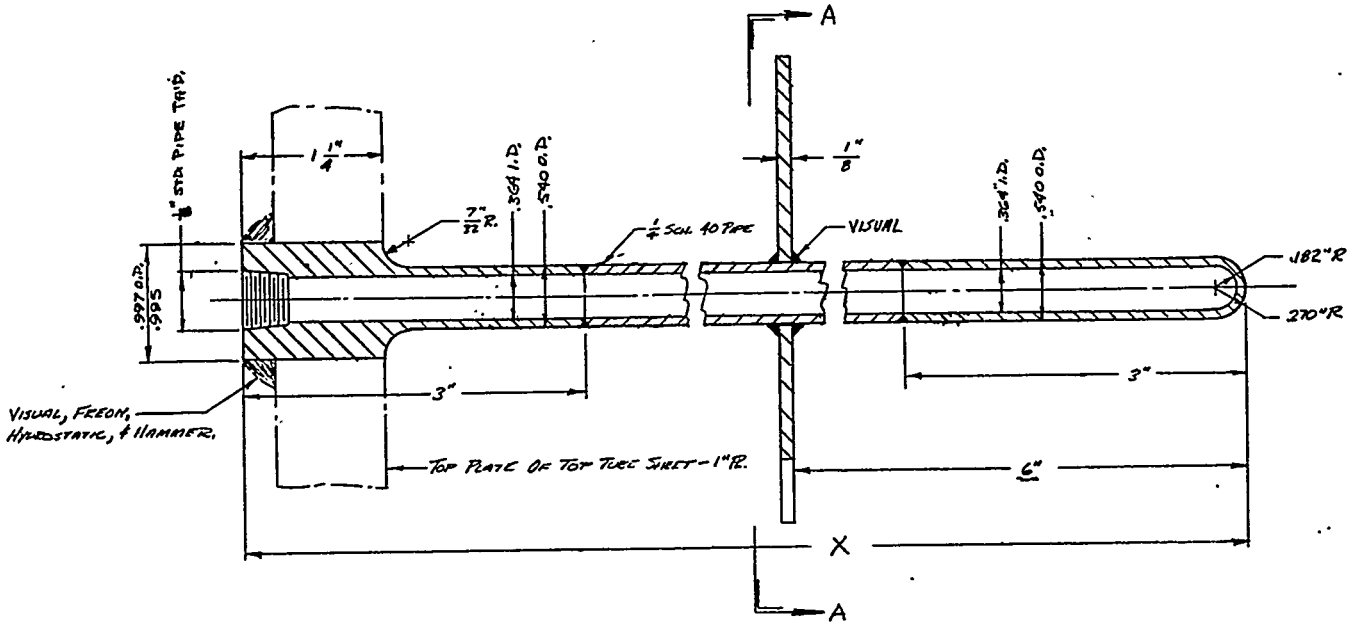
Just prior to welding instrument wells into the top tube sheet, it was requested by the du Pont Inspection Department that New York Ship re-ream the top and bottom weld lines on the I.D. of each well to 0.345" diameter. To check this dimension, a plug gage, slightly larger than the thermocouple to be later inserted into well at the plant site, was made to functionally check the I.D. after reaming. All 12 instrument wells passed the gage freely.

Again, the 12 instrument wells were hydrostatically tested in a similar manner described above, accepted and released for welding into the top tube sheet assembly.

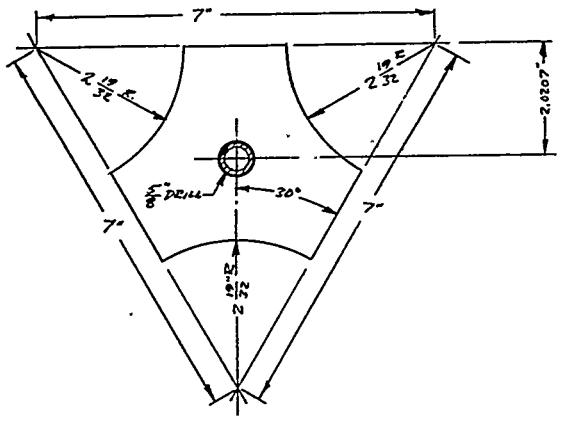
The 12 instrument wells were installed from inside the unit. The well stabilizers were aligned by inserting three large tubes around the instrument well and then tack welding the top end of the well to the outside of the top tube plate. (See du Pont drawing [illegible]-131109, Detail IX) After this the end of each instrument well was fully welded using Manual Aircomatic welding

[redacted]

TOP TUBE SHEET - INST. WELLS.



NOTE:
1. INSIDE WELDS VISUALLY INSPECTED FOR DEGREE OF PENETRATION WITH BORESCOPE & ARE SUBJECTED TO HYDROSTATIC & FREON TESTS PRIOR TO INSTALLATION



SECTION A-A

UNIT	NUMBER REQ'D.	DRAWING NUMBERS ARRANGEMENT	DRAWING NUMBERS DETAIL	DIM. "X"
R	6	W130943 W131109	110150-A	31 1/4"
	5		110150-B	25 1/4"
	3		110150-C	19 1/4"
P	6	W131365 W131417	110167-A	31 1/4"
	3		110167-B	25 1/4"
	3		110167-C	19 1/4"
L	3	W133143 W133146	110272-A	31 1/4"
K	3	W133629 W133629	110296-A	31 1/4"
C	3	W132800 W160569	110355-A	31 1/4"

M & E SECTION
GOV'T CONTRACTS

DWG. 4-3

[redacted]

BY: S.R. COCHRAN
JAN. - 1958

machines. All welding was visually inspected for cracks, porosity, undercutting and other mechanical defects. Necessary repairs were made, re-inspected and accepted.

It was then decided by the du Pont Inspection Department to visually inspect the two butt welds on the inside. The inside welding was visually inspected for degree of weld penetration using a 1/4" diameter borescope. All twelve instrument wells showed 90-100% weld penetration on the I.D. and were accepted.

(9) Large Tube Assembly

Starting in the center of the unit and working out, large tubes were progressively cleaned with CCl_4, inserted in the unit, and tack welded to the inside of the bottom tube plate. Tack welding was visually inspected for undercutting, cleanliness and necessary repairs made. Tube assembly was witnessed by du Pont inspectors.

The approximate number of each type of pre-machined 5" O.D. tubes assembled in this unit was as follows:

Tube Type	Number of Each in Assembly
Cast	130
Welded	469
Seamless	74

Du Pont inspectors identified the above cast tubes with a strong magnet. (Cast S/S tubes are slightly magnetic) The number of seamless and welded tubes was obtained from existing records kept for other purposes and are therefore, only approximate.

The locations of these different type tubes in the assembly could not be easily determined since such records were not previously kept.

(10) Measurements Before Large Tube Welding to Determine Unit Shrinkage

After all large tubes had been inserted into the unit, aligned and tack welded, initial shrink measurements were taken across three major diameters. Part II-A, Section 5-c, describes the method incorporated to take these measurements. Results of these measurements (before welding large tubes and after welding rod tubes) for the top and bottom sides was as follows:

182.418" Average top side measurement before welding
182.412" Average bottom side measurement before welding.

(11) Measurements After All Tubes Had Been Welded

All large tubes were welded in the unit using the same procedure discussed in Part II-a, Section 5-d.

After all large tube welding was completed, measurements were again taken using the procedure discussed in Part VII, Section I, item 7A-(2) e[1]. Results of these measurements for the top and bottom sides after all tube welding was as follows:

182.035" Top Side
182.020" Bottom Side

After all tube welding on the top tube sheet and plenum chamber units was completed, the top and bottom diametral measurements on both were analyzed to determine whether or not all results were within ± 1/32", and if additional shrink welding on either of the units was necessary to bring them within this tolerance. Shrinkage was analyzed in the following manner for the "R" Unit.

Plenum Chamber	Top Tube Sheet
Measurements After All Tube Welding	Measurements After All Tube Welding
182.146" Top Plate	182.035" Top Plate
182.036" Bot. Plate	182.020" Bot. Plate
.110" Diff.	.015" Diff.

In the case of the "R" unit, the plenum chambers top plate was first shrunk until the diametral measurements were within .0312" of each other before comparing the final results with those of the top tube sheet.

Plenum Chamber	Top Tube Sheet
Measurements After Shrink Welding Top Plate of "R" P.C.	Measurements After All Tube Welding
182.048" Top Plate	182.035" Top Plate
182.036" Bot. Plate	182.020" Bot. Plate
.012" Diff.	.015" Diff.

By analyzing the above results on both plenum chamber and top tube sheet as separate units, the difference between the top and bottom plate diametral measurements were within Design's tolerance of .0312". However, Design Division also requested that the top and bottom diametral measurements taken on both units be within this tolerance. By comparing the top and bottom

diametral measurements on both plenum chamber and top tube sheet, it can be readily seen that all measurements were within .0312" of each other; therefore, no additional shrink welding was necessary.

(12) Visual Inspection and Repair of Large and Rod Tube Welding

After all tube welding was completed, weld passes around tubes on the top and bottom sides of the unit were visually inspected with the aid of a flashlight for porosity, crater cracks, undercutting, and other mechanical defects. Defective welds were marked and necessary repairs made by chipping, grinding and re-welding, (if necessary).

(13) Unit Cleanliness Inspection

An intermediate cleanliness inspection was performed on the unit before fabrication continued. Rags, metal chips, wood and other foreign material was removed by air jetting. After the unit was cleaned and visually inspected, it was accepted and released for further fabrication.

(14) Machining Wrapper Plate Weld Preparation and Gusset Plate Milling

This operation was performed in a similar manner to that described in Part VII, Section III, item 8A.

(15) Fitting End Stiffeners to Gusset Plates and Assembling of Inlet and Outlet Cups

Inspection of fitting and welding end stiffeners and assembling of inlet and outlet cups was performed in a similar manner to that described in Part VII, Section III, item 9A.

(16) Inspection of Spiral Core and Inlet and Outlet Tubes

As shown on du Pont drawing D-112639, thirty-six (36) spiral cores, eighteen (18) inlet tubes and eighteen (18) outlet tubes were required for the "R" top tube sheet assembly. Location of the inlet and outlet tubes with spiral cores in each can be seen by referring to du Pont drawing W-130944.

a. Spiral Core Inspection

The thirty-six (36) spiral cores were received from the foundry in the rough cast state. First, the spiral cores were laid out to conform with specified dimensions shown on drawing D-112639. Next, they were rough turned on a lathe and then the spiral pitch was finished to drawing size by grinding to a polished finish. During grinding operations, du Pont inspectors visually examined all spiral core surfaces for "cavities". Defects of this type found were either ground

or chipped out and then spot welded using manual aircomatic welding machines. All welded spots were ground to a polished finish, re-inspected for quality and accepted. Next, the spiral cores were finished turned to size in a lathe, and then cut to the specified length. All machined edges were then dressed by grinding to a polish finish. As specified on the drawing, the required spiral core finish was to be 125 RMS micro-inches; however, New York Ship ground and polished all spiral cores to 25 RMS micro-inches or less which was acceptable to the du Pont Inspection Department.

After all work had been completed on the 36 spiral cores, they were checked dimensionally using a 6' rule graduated in 1/16". All spiral cores were found within tolerance and accepted.

Spiral cores were then acid washed, ferroxyl tested for presence of free iron, accepted and released for assembling into the top tube sheet assembly.

b. Inspection of Inlet and Outlet Tubes

The eighteen (18) inlet and eighteen (18) outlet tubes were fabricated from 3" schedule 40S pipe. Each was cut to the required drawing length and then beveled on the end which protrudes thru the top tube plate in the top tube sheet assembly.

The eighteen outlet pipes which require 2 rows of 69 holes spaced 80° apart to match the pitch of the spirals was laid out from a developed template, drilled and dressed. In addition, seven 3/8" diameter holes were drilled on one side of the pipe for plug welding the spiral core to the inside of the pipe. (See du Pont drawing D-112633-B) All holes were jig drilled. The jig was previously inspected by an inspector and found satisfactory; therefore, no physical measurements were taken to verify the accuracy of a finished drilled tube since the location of the holes was not critical. However, a visual check was made at random to ascertain whether all holes were being drilled in their approximate location.

The eighteen inlet pipes were fabricated and inspected in a similar manner as the outlet pipes, except the 69 holes to match the spiral pitch were not drilled in the inlet pipes. However, seven 3/8" holes spaced on alternate sides of the inlet pipes were drilled for plug welding the spiral core to the inside of the pipe. (See du Pont drawing D-112633-C)

Next, all inlet and outlet pipes were acid washed,

ferroxyl tested by inspectors and released for assembling and welding into the top tube sheet assembly.

c. Assembling and Welding of Inlet and Outlet Pipes With Spiral Cores Into Top Tube Sheet

Spiral cores were assembled into inlet and outlet tubes, aligned and then plug welded to the tubes. All plug welding was ground smooth, acid washed and then visually inspected by du Pont inspectors and approved.

The completed assemblies were then made ready for positioning and welding into the top tube sheet. First, 18 locating blocks (2-15/16" dia. x 1" high) were fit and welded to the top side of the baffle plate for receiving the bottom end of 18 outlet pipes as shown in section B-B, drawing W-130944. All locating block welding was ground, wire brushed and then visually inspected for cleanliness by du Pont inspectors. The eighteen outlet pipe assemblies were inserted into the top tube sheet through holes trepanned in the top tube plate with the bottom end of the pipe co-axially located by the locating blocks on the baffle. The top end of each pipe was then located 1¼" from the top plate surface and tack welded. All tube tack welding was chipped to clean metal, swabbed clean with CCl_4, air dried and then fully welded using manual aircomatic welding machines. After all welding was completed, a visual inspection was made by du Pont inspectors to ascertain the quality of welding and have necessary welding repairs made. All weld inspections were made with the aid of a flashlight.

Finally, the eighteen inlet pipe assemblies were assembled into the unit in a similar manner as the outlet pipes, aligned, tack welded, fully welded, inspected and approved. However, in the case of inlet pipe assembling, the bottom ends were aligned by passing it through holes trepanned in the baffle plate which provided a sliding fit for the tubes, thus holding the tube in position.

(17) Cleanliness and Visual Inspection of Wrapper Plates

After fitting three inch inlet and outlet pipes, turning O.D. of unit to finish size, milling gussets and completing all internal welding, the inside of the unit was inspected thoroughly for cleanliness before welding wrapper plates. All wrapper plates were acid washed and then checked for "free iron" using the ferroxyl test. Wrapper plates were fitted and tack welded to the circumference of the unit. Next, the unit was placed on a welding positioner for downhand work while welding the circumferential joints. Due to inaccessibility, circumferential welding could not be x-rayed. Butt welded wrapper plates were visually inspected for porosity, undercutting, cracks and other machanical defects

and necessary repairs made.

(18) Facing Operation

The top tube sheet assembly was set up and leveled bottom side up under three radial drill presses by New York Ship mechanics and checked by du Pont inspectors using the Wild NIII Level and target. This was done in order that the "hour glass effect" (shrinkage) at the weld line (caused from welding tube to tube sheet) on the I.D. of the tubes at the bottom ends could be reamed to original dimensions, allowing the verticality gage to pass through. No other tubes were reamed other than the "spider web tubes" in this operation.

While the unit was bottom side up, the location of twelve bearing pads was established from layout by New York Ship layout men. All layout work was witnessed by a du Pont inspector and approved. The twelve bearing pads were fit, set, tack welded to layout, fully welded, and dressed. Welding was visually examined by du Pont inspectors for evidence of porosity, undercutting, cracks and other mechanical defects. Necessary repairs were made, welding re-inspected and accepted by the du Pont Inspection Department.

Next, the unit was turned top side up and re-leveled by New York Ship mechanics under the three radial drills in order to ream out the "hour glass effect" in the top ends of the "spider web tubes". Leveling of unit by New York Ship was again checked by du Pont inspectors using the Wild NIII Level and target.

After the tube reaming operation was completed, the unit was then set to the best verticality using the "spider web tubes" for verticality readings. After adjusting the level of the unit to the best verticality, bench marks for machine set-up were established at tube numbers X48-Y28, X55-Y51, X21-Y93 and X9-Y15 using the Wild NIII Level and target.

The top tube sheet assembly was moved to the 20' boring mill that had two cutting heads. With the aid of lifting pads, cables, and the overhead crane, the top tube sheet assembly was positioned on the mill table and centered on blocks at the unit X and Y axes. With the top side of the unit up, it was set with the blocks under the bottom tube ends for facing the bearing pads. The unit was rough leveled using an 18' straight edge and 6" precision level and then adjusted to the previously established bench marks using the Wild NIII Precision Level and target.

First of all, the top tube sheet assembly orientation discs were machined or finished faced to size. Two tools were used for

machining the tube ends. The first or lead tool was 1/16" higher than the second tool. The initial machining or facing operation took place using a .060" feed at 45 F.P.M. Measurements were taken to ascertain the amount of metal removed and the amount to be removed. After the last rough cut was made in the large tube ends, a finishing tool of the square nose type was employed for finish machining the tube ends.

Since the orientation discs were finished machined to a known elevation, they were used as bench marks or reference points for the finish machining of the large tubes. In reality the large tubes were finished machined to the best average elevation between the tube plate and the plane of the finished faced or machined tube ends. The tube length specified on "R" drawings was also taken into consideration. Since the large tube faces on the bottom side were not machined, it was necessary to use the average tube lengths to satisfy Design's requirements. The bearing pads were faced to the proper distance or drawing specification from the top ends of the tubes on the top side.

The profile of the machined tube faces was checked on the top side of the top tube sheet assembly to see if the tube faces were within drawing tolerance. (See Exhibit #1 for results). An 18' straight edge was positioned on top of the tubes located on both the "X" and "Y" axes. Feeler or thickness gages calibrated to .001" were inserted between the face of the straight edge and the machined tube faces to determine the difference in the height of the tubes. Next, the distances from the bottom side of the bearing pad plates to the top of the tubes were measured using a pin gage set at 47.125" and feeler gages. Sketch #15 in Part II illustrates pictorially how these measurements were taken. For results, see Exhibit #1 presented herewith. After the machined tube faces (top side) and bearing pads had been inspected and accepted for finish and elevation, copper shields were placed over the bearing pads to protect the machined surfaces.

(19) Deburring and Inspection

This operation and inspection was performed in a similar manner to that discussed in Part II-A, Section 10.

(20) Lifting Lug Inspections

Four lifting lugs were butt welded to prolonged wrapper plates on the top tube sheet, 30° on each side of Y1-Y2 axis. Welding was visually inspected for porosity, undercutting, cracks and other mechanical defects. After this the welding was zy-glo tested, inspected and necessary repairs made. (See Dwg. 4-4) The four

EXHIBIT #1

RESULTS OF TUBE END FACING OPERATION ON THE "R"

TOP TUBE SHEET ASSEMBLY

S [redacted]

I. DU PONT DE NEMOURS & CO., INC.
WILMINGTON, DELAWARE

Construction Division

CC: C. E. Buckley, F.P.M.
R. K. Mason, F.P.M.-SRP(3)
H. L. Bunker-J.G.Brewer(2)
H. B. Gage
F. C. Breuninger
A. H. Hughes
C. W. Dunn — File

This material contains information affecting the national defense of the United States within the meaning of the espionage law Title 18, USC, Sec. 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM A. J. PIATEK DATE MARCH 18, 1952

PROJECT NO. 8980 PLANT SAVANNAH RIVER ORDER NO. AXC-167½

EQUIPMENT TOP TUBE SHEET & MILL TABLE EQ.PC.NO. "R" UNIT

DRAWING NOS. W-130943 JOB RATING

VENDOR NEW YORK SHIPBUILDING CORP. LOCATION CAMDEN, NEW JERSEY

This is a report on measurements made on the top ends of the top special tube bundle of "R" Unit, with tops of tubes in up position on vertical boring mill table just after the finish facing operation.

Exhibit "A"

With tube bundle clamped to the mill table and the bundle rotated such that the X_1-X_2 Axis was parallel with the cutting rail, a straight edge was placed on X_1-X_2 axis of tubes. The straight edge was checked for levelness and was found to be leaning west ½ a thousand. "Feeler" gages were inserted between the straight edge and the tube tops to determine the clearances as shown on the sketch on Page 3.

Also shown on the sketch, are dimensions taken around the periphery of the tube sheet having a basic measurement of 47-1/8. The distances are from the bottom side of the bearing plates to the top of the tubes. Measurements were obtained by means of a Pin Gage set at 47.125" and "feeler" gages inserted between two straight edges. One resting on the tops of the tubes and the other held by a jack to the bottom side of the bearing plate.

Exhibit "B"

Clearances were taken same as in Exhibit "A", with X_1-X_2 axis rotated 90° from cutting rail. Straight edge was found to be leaning .006 south.

[redacted]

LD INSPECTOR'S REPORT

OM A. J. PIATEK A March 18, 1952

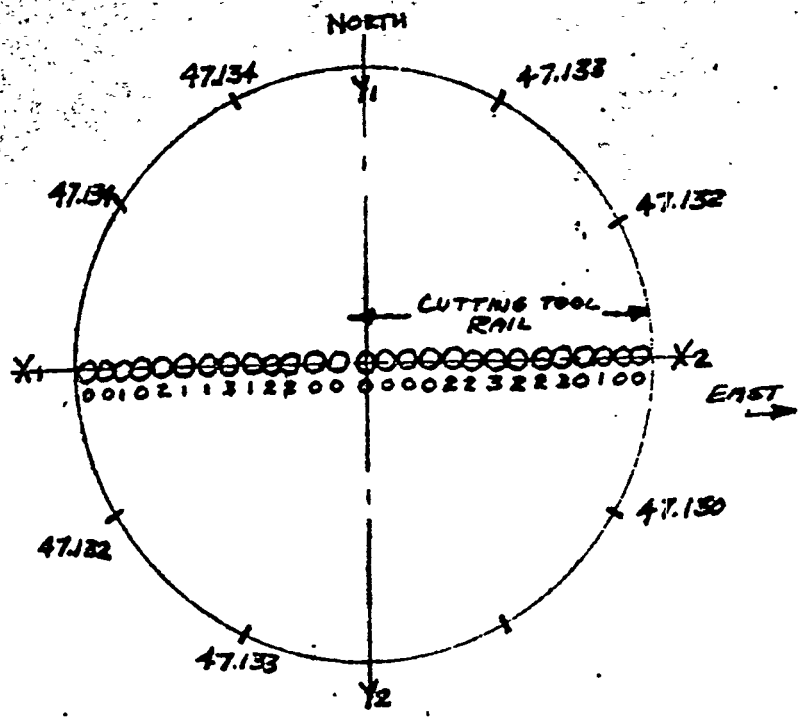
Exhibit "C"

With tube bundle clamped to the mill table and rotated such that the Y_1-Y_2 axis of tubes were parallel with the cutting rail, a straight edge was placed on Y_1-Y_2 axis of tubes. "Feeler" gages were inserted between straight edge and tubes to determine clearances. Base of straight rested partially on adjacent row X-29 because the face of the straight edge is 3-1/8" wide. This difficulty was not encountered on the X_1-X_2 axis.

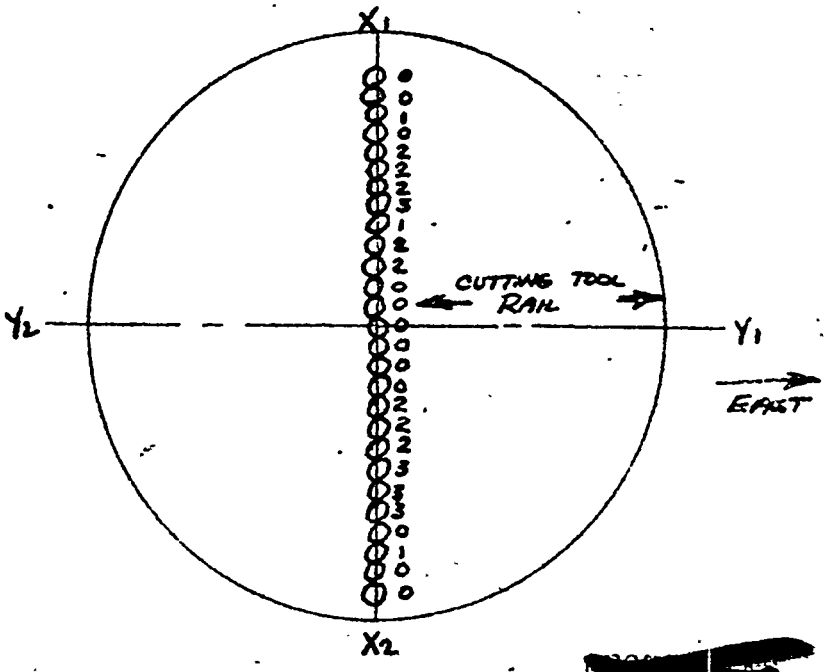
Exhibit "D"

Clearances were taken same as in Exhibit "C" with Y_1-Y_2 axis rotated 90^0 from cutting rail. Straight edge was found to be leaning south .006".

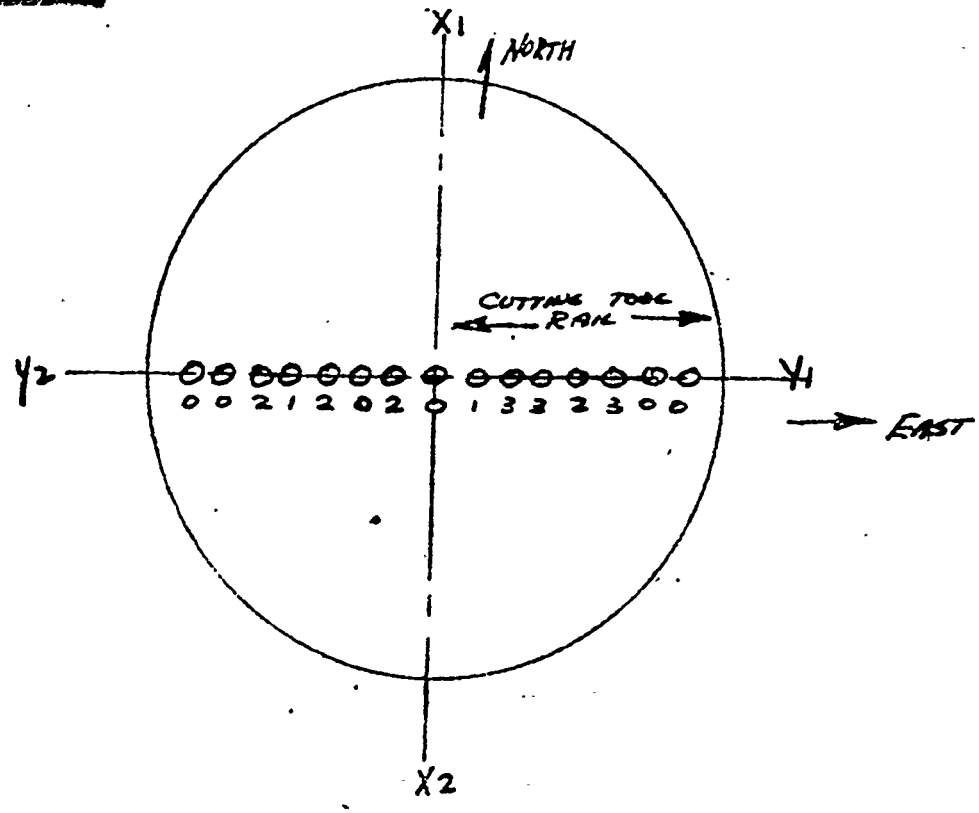
SKETCH OF EXHIBIT "A"



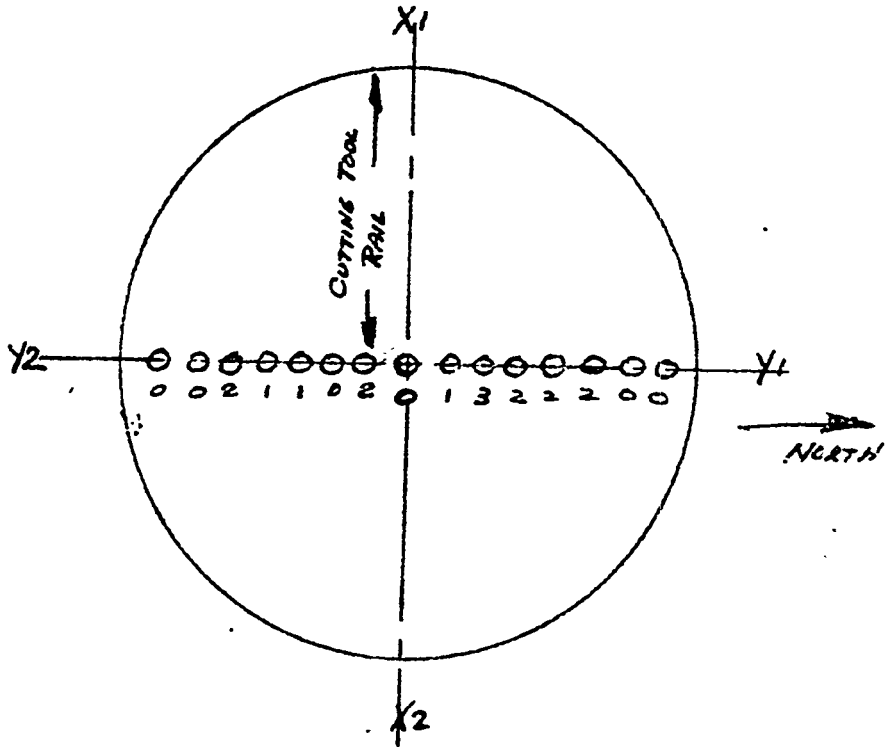
SKETCH OF EXHIBIT "B"



SKETCH OF EXHIBIT "C"

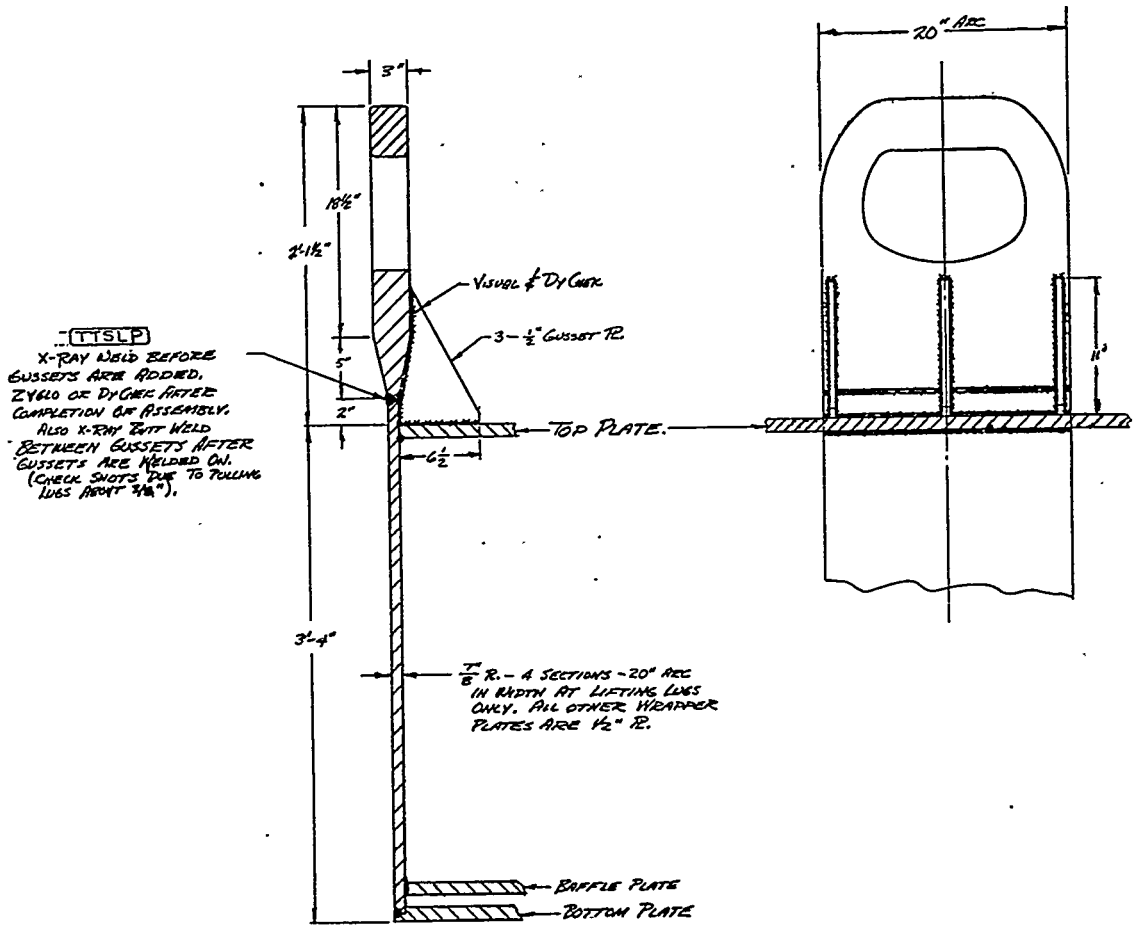


SKETCH OF EXHIBIT "D"



[redacted]

TOP TUBE SHEET — LIFTING LUGS



M & E SECTION
GOV'T. CONTRACTS

DWG 4-4

[redacted]

BY: S. R. COCHRAN
MAR-53

[redacted]

lifting lug attachment welds were x-rayed and necessary repairs made.

(21) Tube Reaming Operation

Using an 18' straight edge and box level, New York Ship mechanics again leveled the top tube sheet assembly under three radial drill presses. Inspectors checked the levelness with the Wild NIII Level using the following method: A lighted target (graduated in centimeters) was placed on the center tube (X48-Y28) and read with the Wild NIII Level in millimeters. Readings were also taken on the end tubes on the X and Y axes, making a total of five readings. All readings were converted from millimeters to thousandths of an inch. For the unit to be level, all five readings must not deviate more than .015".

After the unit was leveled, all large and rod tube bores, except those previously reamed in the "spider web" pattern, were reamed to the specified diameter at the top weld lines to remove the "hour glass" effect caused by welding. Also, the large tube ends were chamfered to 10° and rod tubes to 30°. Chamfers were checked using a plug type chamfer gage. During the reaming operation, the finished bores were spot checked with a standard dial indicator bore gage and ring gage. All tube bores were then visually checked for evidence of tool steps, gouges, rough finishes and other mechanical defects. Defects found were removed either by honing or cloverleafing until the defect was blended into the tube wall.

Before turning the unit bottom side up, the six gas tubes were faced 5-3/8" from the top tube plate. (See du Pont drawing W-131365 for location of gas tubes. Also see drawing W-130944 for cross-section of gas tube and required specifications) The distance from the top tube plate to the end of each gas tube was measured using a 6" scale graduated in 1/32". All results were satisfactory. In addition, the six gas tube ends were chamfered 1/16" x 10° and then checked using a plug type chamfer gage and approved.

The top tube sheet was turned bottom side up and leveled in a similar manner described above. All large and rod tubes were reamed from the bottom side in a similar manner to that done on the top side of the unit. In addition, the six gas tubes were faced flush with the bottom tube plate. The inside diameter of the "flushed" gas tube ends were radiused 3/16", inspected and accepted. Also, the welding joining the bottom end of the gas tubes to the bottom tube plate was inspected for porosity and cracks. Defects of this nature discovered by du Pont inspectors were removed by chipping then re-welding using manual Aircomatic welding machines. All repaired spots were ground

smooth, re-inspected and accepted.

After the reaming operation was completed, all large tubes were checked with a 4.372" diameter plug gage which was .003" under the minimum bore size. First, each large tube was plug gaged from the top side of the unit by inserting the gage into the tube approximately two-thirds the way down. This same check was performed from the bottom side of the unit. The first check revealed that 105 tubes gaged from the top side and 21 gaged from the bottom side failed to receive the plug gage. These tubes were honed, re-gaged and accepted.

The rod tube bores were checked in a similar manner using a 1.307" "GO" gage and 1.317" "NO-GO" gage after reaming to remove bore distortion caused from welding. The "GO" gage was successfully passed through the entire length of each tube working from the top ends of the rod tubes. The "NO-GO" gage entered the top end of tube X4-Y68 for approximately 1" and tube X10-Y56 for approximately 3". No other tubes received the "NO-GO" plug gage. The "NO-GO" gage was not "tried" in tubes from the bottom ends. All tubes were accepted for functional gaging, including the two oversize rod tube bores.

Finally, all large tube and rod tube bore diameters were measured in the X and Y direction at the weld line in the top end of each tube. Measurements were taken using a dial indicator bore gage and ring gage. All results were accepted as being satisfactory

(22) Large Tube and Rod Tube Verticality Measurements

After the tube reaming operation was completed, the unit was releveled in a similar manner to that described in Section 7A-(21) of this manual. Next, the verticality of all large and rod tubes were taken using a specially designed calibrated verticality gage which indicates the inclination with the vertical. Readings were recorded in .001" per foot. For use of verticality gages for determining tube verticality, see Part III, Section II-L. Results of these measurements are presented herewith as Exhibits #2 and #3.

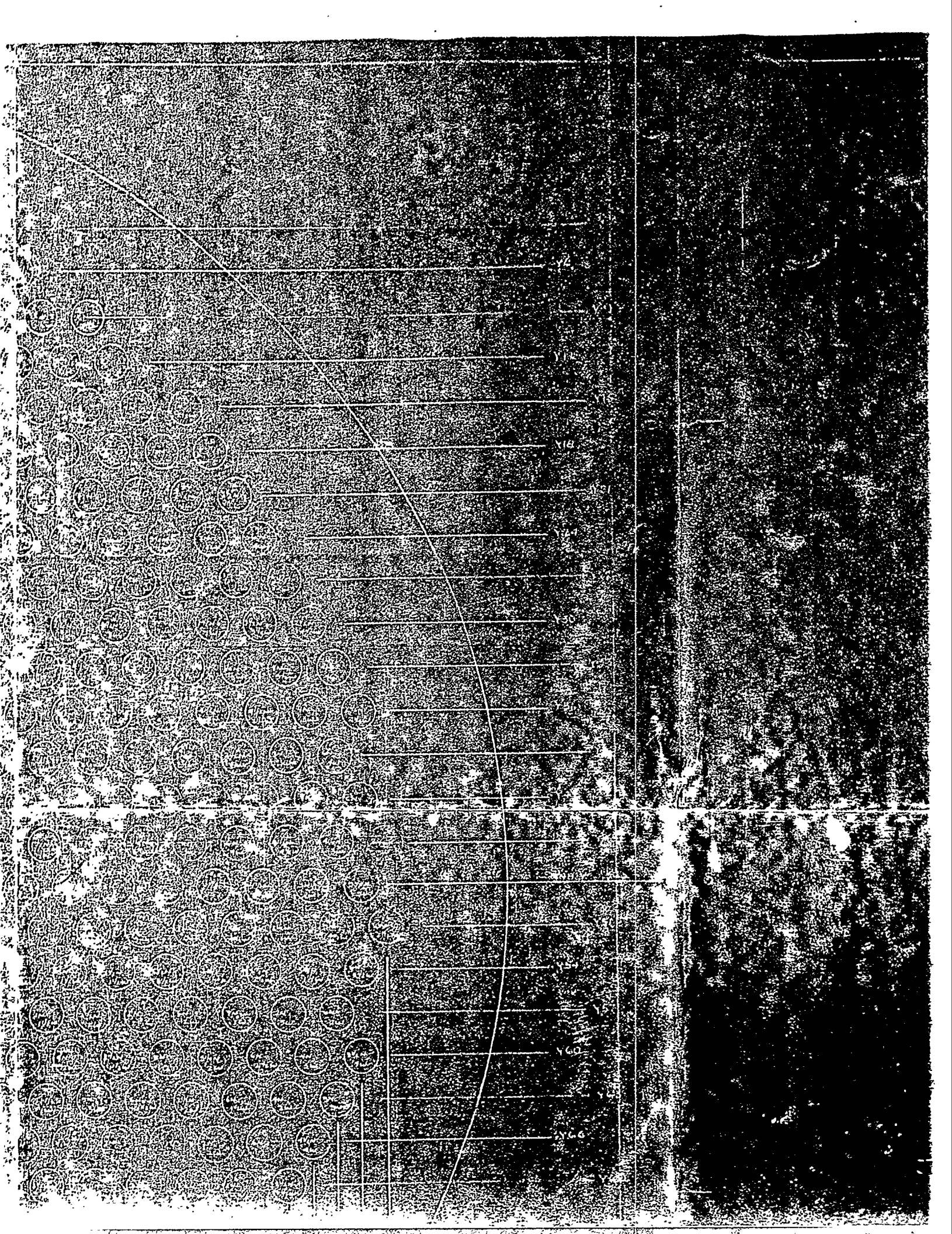
(23) Preliminary Hydrostatic Test

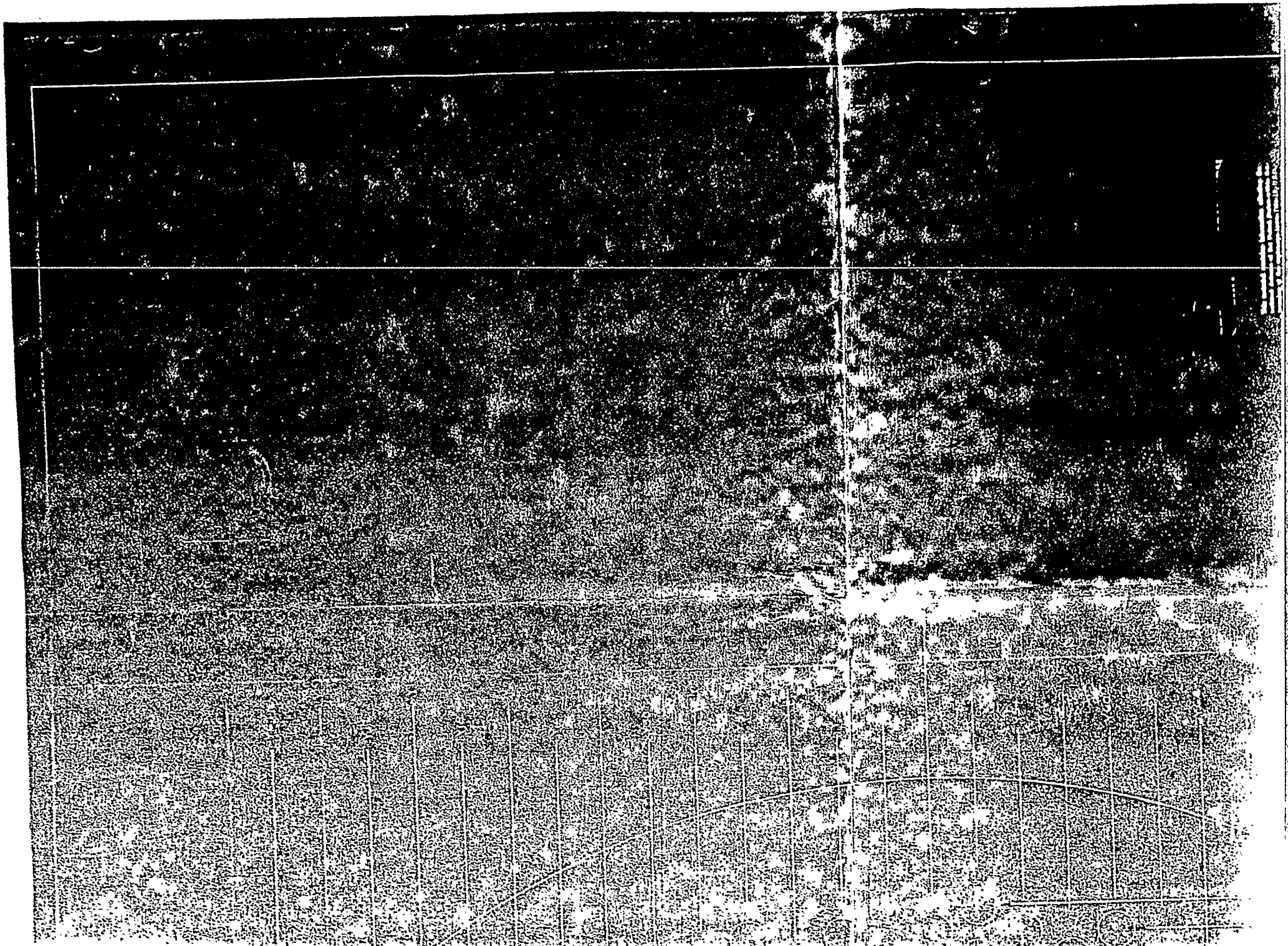
The top tube sheet (top side up) was filled with city water, brought up to 52½ lb./sq.in. gage with a hand pump and held at this pressure for one hour (see photo serial #116, Part II-B, Section II). All shell welding and tube welding was visually inspected for leaks with the aid of a flashlight. Four large tubes were found to be leaking through tube welds; three on top of unit and one on the bottom. All defects on the top side were

EXHIBIT #2

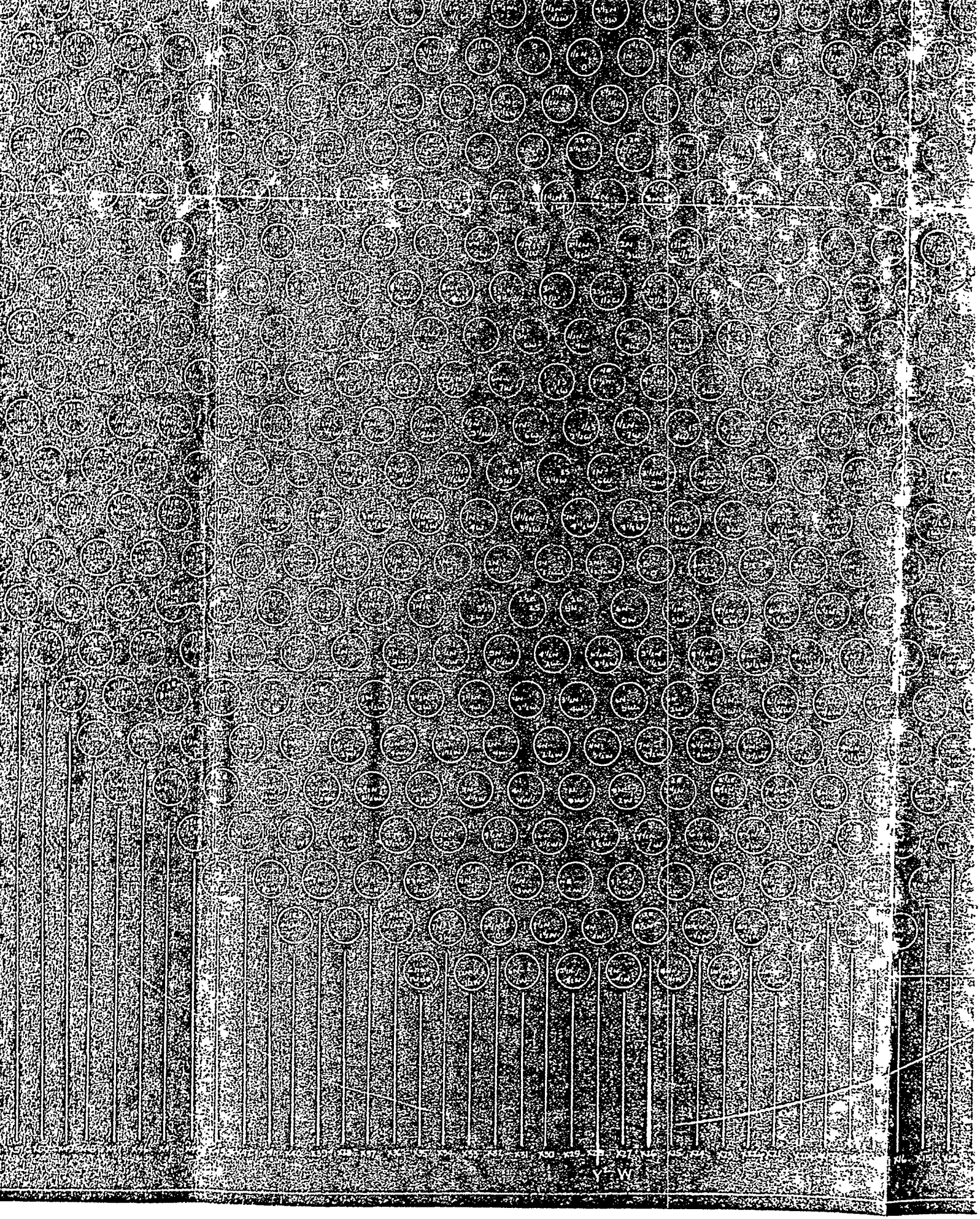
RESULTS OF THE AVERAGE VERTICALITY OF ALL LARGE TUBES IN THE "R" TOP TUBE SHEET ASSEMELY

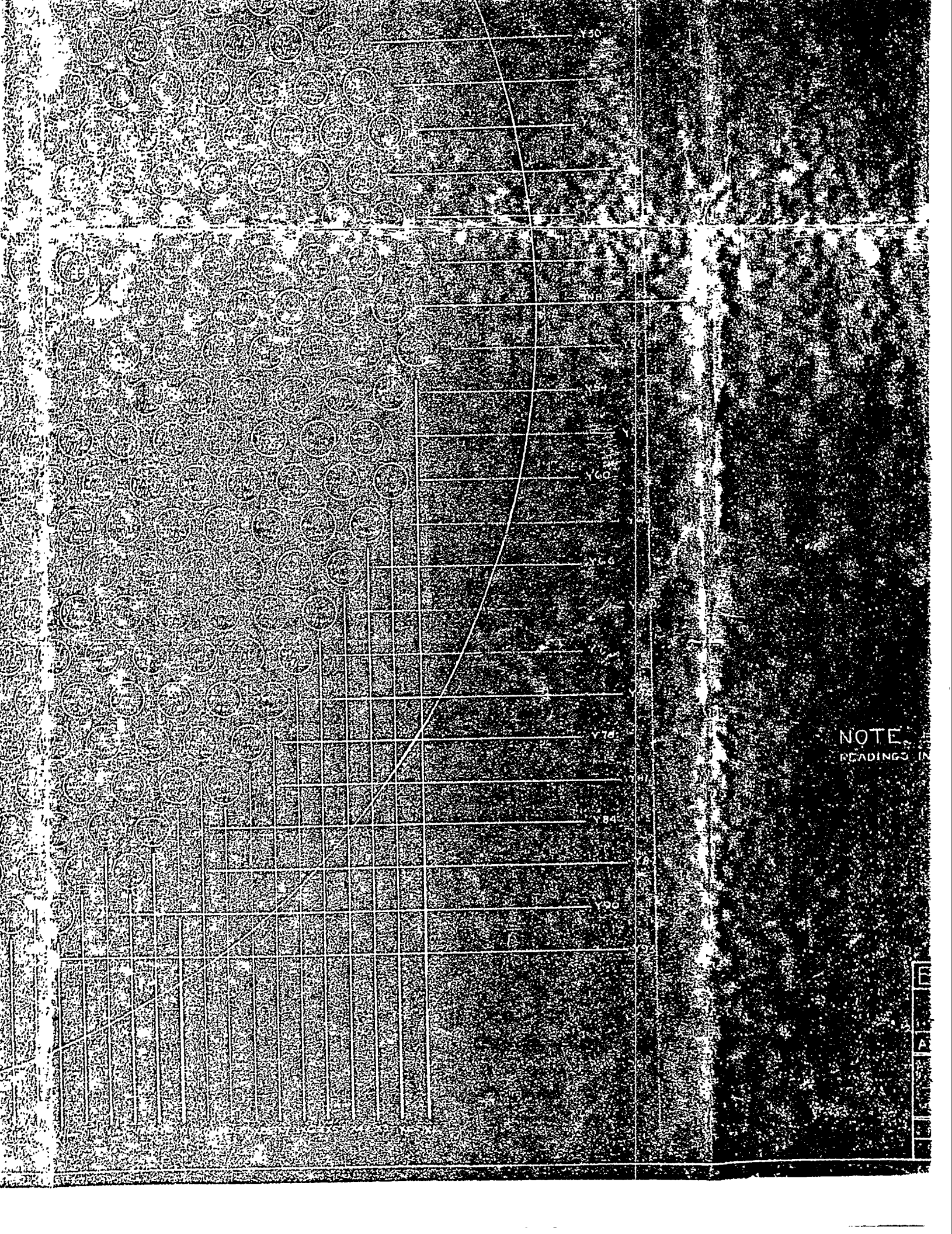
N.X.

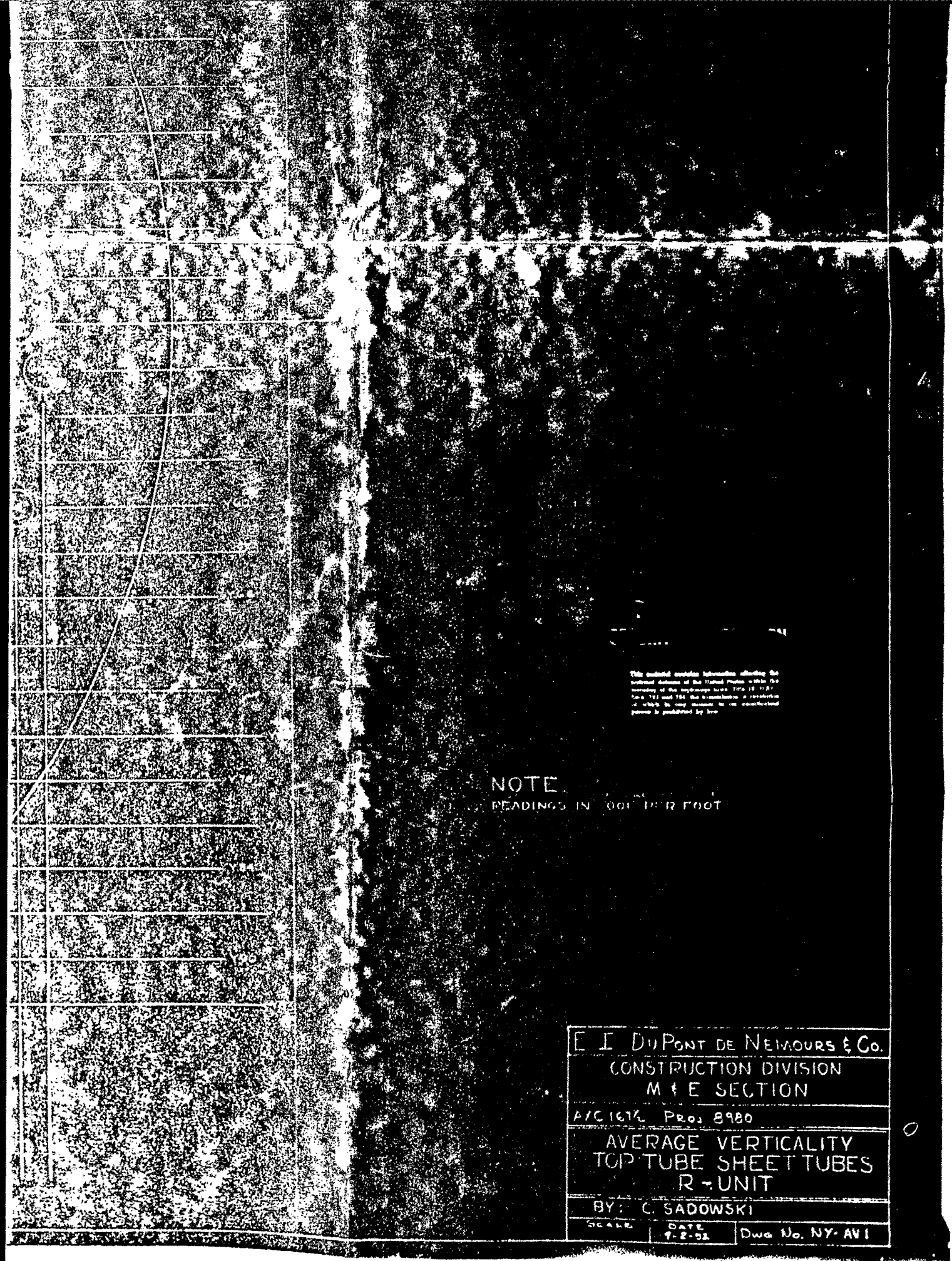




N.X




NOTE
READINGS IN



NOTE.
READINGS IN .001" PER FOOT

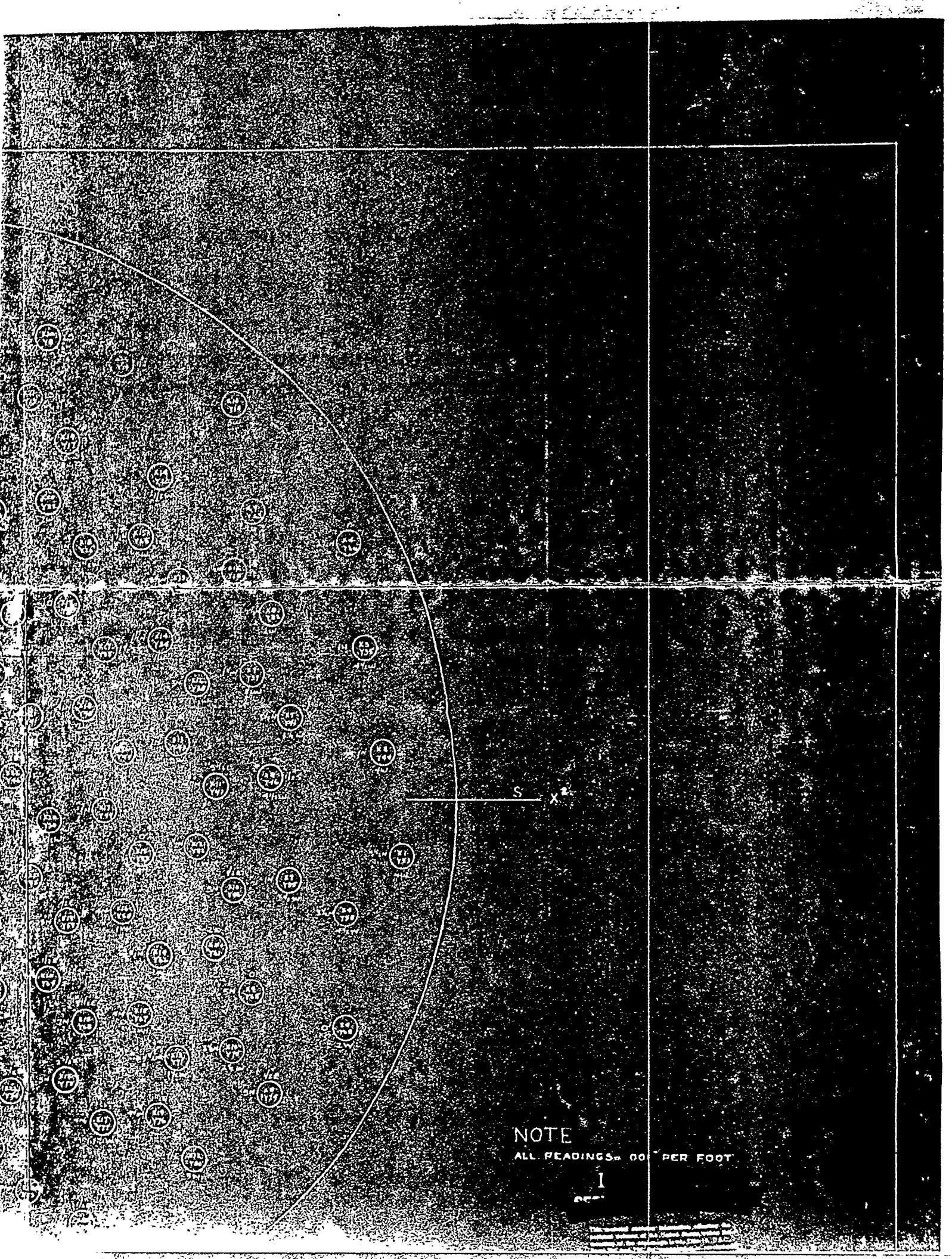
E. I. DuPont de Nemours & Co.	
CONSTRUCTION DIVISION M & E SECTION	
A/C 1612 Proj 8980	
AVERAGE VERTICALITY TOP TUBE SHEET TUBES R-UNIT	
BY: C. SADOWSKI	
SCALE	DATE 7-2-52
	Dwg No. NY-AV1

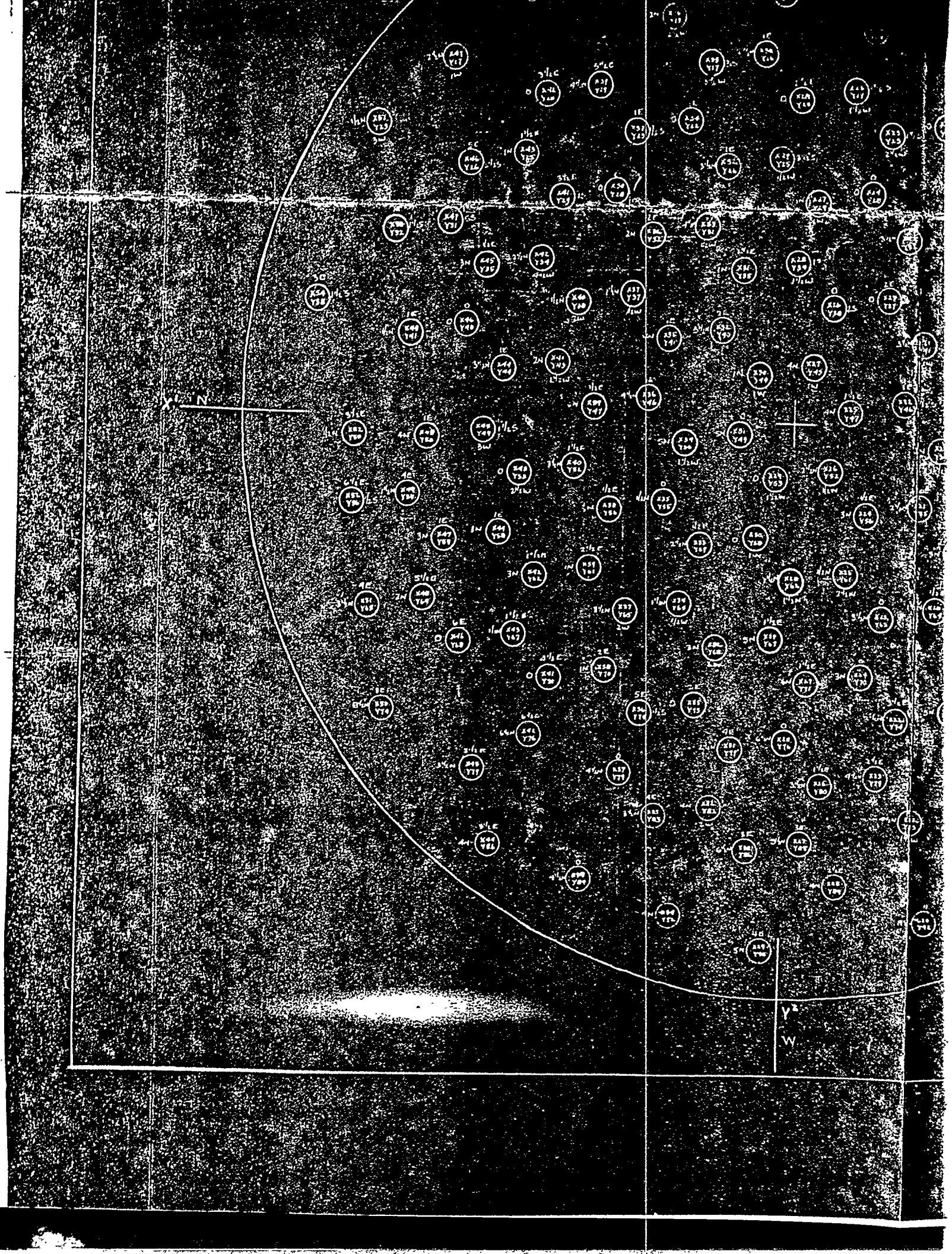
EXHIBIT #3

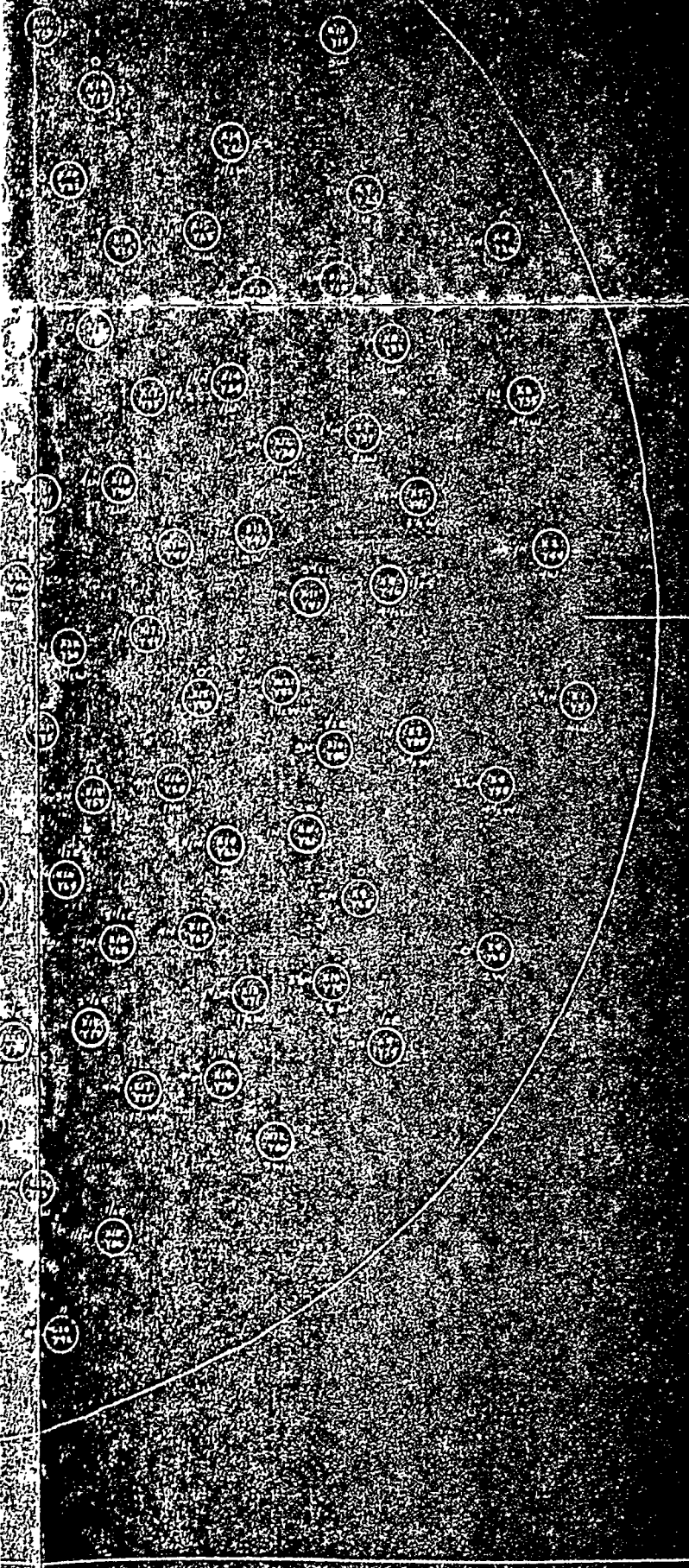
RESULTS OF THE AVERAGE VERTICALITY OF ALL ROD TUBES

IN THE "R" TOP TUBE SHEET ASSEMBLY

Y
E
N


S
X²
NOTE
ALL READINGS .00 PER FOOT





NOTE

ALL READINGS = 001" PER FOOT

I

E I DU PONT DE NEMOURS & CO.

AVERAGE VERTICALITY TOP SPECIAL TUBE SHEET ROD TUBES - R UNIT

BY C. SADOWSKI	PROJECT 8080
DATE 9-2-52	DRWG RT 1

chipped down to the tube sheet and repaired. The unit was turned bottom side up and the leaking large tube weld repaired in a similar manner. The unit was subjected to another hydrostatic test and again completely inspected for leaks. None were found and the unit was accepted as being water tight.

(24) Line Boring Operation

The use of the top tube sheet assembly for line boring plenum chamber tubes and problems encountered during this operation are covered in Part VII, Section I, item 15A. Also, inspection of indexing devices and establishing of temporary centerlines is discussed in this section.

(25) Preliminary Freon Test

After the line boring operation was completed, the top tube sheet was prepared for a preliminary freon test. Before the freon test was applied to the unit, the top tube sheet was subjected to an air test for the purpose of insuring that all openings, pipe fittings, etc., were air tight. Air pressure was raised to 35 lb/sq. in. and all fittings were visually examined by applying a soap test to determine if any fittings leaked. The air test was performed by New York Ship personnel. Du Pont inspectors were given strict orders to stay clear of unit while this test was in progress.

After all openings were made airtight, twenty pounds of freon 12 (by weight) was introduced into the unit and pressure raised to 30 psig. with air. All welds were then checked with a General Electric Type "H" Halide Leak Detector. During the preliminary freon test, leaks were found on the top side of the unit in the following tube welds: X21-Y69, X30-Y72, and X29-Y81. These tube weld defects were chipped out, re-welded and the unit again subjected to a freon test. All welding was re-inspected in a similar manner described above. No leaks were found in this second test and the unit was accepted.

(26) Individual Tube Hydrostatic Test in Unit and Tube Zy-glo Test

During the time that the above freon test was in progress, the "R" bottom tube sheet was being subjected to a hydrostatic test. It was discovered that several welded type tubes in the bottom tube sheet were leaking in the tubes welded seam. (See Part VII, Section III, item 14A) To thoroughly evaluate the extent of the unsatisfactory quality of welded tubes in the "R" B.T.S., all fabrication work was discontinued and a testing program was studied and formulated for this unit as discussed in the above referenced section. Since the "R" top tube sheet had 469 welded type tubes assembled into the unit, it was decided jointly by the M & E Section, du Pont Design Division and New York Ship to

individually hydro test all large tubes in the "R" top tube sheet. In addition, tube ends and bores were to be zy-glo tested to determine the location of cracks (in tube welded seam), laminations and other mechanical defects that may be present in the tube ends and bores.

Each tube in the "R" top tube sheet assembly was hydrostatically tested using a special pressure testing mandrel adaptable to the size tubes in this unit (see du Pont drawing D-112848). This test was conducted by New York Ship personnel and witnessed by du Pont inspectors. Each tube was filled with city water (after installing test mandrel) and 1000 psig. applied and held for fifteen minutes. No leaks were found. (For a more detail discussion of individual tube hydro testing, see Part VII, Section III, item 14A-(3)b.)

After the hydro test of all tubes was completed and accepted, the tube ends and bores were zy-glo tested in a similar manner to that described in Part VII, Section III, item 14A-(3)a. No tubes were found defective and the unit was released for further fabrication.

(27) Pattern Measurements

After all machining and repair work had been completed on large tubes, pattern measurements were taken to show the position of each tube center from the X and Y centerlines. Pattern measurements were taken on the top side only. All measurements were taken using ligament gages. Part II-A, Section 18, describes the manner in which ligament gages were used. Part III, Section II-G, describes how the gages were calibrated and how pattern coordinates were calculated. Sketch #35 in Part VII, Section I, item 16A-(8), illustrates pictorially how X and Y centerlines (final) were established on the Top Tube Sheet assembly for tying in pattern coordinates on the top side of the assembly. For results of pattern measurements taken on the top side of the "R" top tube sheet assembly, see Exhibit #4 presented herewith.

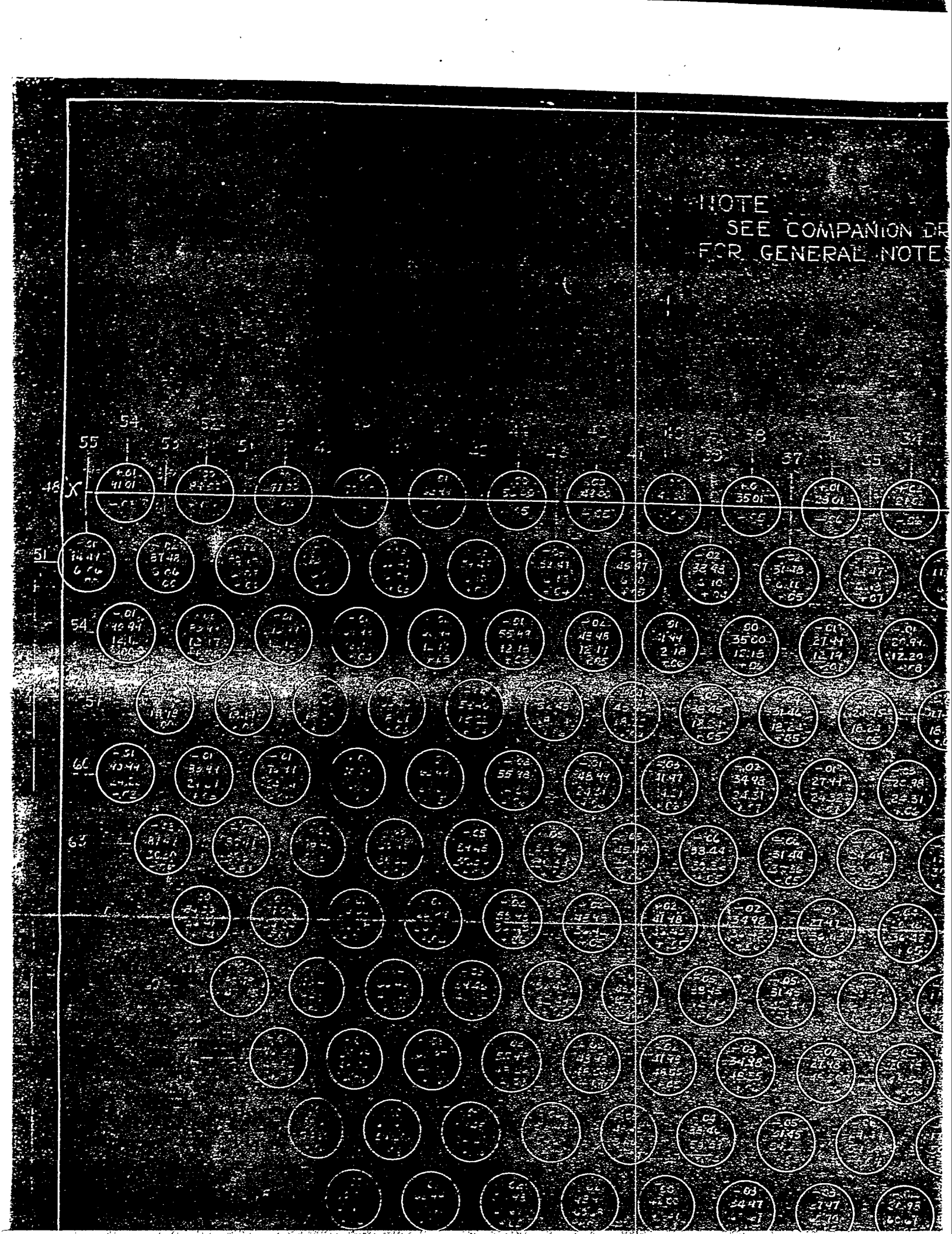
(28) Chime Inspections

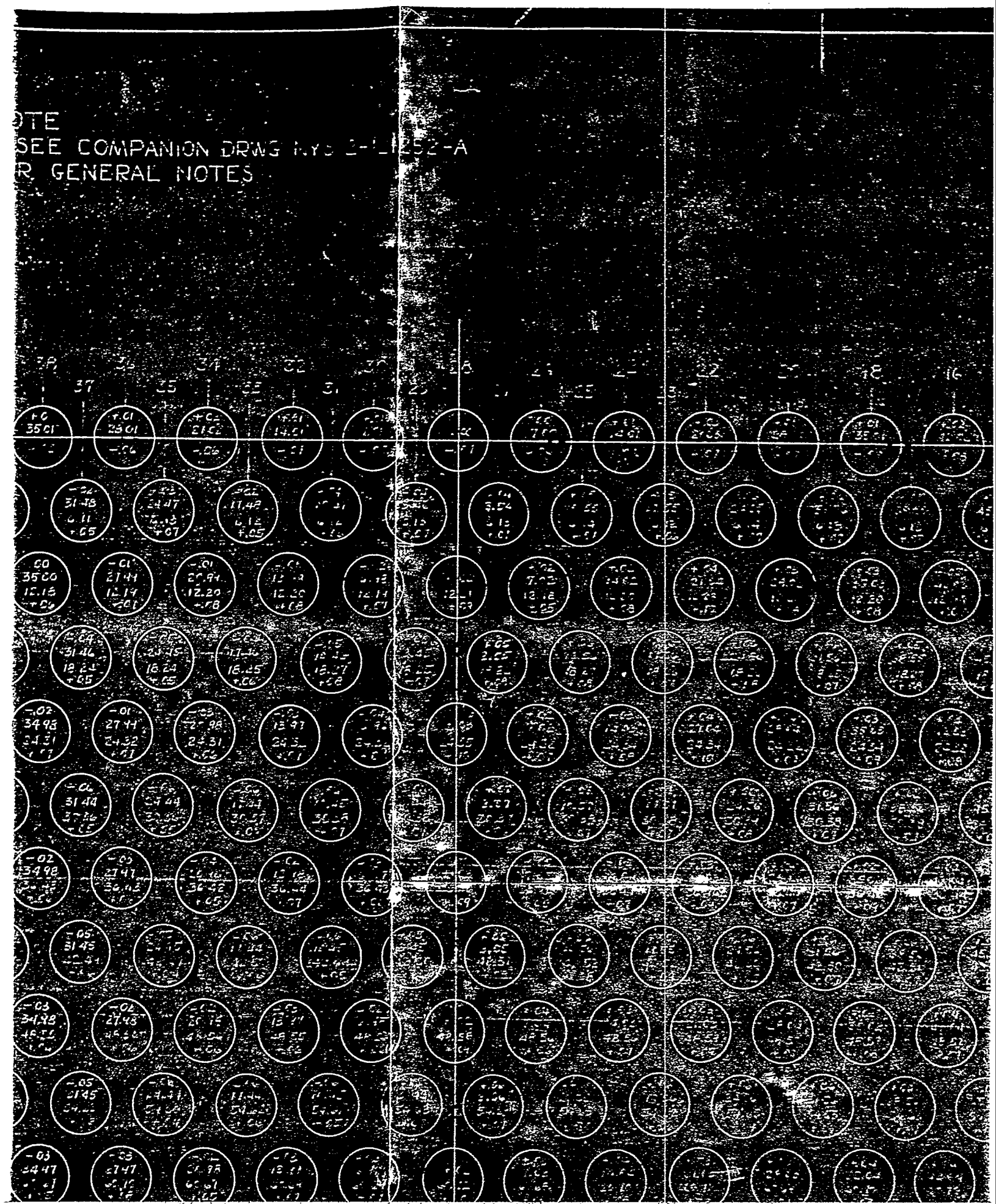
As shown on du Pont drawing W-132354, twelve chime bracket assemblies were cut, fit and welded to the bottom side of the "R" top tube sheet assembly using the chime assembly as a jig. After all brackets were welded in place, the welding was visually inspected for porosity, undercutting, cracks, and other mechanical defects. Necessary repairs were made, re-inspected and accepted. A $1\frac{1}{2}$" pipe drain in the bottom tube sheet was found to be in way of one set of chime brackets. Pipe drain was located 15° off the Y2 axis toward the X1 axis.

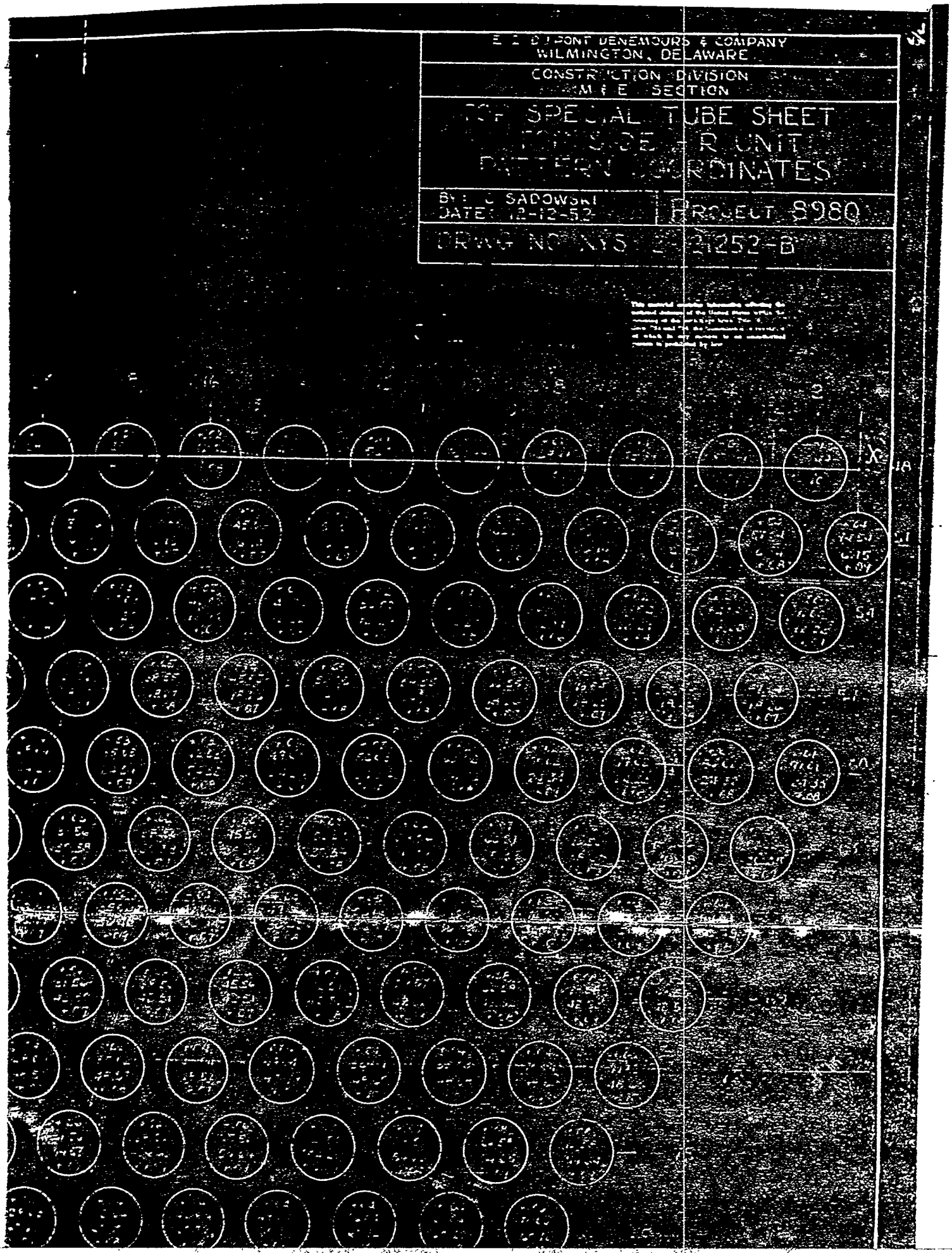
EXHIBIT #4

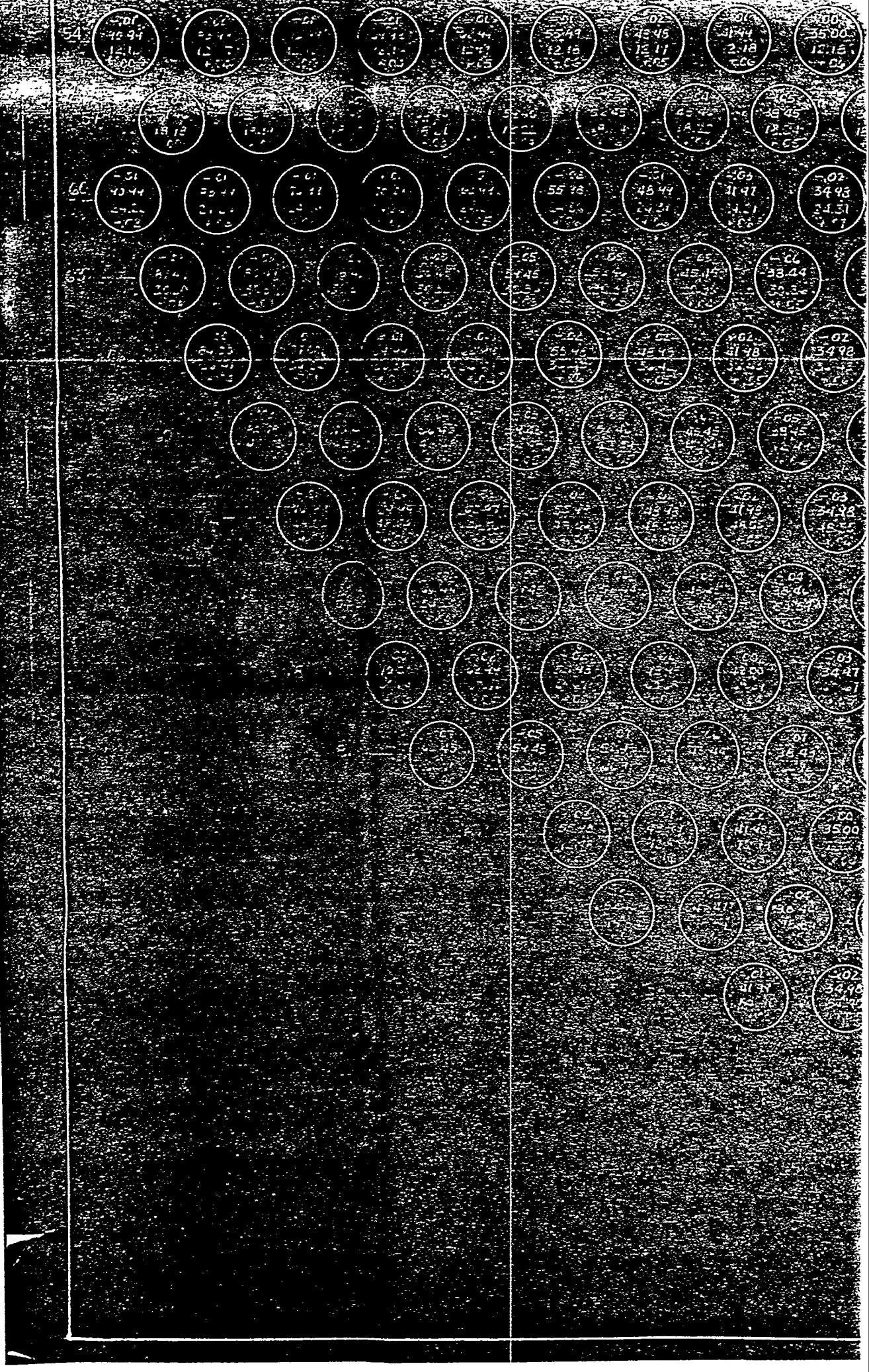
RESULTS OF PATTERN MEASUREMENTS TAKEN ON TOP SIDE OF THE

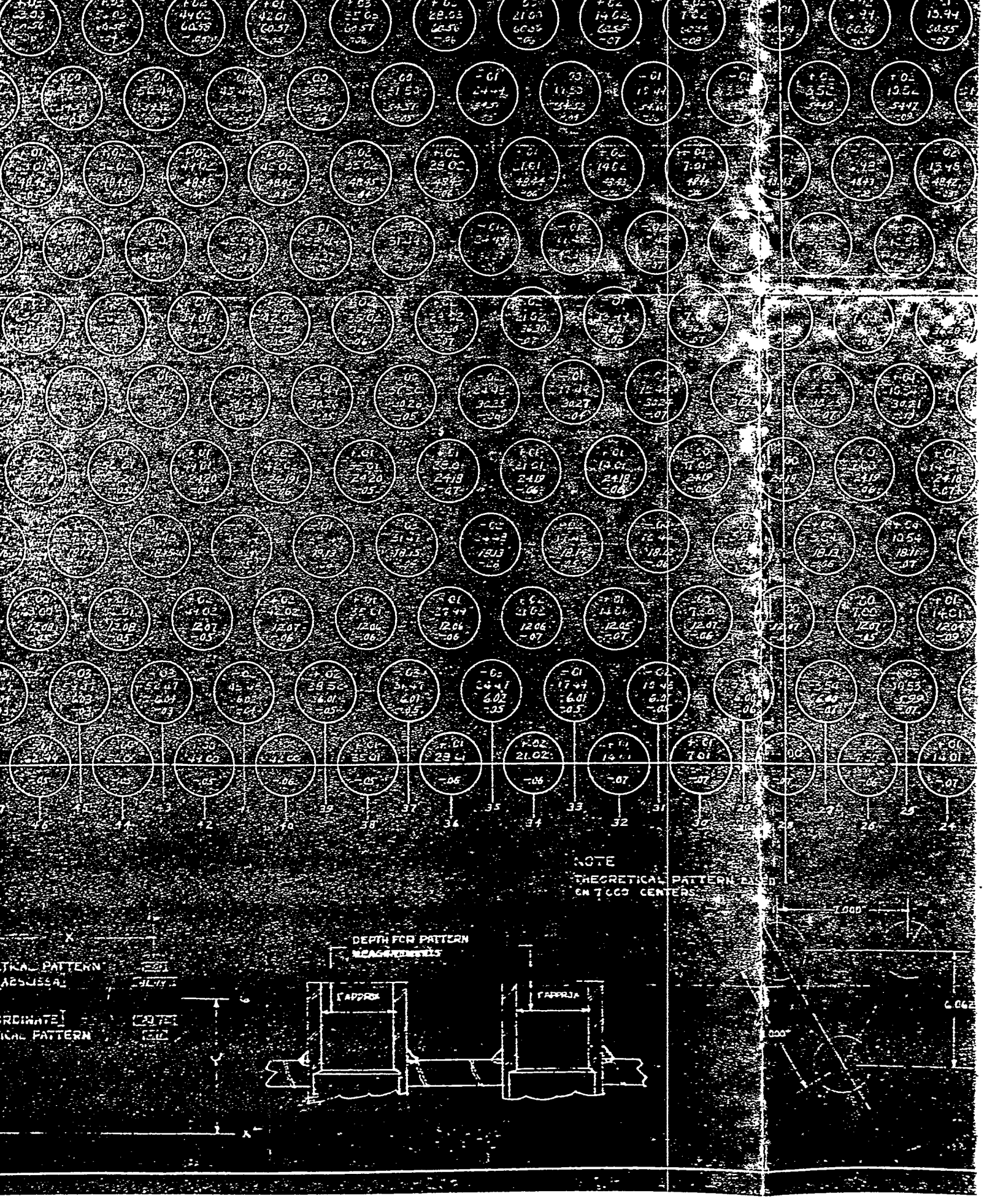
"R" TOP TUBE SHEET ASSEMBLY

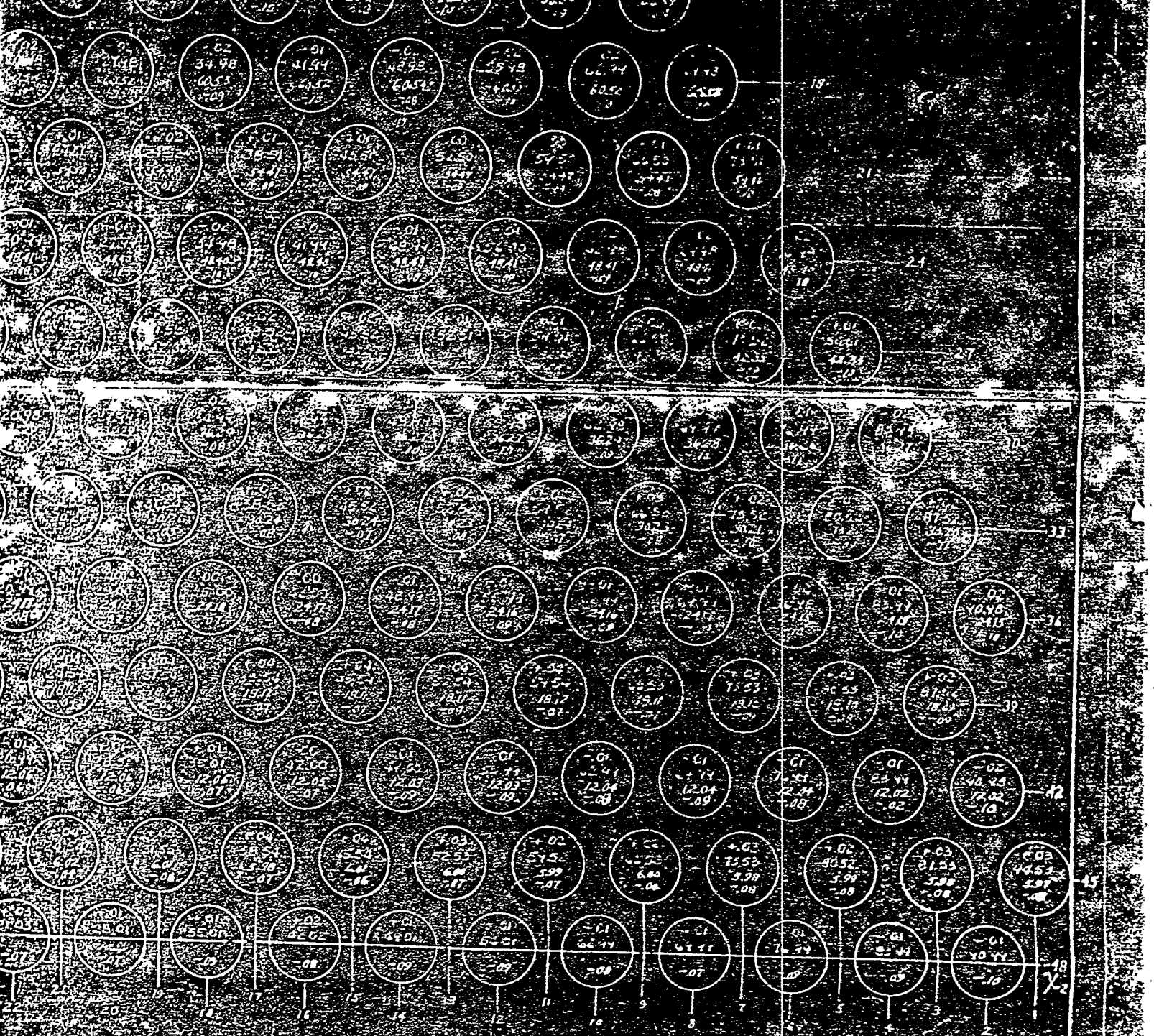

NOTE
SEE COMPANION DR
FOR GENERAL NOTES


OTE
SEE COMPANION DRWG
R GENERAL NOTES


E. I. DU PONT DENEMOURS & COMPANY
WILMINGTON, DELAWARE
CONSTRUCTION DIVISION
M & E SECTION
SPECIAL TUBE SHEET
FOR SHELL UNIT
PATTERN COORDINATES
BY J. SADOWSKI
DATE 12-12-52
PROJECT 8980
DRWG NO. NYS 2-2252-B




NOTE
THEORETICAL PATTERN
ON 7.000 CENTERS
DEPTH FOR PATTERN
APPROX
APPROX
7.000
6.062



NOTE

COORDINATES AND DEVIATIONS AS LISTED ABOVE HAVE BEEN ROUNDED OFF FROM THREE DECIMAL PLACES AND TOGETHER MAY NOT TOTAL THE THEORETICAL TWO DECIMAL DISTANCE FOR EXAMPLE THE THEORETICAL DISTANCE OF ROW Y27 FROM ℄ OF TUBE Y27 X9 IS 42.366 INCHES; THEREFORE COMPUTED DEVIATION IS -0.3 INCHES. TUBE IS PLOTTED AS 42.37 INCHES AND DEVIATION -.07 INCHES WHICH TOTALS 42.44 INCHES.

E. I. DU PONT DE NEMOURS & CO.
WILMINGTON, DELAWARE

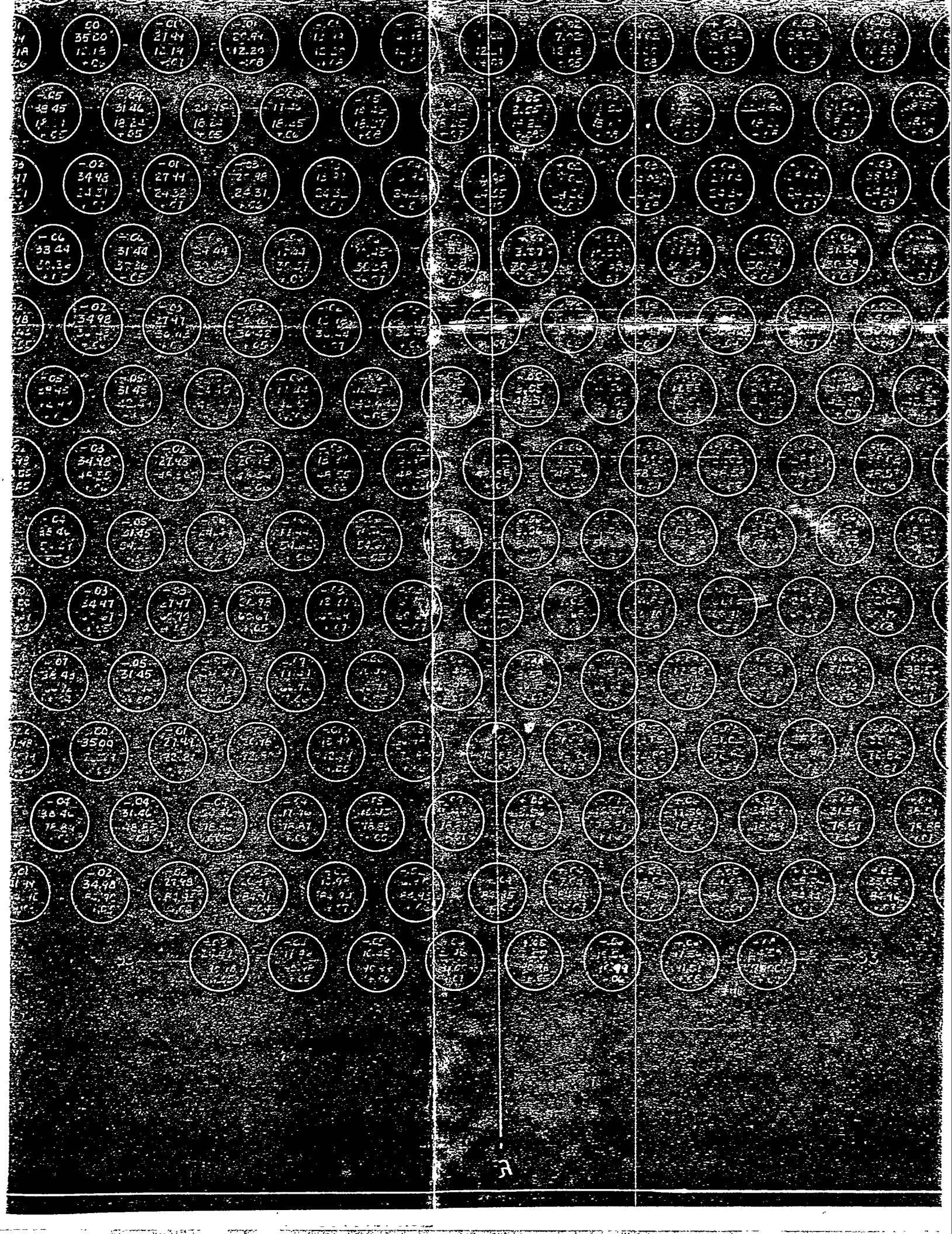
CONSTRUCTION DIVISION
M & E SECTION

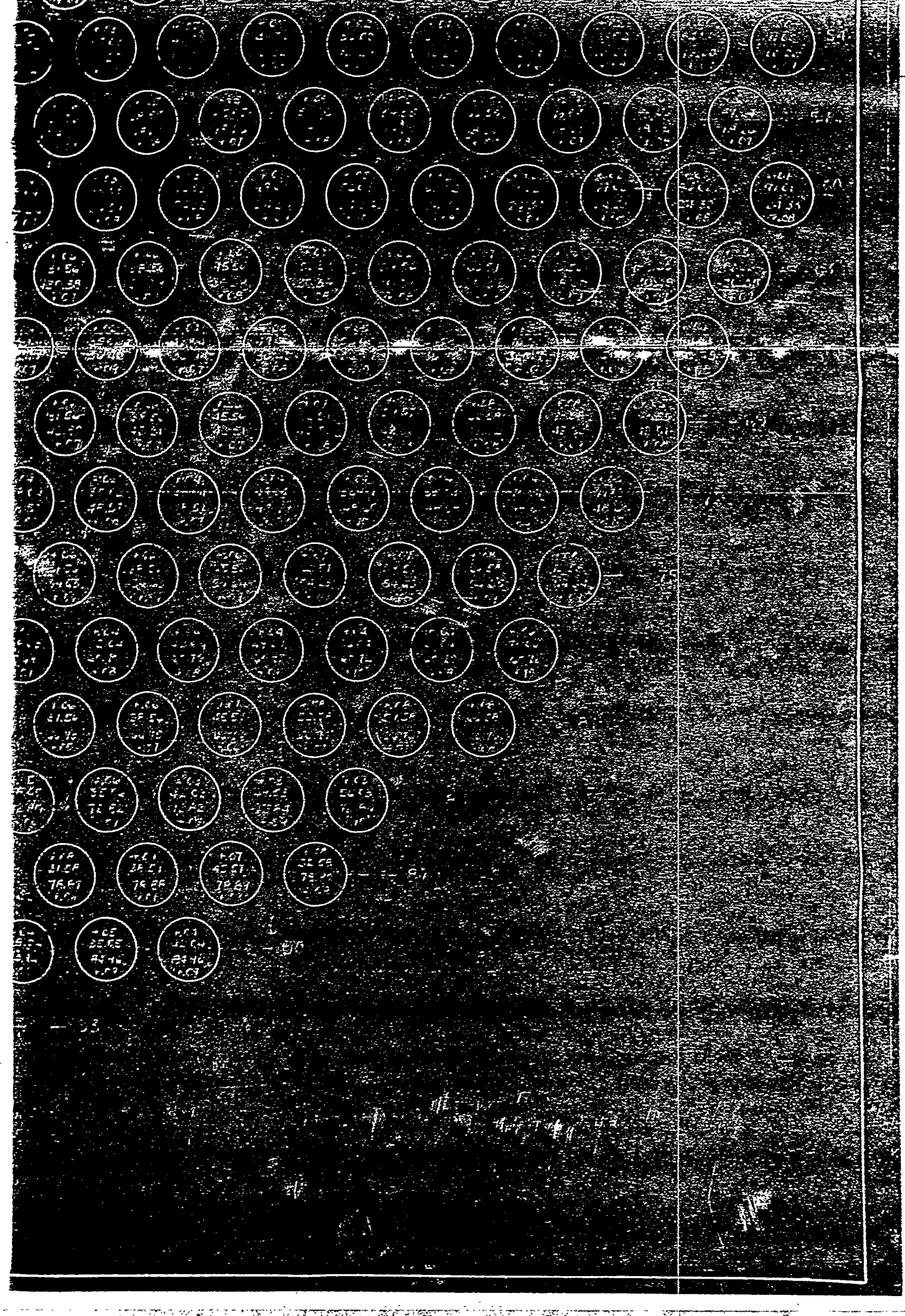
TOP SPECIAL TUBE SHEET
TOP SIDE - R UNIT
PATTERN COORDINATES

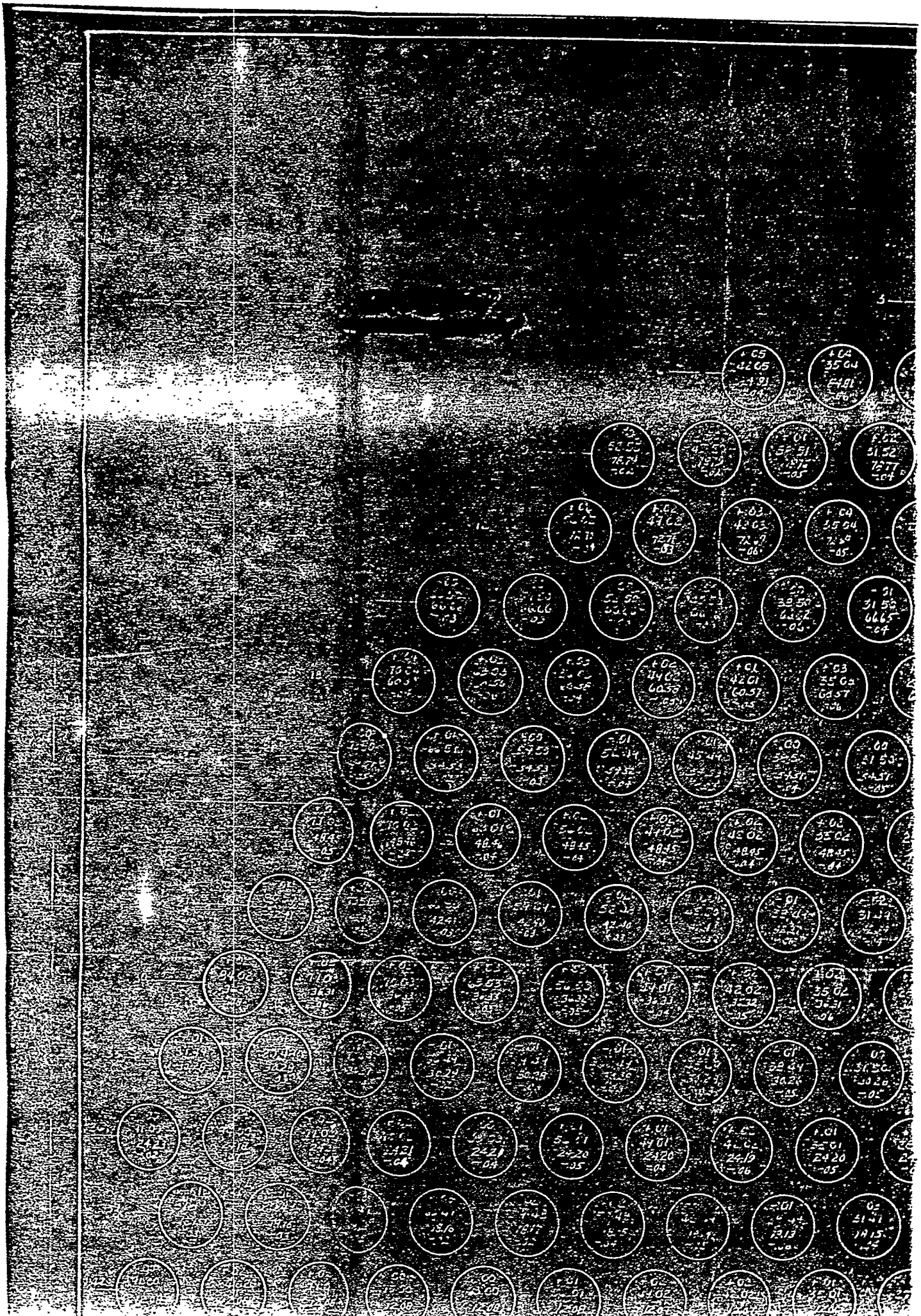
BY: C. SADOWSKI
DATE: 12-12-52

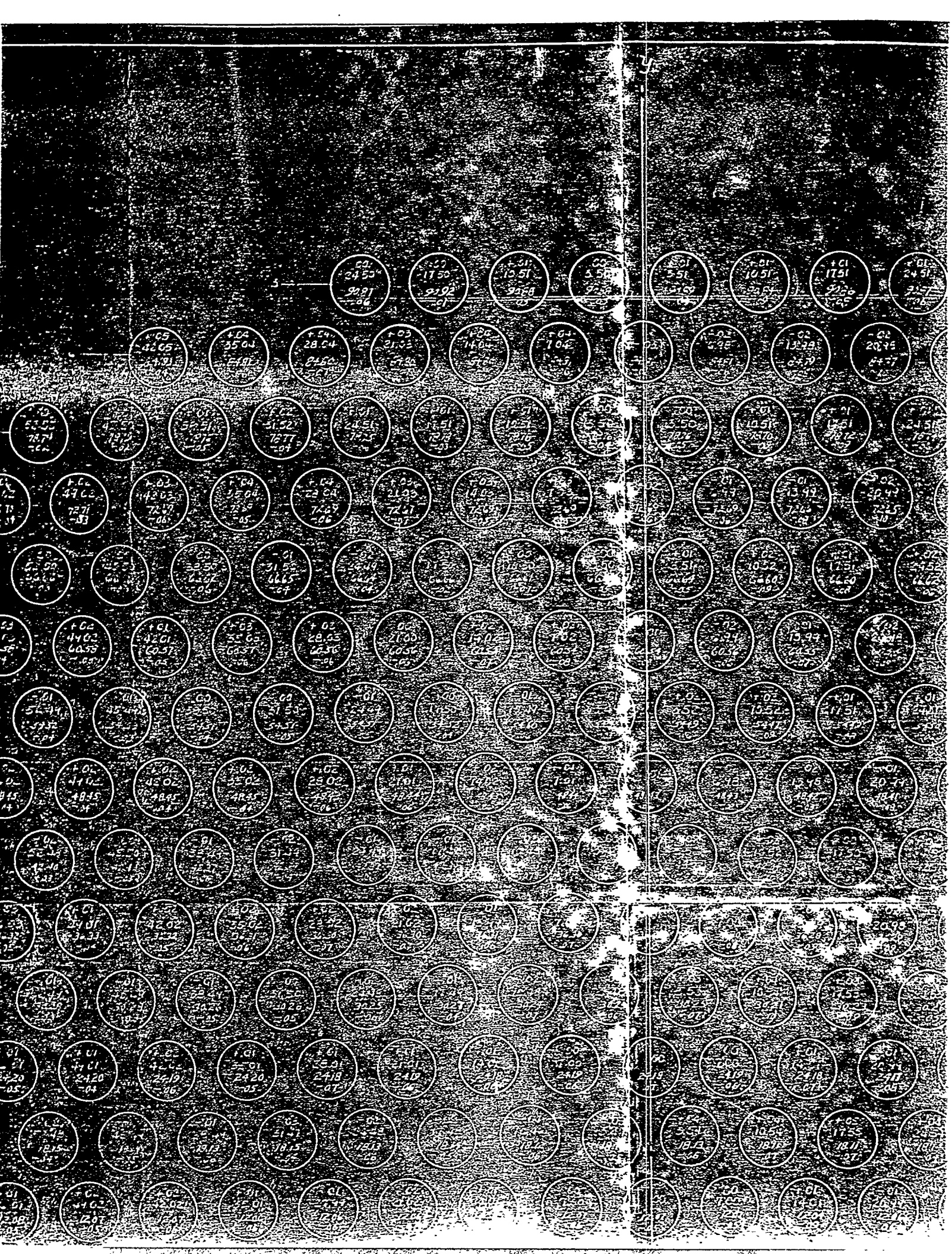
PROJECT 8980

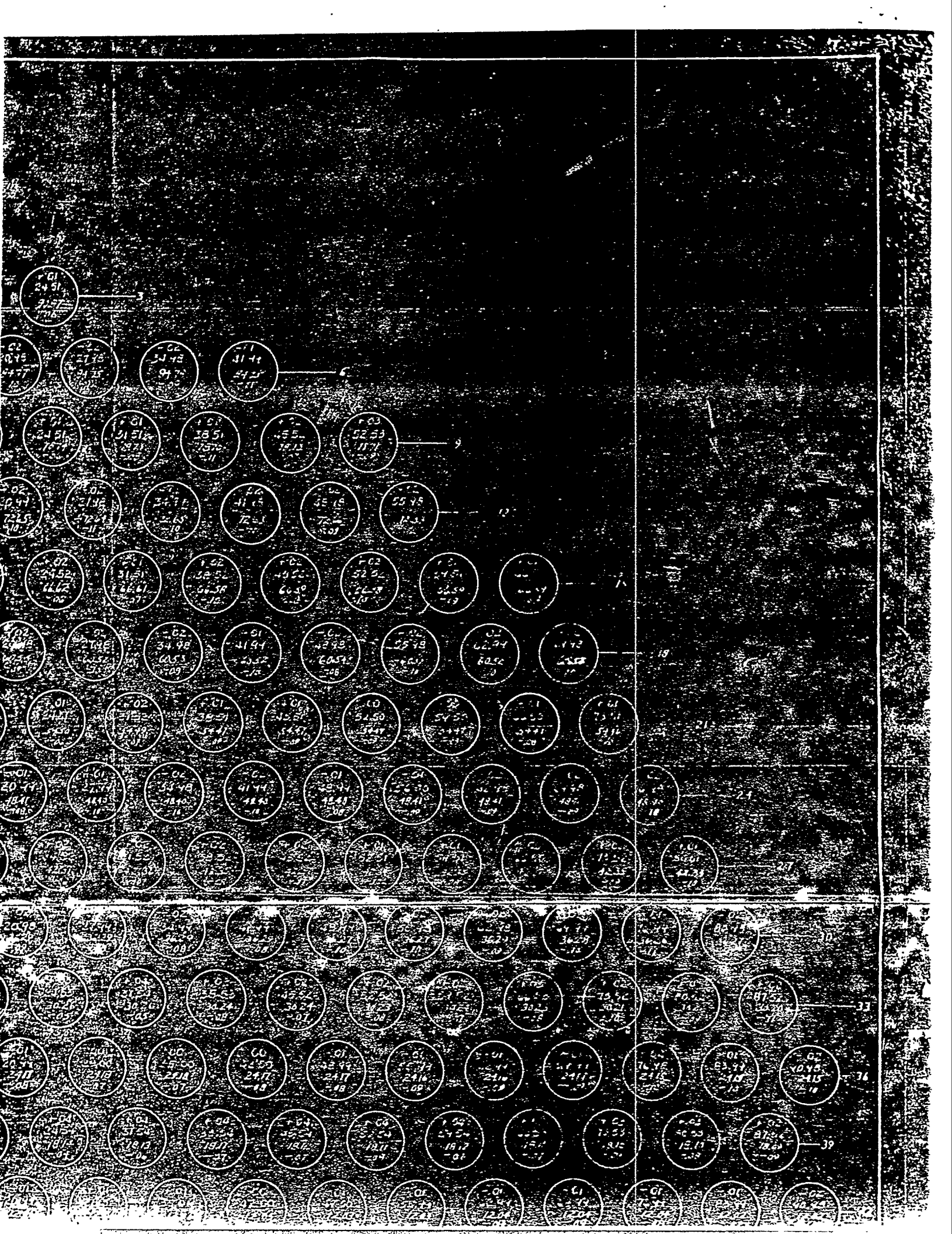
DRWG NO NYS 2-121252-A

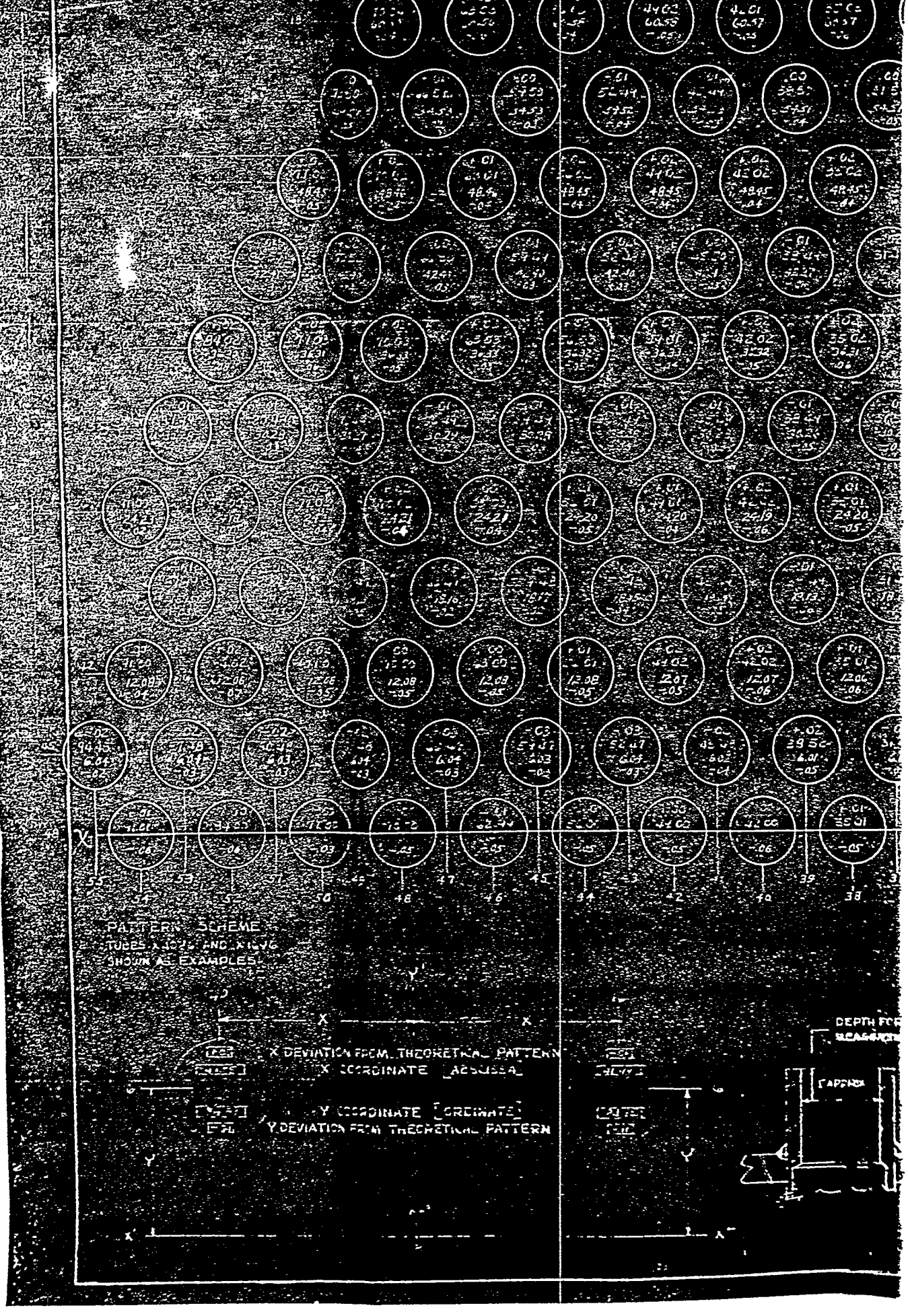











PATTERN SCHEME
TUBES X 10 Y 5 AND X 10 Y 6
SHOWN AS EXAMPLES
X DEVIATION FROM THEORETICAL PATTERN
X COORDINATE
Y COORDINATE
Y DEVIATION FROM THEORETICAL PATTERN

Permission was obtained from the Design Division to move hole to new location. The original hole was plug welded and ground flush with the bottom tube plate. Weld inspection proved satisfactory. The new drain hole was laid out, drilled and tapped, inspected and accepted. Chimes for the "R" top tube sheet received no rigid inspection other than visually inspecting for proper fit to the bottom side of the unit after installation. New York Ship mechanics encountered much difficulty in fitting chimes to the unit due to out-of-roundness of the chime sections; however, after straightening and aligning the chimes as concentric as possible, chimes were properly fitted to the unit and accepted by the du Pont Inspection Department.

The chime assembly was removed from the unit, acid washed, ferroxyl tested, accepted, and boxed for shipping to the plant site.

(29) Sandblasting and Acid Washing

The unit was prepared for sandblasting outside by bolting wood blanks on tube ends and closing all other openings. Before sandblasting this unit, approximately 15 psi. of air was introduced into the interior to prevent fine grit from entering the assembly. Following sandblasting and acid washing on the top side, it was turned over and bottom side and wrapper plates sandblasted and acid washed. Both sides of the unit and wrapper plates were then ferroxyl tested at random spots; contaminated areas re-cleaned by grinding and then re-acid washed until no evidence of free iron was noted as ascertained by the ferroxyl test.

(30) Deflector Plate Inspections

The fabrication and machining of the one deflector plate required for this unit was performed in a similar manner to the building of a top tube plate. Pre-assembly deflector plate inspections were performed by du Pont inspectors in a similar manner to those discussed for the top and bottom tube sheets in Part VII, Section I, items 1A, 4A, 5A and 6A.

The top tube sheet assembly was placed top side up on four 6' pedestals and then the deflector plate was made ready for bolting to the bottom side for trial fit. However, it was discovered that the 3/4" top holes for holding the deflector plate in position were drilled and tapped 5/8". Holes were immediately drilled and tapped 3/4" per drawing requirements. The deflector plate was then bolted to the bottom side of the unit. Measurements between the bottom tube plate and deflector plate were taken using a six-inch scale to determine the amount of plate separations. Fit-up of supporting studs and spacing between

deflector plate and top tube sheet assembly was accepted. All rod tube and large tube holes in the deflector plate were checked for concentricity with corresponding rod tubes and large tubes in the top tube sheet using a straight edge. All holes were found to be in vertical alignment and accepted.

(31) Dowell Cleaning

Prior to loading raschig rings in the top tube sheet, Dowell, Inc., Wilmington, Delaware, chemically cleaned the interior of the assembly. Essentially, internal cleaning of the "R" top tube sheet was the same as the "R" bottom tube sheet insofar as handling and getting the cleaning solution into and out of the unit for cleansing action. (See Part VII, Section III, item 16A-(1))

Four washes and inspections were required and the results were as follows:

Cleaning Process	Result of Inspection
a. Washed with Dowell Detergent	Assy. not clean
b. Re-washed with Dowell Detergent	Assy. not clean
c. Washed with Oakite #31 and Phosphoric Acid	Assy. not clean
d. Re-washed again with Dowell Detergent	Assy. not accepted; released for further cleaning by tumbling raschig rings

The loading cradle was installed in the unit and then put in the loading cradle bed and cleaned by tumbling raschig rings in the unit and washing with Dowell detergent. After this, the detergent was drained and rings emptied, the unit was filled with distilled water, air agitated and rolled numerous times, then drained. A visual inspection was made and the unit was accepted for raschig ring loading.

(32) Raschig Ring Loading Operation

Inspection and filling of the "R" top tube sheet with raschig rings was accomplished in a similar manner to that described in Part VII, Section III, item 17A.

The "R" top tube sheet was filled with forty-nine (49) tons and three-hundred (300) pounds of raschig rings.

(33) Functional Gaging of Plenum Chamber and Top Tube Sheet Assembly

This inspection along with all problems encountered are discussed in Part VII, Section I, item 15A-(5).

(34) Final Freon and Hydrostatic Tests

The unit was subjected to a final freon and hydrostatic test, respectively. These two tests were performed in a similar manner discussed above in Sections (23) and(25). No leaks were found in either test.

(35) Cleaning of Large Tube and Rod Tube Bores

The large tube and rod tube bores were cleaned using a nylon brush attached to airmotor with a special rotary head and a cleaning solution of F.O. 128 (Saf-Tee Solvent, Fine Organics) and water. After each tube was cleaned with the solution, a dry cloth tied to a long stick was passed through the tube bore to remove any foreign matter that may be present. A visual inspection by du Pont inspectors revealed that the tubes had been satisfactorily cleaned. Also a visual inspection was made at the top and bottom weld line in both large and rod tubes for evidence of weld burn through and cracks. No defects were found.

(36) Large Tube to Rod Tube Ligament Measurements

This inspection was performed on the top side of the "R" top tube sheet assembly. See Part III, Section II-B for a resume of the gages used and interpretation of results. All large tube to rod tube ligament measurements taken on the top side of this unit was accepted by the Design Division as being within tolerance.

(37) Top Tube Sheet Indexing Devices

As shown on du Pont drawing D-110139, three indexing devices were required for the top tube sheet assembly. After the three indexing devices were fabricated, they were visually and dimensionally checked by du Pont inspectors. All dimensions were checked using a six-inch scale, depth micrometers, telescope gages, and outside micrometers. Results indicated that all three indexing devices were within tolerance.

Next, the three indexing devices were located and welded to the bottom side of the top tube sheet 120° apart. Welding was visually inspected for porosity, undercutting, cracks and other mechanical defects. Necessary repairs were made, re-inspected and accepted. The radial location of each centering device was measured from the center tube (X28-Y28) to the inside edge of the device. A 50' S/S Starrett tape graduated in 1/16" was used to take these dimensions. Also, chordal measurements were taken with this tape to determine if the 120° spacing was maintained after welding. All measurements proved satisfactory and the inspection of the three indexing devices was accepted.

(38) Inspection of Instrument Lead Tubes

As shown on du Pont drawing W-130944, Detail "A", the bottom ends and bottom I.D. of instrument tubes (3) designated as "V" on W-130943 were machined to specified dimensions shown. The bottom ends were faced off 1/4" from the bottom tube plate using a bar and fly-cutter attached to an air motor. Tube numbers X04-Y26, X51-Y23 and X29-95 (designated as "V" on W-130943) were reamed to the specified bore diameter and then cloverleafed to obtain the required finish. These tubes were chamfered 30° on both ends; inspected using a 6" scale and accepted.

After all work was completed on these tubes, du Pont Inspectors performed the following checks:

a. The 1/4" dimension from the bottom tube plate to the bottom end of each tube was measured using a 6" scale graduated in 1/64". All results were within tolerance.

b. The "L" dimension for each of these three tubes was checked using a telescope gage and 1-2" outside micrometer. All results were within tolerance.

c. The required 125 RMS micro-inch finish was checked using a profilometer.

All bore finished were 125 RMS or less.

Also, shown on W-130944, Detail "B", the bottom ends of instrument tubes (3) designated as "X" on W-130943 were machined parallel with bottom of bearing plate within ± .002" and to a finish of 125 RMS. The bottom ends were faced off between 1/8" and 1/4" referencing from the bottom tube plate using a bar and fly-cutter attached to an air motor. Tube numbers (designated as "X" on W-130943) were pre-machined to the required bore diameter and cloverleafed to obtain the required finish in the bottom area of the tubes. The required finish of 125 RMS on tube ends was obtained by hand filing. These tubes were chamfered 30° on both ends, inspected with a 6" scale and accepted.

After all work was completed on these tubes, the following inspections were performed:

(a) The entire bottom surface of each tube was checked for being parallel with bottom of bearing plate to within ± .002" using a surface gage and straight edge. All tube ends were found to meet tolerance.

(b) The distance from the bottom tube plate to the bottom end of each tube was checked with a 6" scale graduated in 1/64". All inspections proved satisfactory.

(c) The bottom bore diameter of the tubes were checked using a telescope gage and one 2" micrometer. All dimensions were satisfactory.

(d) The required 125 RMS micro-inch finish was checked by comparing with a set of finish standards. All results were satisfactory.

One instrument tube located near the extremity of the I2 axis and two located near the extremity of the I1 axis shown on du Pont drawing W-130943 were faced off on the bottom ends 1/8" from the bottom tube plate in a similar manner described above. These tubes were also chamfered 30° on both ends; inspected using a 6" scale and accepted. The distance from the tube end to the bottom tube plate was checked using a 6" scale and found within tolerance. The bottom bore diameter of each tube was checked using a telescope gage and 1 - 2" micrometer. All inspections proved satisfactory.

(39) Photographing of Top Tube Sheet Large Tube Pattern

Photographing of the top tube sheet large tube pattern (top side only) was performed by the du Pont Inspection Department in a similar manner to that described in Part VII, Section I, item 16A-(13).

(40) Final Inspection of Unit and Shipping Gear Installation

The top and bottom sides of the "R" top tube sheet were jetted with air to remove all loose material present. All dirty spots on the unit were acid washed and then rinsed with city water and allowed to dry. Ferroxyl tests were performed at random to determine if any "free iron" was present on the surfaces of the unit.

Next, all tube bores were swabbed out using F.O. 128 (Fine Organics Safe-Tee Solvent) and then followed up with a dry, clean cloth to remove the excess F.O. 128 and any grime left in the tube bores.

After all cleaning was completed, a visual inspection revealed a satisfactory condition of cleanliness and the unit was accepted. Wood plugs with an O-ring fitted to its diameter was inserted into the bottom and top end of all large tubes. These were similar in design to those shown in Sketch #38 in Part VII, Section I, item 15 thru 16. In addition, both ends of all rod tubes were plugged with rubber stoppers. A visual inspection was again made to determine if all large tubes were plugged on the top and bottom ends. All inspections proved satisfactory. Then, New York Ship bolted an aluminum disc to each side of the large tube

pattern to serve as a protective covering for the tube ends. Handling gear was installed; then the unit was "pillow-cased" with canvas and laced on the outer periphery and made ready for shipping.

The "R" top tube sheet was shipped by tug boat and barge from New York Ship on November 1, 1952, to the Savannah River Plant located in the state of South Carolina.

B. "P" Unit

(1) Gusset Plate Pre-assembly Inspections

The pre-assembly gusset plate inspections performed on the "P" top tube sheet were similar to those discussed in Part VII, Section III, item 7A-(1) for the "R" bottom tube sheet. Also, see Part II-B, Section 1a, photo serial number 129 and 130.

(2) Inspections Performed during Assembling of Gusset Plates Into Unit

These inspections were performed in a similar manner to those discussed in Part VII, Section III, item 7A-(2) for the "R" bottom tube sheet. For location of gusset plates (or web plates), see Dwg. 4-2 in Section 7A-(2) of this manual.

(3) Baffle Plate Spacers, Sandblasting, Acid Washing and Ferroxyl Testing

All of these inspections were performed in a similar manner to that described in Part VII, Section III, item 7A-(3).

(4) Collar Inspections

Inspection of all type collars for the "P" top tube sheet assembly was performed in a similar manner to that described in Section 7A-(4) of this manual.

(5) Verticality Check After Placing Tube Sheets in Circumferential Handling Jig

This inspection was performed in a similar manner to that described in Part VII, Section I, item 7A-(5).

(6) Gusset Plate Welding Inspections

Inspections performed after gusset plates had been fully welded in the "P" top tube sheet were similar to those performed on the "R" bottom tube sheet discussed in Part VII, Section III, item 7A-(6). No problems were encountered.

(7) Rod Tube Assembly and Welding Inspections

These inspections were performed in a similar manner to that

described in Section 7A-(7) of this manual, except as follows: Design requested that no solvent containing chlorides be used in cleaning any tubes or for any preliminary cleaning operations. In lieu of the original solvent(CCl_4) used to clean tubes, Safe-Tee Solvent F.O. 128 (Fine Organics) was substituted (with Design's approval) and used for cleaning tubes prior to inserting them into this unit.

(8) Instrument Wells

A complete history of all inspections performed on the twelve (12) instrument wells and the problems encountered before and after assembling and welding them into the top tube sheet is covered in Exhibit #5 presented herewith.

(9) Large Tube Assembly

Starting in the center of the unit and working out, large tubes were progressively cleaned with F.O. 128, inserted into the unit (bottom side up) and tack welded to the inside of the top tube plate. Tack welding of tubes was inspected for undercutting and melt downs during the tube assembling operation. No major defects were found and all tube tack welding was accepted.

During the tube assembling operation, du Pont inspectors recorded the location of all tubes and the type. Large tubes were identified by a serial number stenciled near one of the tube ends. Prior to assembling of tubes into this unit, dimensional inspections performed onthe tubes were recorded for each using this numbering system, thereby tying in tubes welded in the unit with their preassembly inspection measurements. This new numbering system was necessary since there was no method used in the past for comparing tubes in the assembly with pre-assembly inspection results.

The number of each type of pre-machined 5" O.D. tubes assembled in this unit was as follows:

Tube Type	Number of Each in Assembly
Cast	438
Seamless	235

For location of cast and seamless tubes in the unit, see Exhibit #6 presented herewith.

(10) Measurements Before Large Tube Welding to Determine Unit Shrinkage

After all large tubes had been inserted into the unit, aligned and tack welded, initial shrink measurements were taken

EXHIBIT #5

(1) Report #464-P - Instrument Well Weld Penetration Inspections and Results.

(2) Dimensional Checks Performed on 12 Instrument Wells

(3) Report #455-P - Summary of All Inspections Performed and Problems Encountered on the 12 Instrument Wells Required for the "P" Top Tube Sheet Assembly.

E. I. DU PONT DE NEMOURS & CO., INC.

Construction Division

[redacted]

Report Number 464-P

CC: H. W. Gosney, F.P.M.
R. K. Mason - D. A. Hauser
Savannah River Plant (3)
R. K. Mason - E.M.Vass-SRP
H. L. Bunker - J. G. Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
J. B. Johnson - File

April 21, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM O.R.Frandsen, F.J.Jarczynski, H.Neicen, A.Piatek DATE March 28, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AKC-167½

EQUIPMENT Instrument Wells "P" Unit Top Special Tube Sheet EQ.PC.NO. 154-P

DRAWING NOS. W-131417 & D-110167 JOB RATING

VENDOR New York Shipbuilding Corporation LOCATION Camden, N. J.

Scope: To determine the % of weld penetration on inside of upper and lower weld on instrument well. Also, to check for any melt through on inside due to welding of stabilizer brackets to outside of well. The upper weld is 3" from top, lower weld 3" from bottom, and bracket is welded on 6" from bottom of instrument well. Inspection performed 3-28-53.

Procedure:
A type ACM1 borescope was inserted into the instrument well and the well visually examined.

Results: See attached sheet.

lmw
attach. 2

[redacted]

[redacted]

FIELD INSPECTOR'S REPORT
FROM: Frandsen/Jarczynski/Neicen/Piatek

Report # 464-P
Page 2 of 3

Location of Instrument Well	Top weld; 100% penetration on % of circumference	Bottom weld; 100% penetration on % of circumference	General Condition of over-all bore of instrument well
On row Y18 between X40 & X42	100% of circum	100% of circum.	Melt through of weld material where bracket is welded on to inst. well
On row Y15 between X39 & X41	100% of circum.	100% of circum.	Melt through of weld where bracket is welded to inst. well
On row Y48 between X37 & X39	70% of circum.	95% of circum.	Same as above
On row Y45 between X37 & X39	90% of circum.	90% of circum.	Melt through where bracket is welded to inst. well.
On row Y63 between X 31 & X33	100% of circum.	95% of circum.	Same as above
On row Y81 between X37 & X39	95% of circum.	70% of circum.	Melt through where bracket is welded to inst. well 2 spots ¼" & ½" in dia.
On row Y81 between X15 & X17	70% of circum. one spot poor penetration	90% of circum.	Good-no melt through at brackets
On row Y63 between X21 & X25	90% of circum.	80% of circum.	Good
On row Y45 between X5 & X7	95% of circum.	75% of circum.	Weld splash at bottom of well.
On row Y45 between X18 & X20	95% of circum.	75% of circum.	Melt through at 2 points where bracket is welded to inst.well ¼" &½" in diameter.

[redacted]

Location of Instrument Well	Top weld; 100% penetration on % of circumference	Bottom weld; 100% penetration on % of circumference	General Condition of over-all bore of instrument well
On row Y33 between X22 & X24	95% of circum.	75% of circum.	Good
On row Y33 between X20 & X22	90% of circum.	75% of circum.	Melt through at 1 point where bracket is welded to inst. well.

Note: These instrument wells are considered acceptable "as is" since they were successfully hydrostatically tested at 2000 psi and freon tested at 100 psi prior to installation. For complete history on these wells, refer to report number 455-P.

E. I. DU PONT DE NEMOURS & CO., INC.
WILMINGTON, DELAWARE

Construction Division

CC: C. B. Buckler, P.P.M.
R. K. Mason, P.P.M. SRP (3
H. L. Bunker - J.G. Brewer (2
H. B. Gage
F. C. Breuninger
~~A. H. Hughes~~
C. W. Dunn - File

FIELD INSPECTOR'S REPORT

TO: C. J. VEITH - M & E FILE

FROM: R. E. CHANEY DATE APRIL 10, 1952

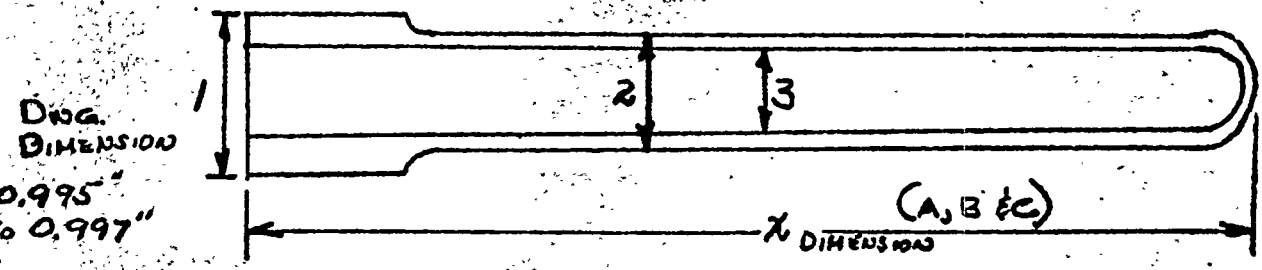
PROJECT NO. 8980 PLANT SAVANNAH RIVER ORDER NO. AXC-167-S

EQUIPMENT INSTRUMENT WELLS, TOP SPECIAL EQ.PC.NO. "P" UNIT

DRAWING NOS. D-110167 JOB RATING

VENDOR NEW YORK SHIPBUILDING CORPORATION LOCATION CAMDEN, N. J.

The following is the report on a dimensional check of the subject thermo-couple wells shown in the sketch below:



No.	X Length	Dim. (1) Actual	Dim. (2) Dwg.	Dim. (3) Dwg.	Below Tol.	Above Tol.	Remarks
6	A 31¼"	.966 .968	.540 ±.005	.364 ±.005	Dim.(1) .029"	None	Tool marks on Dim. (1)
3	B 25¼"	.967 .969	.540 ±.005	.364 ±.005	Dim.(1) .028"	None	Tool marks on Dim.(1)
3	C 19¼"	.961 .969	.540 ±.005	.364 ±.005	Dim.(1) .034"	None	Tool marks on Dim. (1)

NOTE: ABOVE THERMO WELLS ARE ACCEPTABLE (PER J.G. BREWER) PROVIDING CORRESPONDINGLY SMALLER HOLES ARE DRILLED IN THE T.T.S. PLATES (R.V.G.)

[redacted]

E. I. DU PONT DE NEMOURS & CO., INC.

Construction Division

Report Number 455-P

CC: H. W. Gosney, F.P.M.
R. K. Mason - D. A. Hauser
Savannah River Plant (3)
R. K. Mason - E. M. Vass - SRP
H. L. Bunker - J. G. Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
J. B. Johnson - File

April 17, 1953
New York Ship - Camden, N.J.

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FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM A. J. Piatek DATE April 10, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Top Tube Sheet Instrument Wells EQ.PC.NO. 154-P

DRAWING NOS. D-110167 - W-131417, Detail IX JOB RATING

VENDOR New York Shipbuilding Corporation LOCATION Camden, N. J.

Inspection of 12 instrument wells in "P" Top Tube Sheet

The 12 wells were fabricated by New York Shipbuilding Corp. and the first dimensional check on the wells was performed April 10, 1952. The wells were accepted dimensionally.

On April 22, 1952 the subject wells were hydrostatically tested. The wells were filled with water and put under 2000 psi pressure for one hour. On the first inspection, all 12 wells were found to be leaking. The leaks were repaired and another hydro test showed no leaks on inspection.

On June 25, 1952 the wells were freon tested for leaks. Freon gas at bottle pressure, which was approximately 100 psi, was introduced into the interior of the wells. A G. E. Halide Leak Detector, set on medium sensitivity, was used to inspect for leaks. No leaks were detected in any of the 12 wells. The 12 wells were then welded into the "P" Top Special Unit.

After all welding was completed on the unit, the unit was freon tested. This test was performed Sept. 26, 1952. The unit was filled with [illegible] pounds of freon, by weight, and the pressure was raised to 35 psi. with air. The G. E. Leak Detector was used to check for leaks. On this test all of the 12 wells were plugged and the interior was not checked. The wells were then completely cleaned with detergent.

After the unit was filled with raschig rings, the unit was again freon and hydrostatically tested.

The Freon test started March 3, 1953. While the freon test was in progress, all caps were removed from the tops of the 12 wells. The gun tip of the G. E. Leak Detector was inserted into the bore of each of the 12 wells. The needle on the milliammeter of the leak detector moved rapidly indicating some gas present in the wells that affected the detector. This happened in all 12 wells.

It was decided to clean out the wells. The wells were first cleaned with carbon tetrachloride, purged with air under pressure, capped and let stand for 1/2 hour. Half hour later caps were removed from wells and the tip of gun of the detector was inserted into the wells. The milliammeter needle moved again but not as rapidly as the first time, indicating some cleaning was done.

The 12 wells were then filled with sodium metasilicate and let stand for one hour. One hour later, the wells were flushed with deionized water, purged with air under pressure, capped and let stand for one hour. Later the caps were removed and the gun tip of the detector was again inserted into the wells. A slight rise was noted on milliammeter of the detector. This indicated that some success was accomplished in washing out of the wells the gases that affected the detector. If the gun tip was held in the well long enough, the needle of the milliammeter would drop back to its original setting of .2 milliamps.

Next, the wells were filled with a nitric acid solution. A 25% solution of nitric acid was poured into the wells and let stand for 1/2 hour. Later the wells were rinsed, purged with air and capped. Four hours later the caps were removed and the gun tip of the detector was inserted into the wells. The milliammeter showed no indication of any gases present in the wells. The wells were capped and 16 hours later uncapped and the gun tip again inserted into the wells. Some slight indication on the milliammeter was shown by the rise of the needle.

The wells were again filled with 25% solution of nitric acid and let stand for 2 hours. Later the wells were rinsed with deionized water, purged with air under pressure and capped. No indications of gas in the wells was evident until 24 hours later. The cleaning of wells reduced greatly the indications on detector.

It was decided to relieve the air pressure in the unit, to fill unit with water and to hydrostatically test the unit.

While the unit was under a pressure of 52½ psi hydrostatically, a borescope was inserted into each of the 12 wells to inspect for any water leaks. All 12 wells were carefully examined with borescope and no water leaks were found. During hydro test gun tip of leak detector was inserted in wells. No indications on detector of gas in wells.

[redacted]

[redacted]

[illegible]CTOR'S REPORT

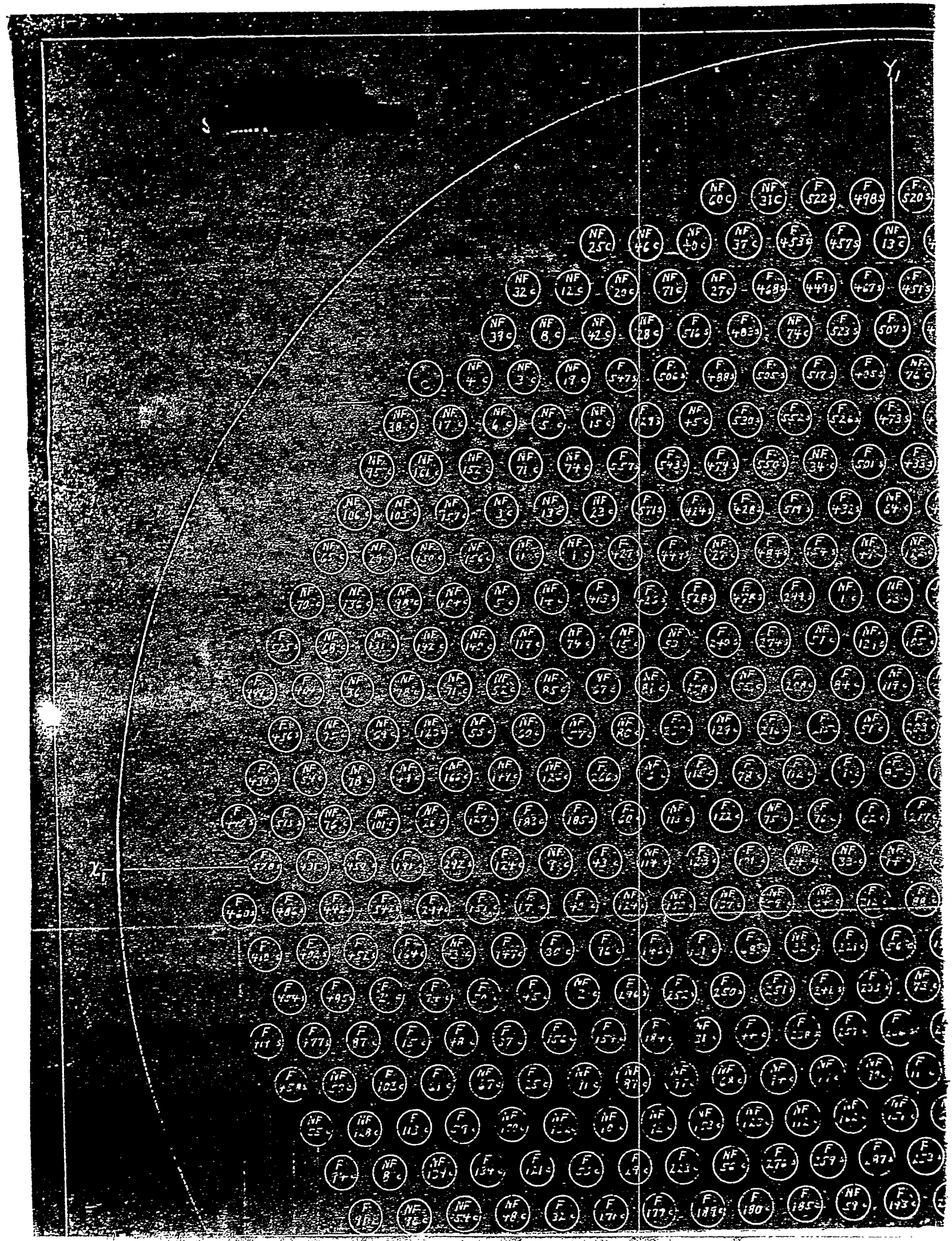
[illegible] gun tip of the leak detector was placed into the bore of the [illegible] wells in "L" Unit Top Special, which has not as yet had any [illegible] performed on it, and the needle of the milliammeter moved rapidly as indicated at first on "P" Top Special. This indicates that some other gas besides freon is giving us an indication on the leak detector.

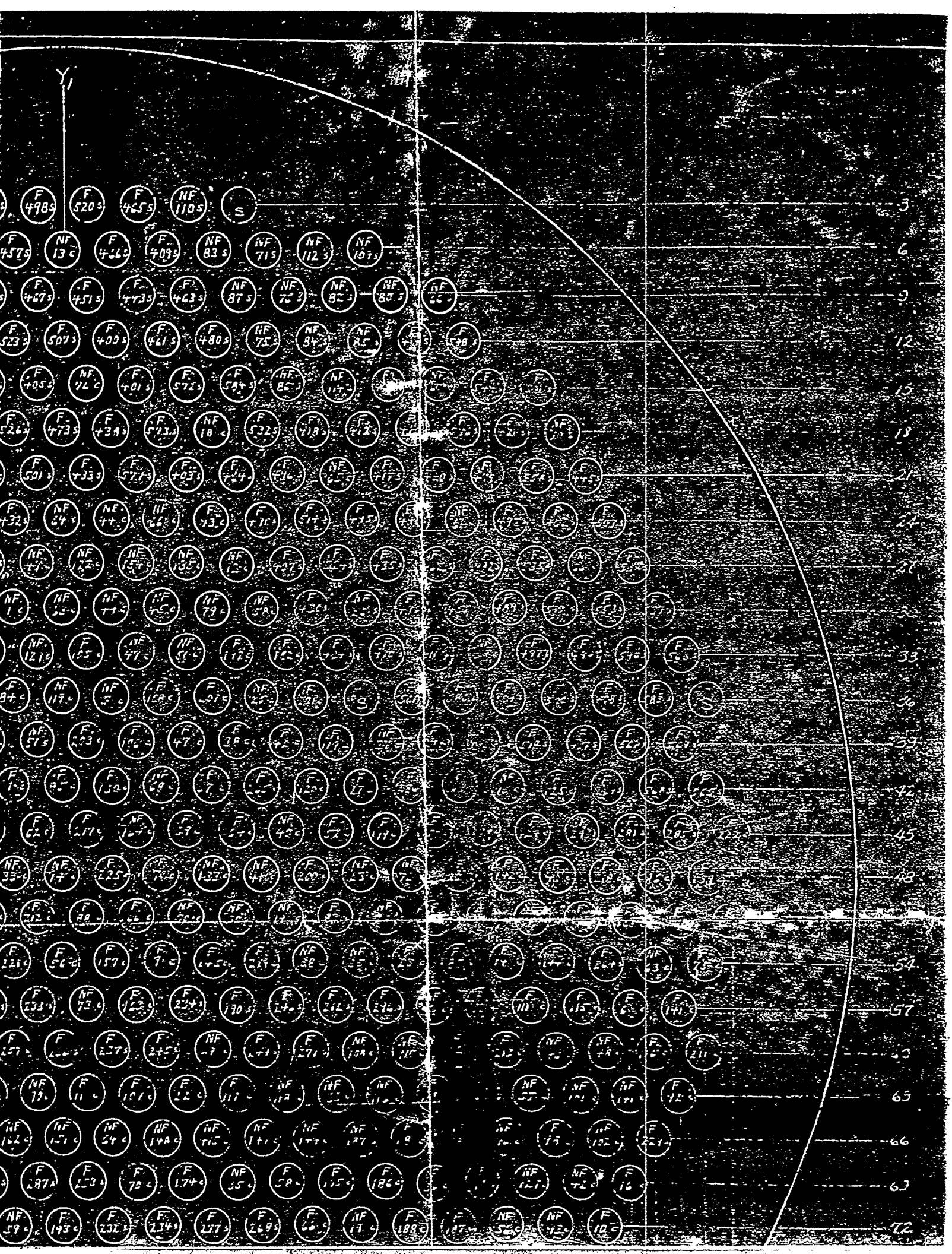
lmw

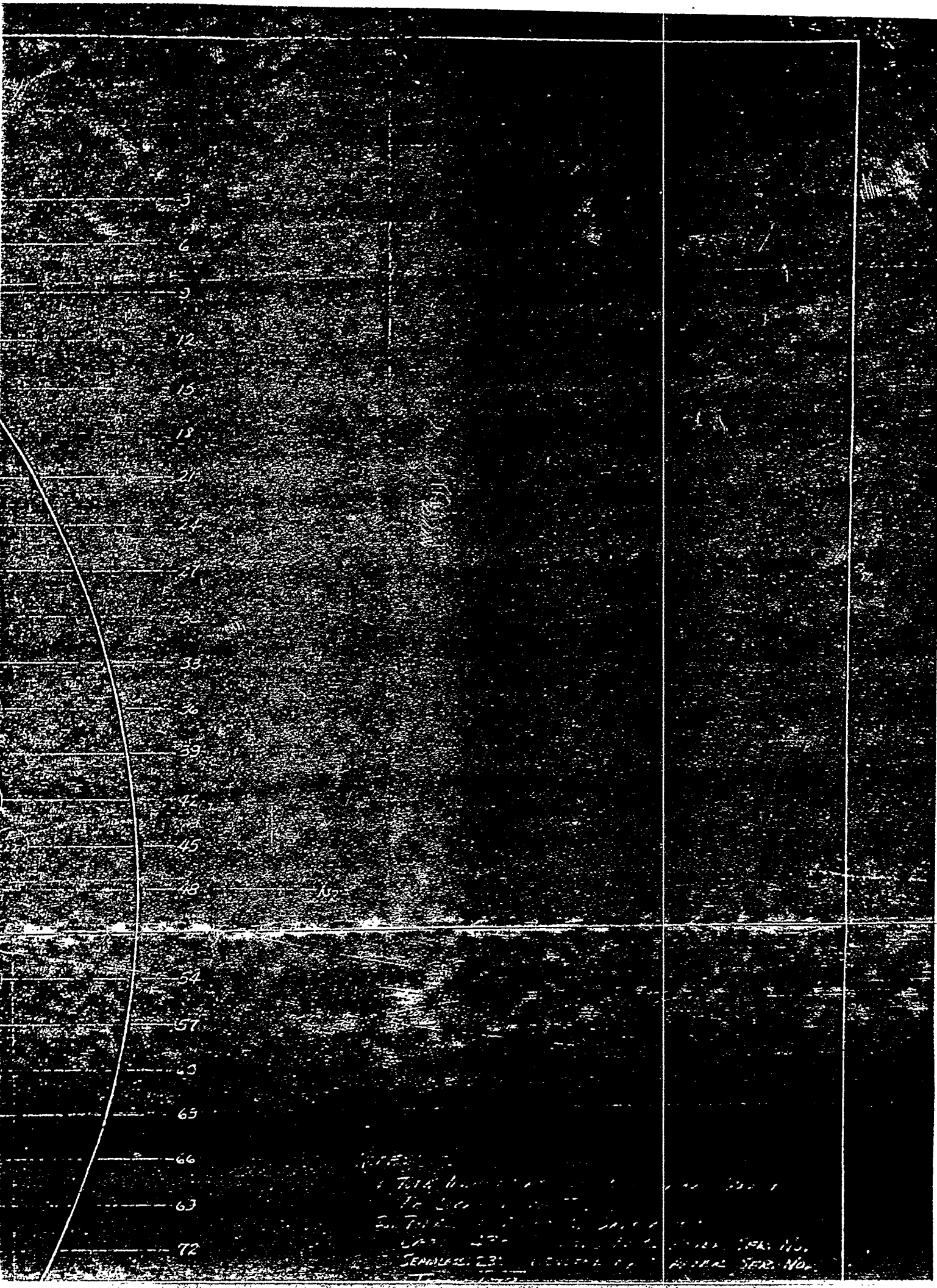
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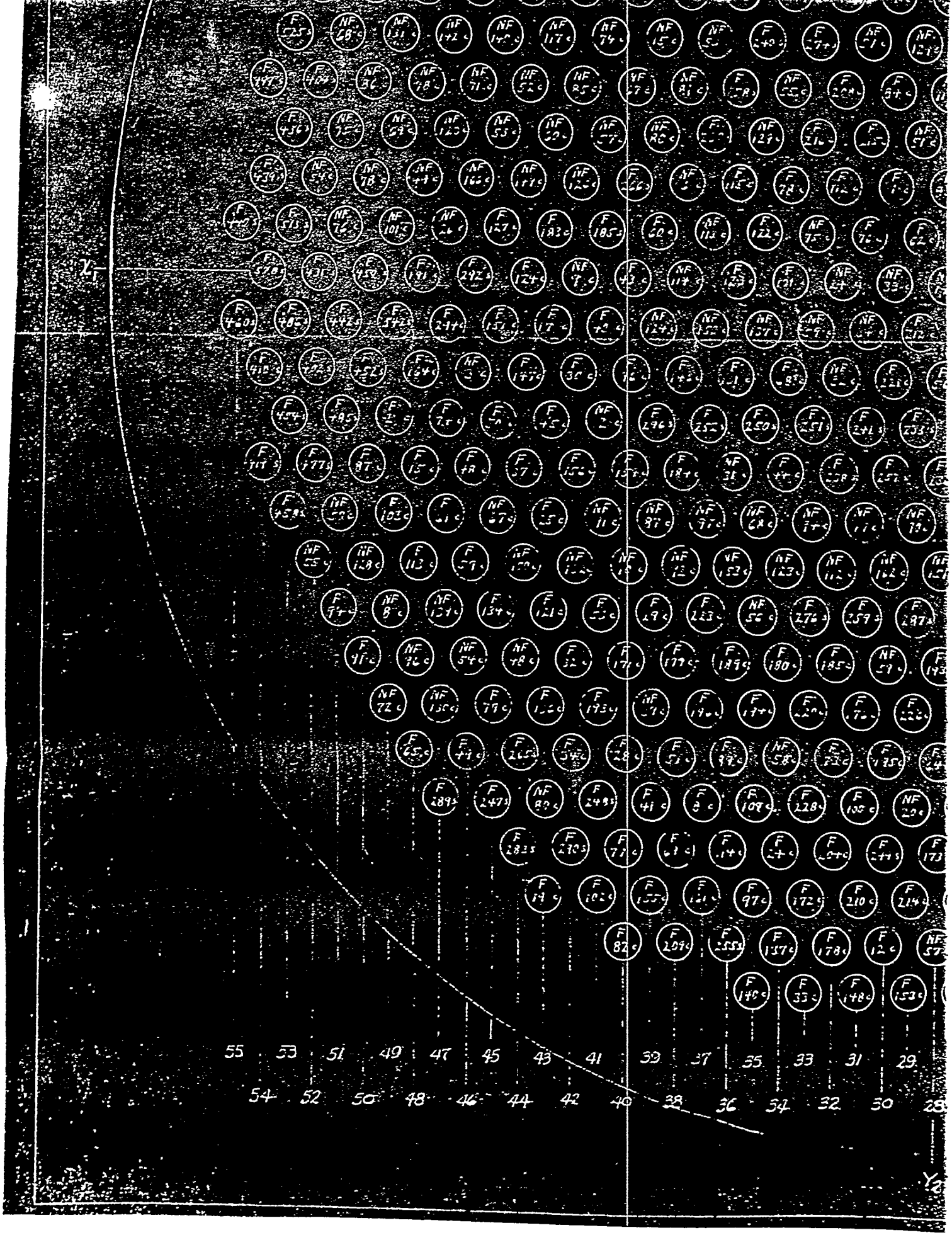
EXHIBIT #6

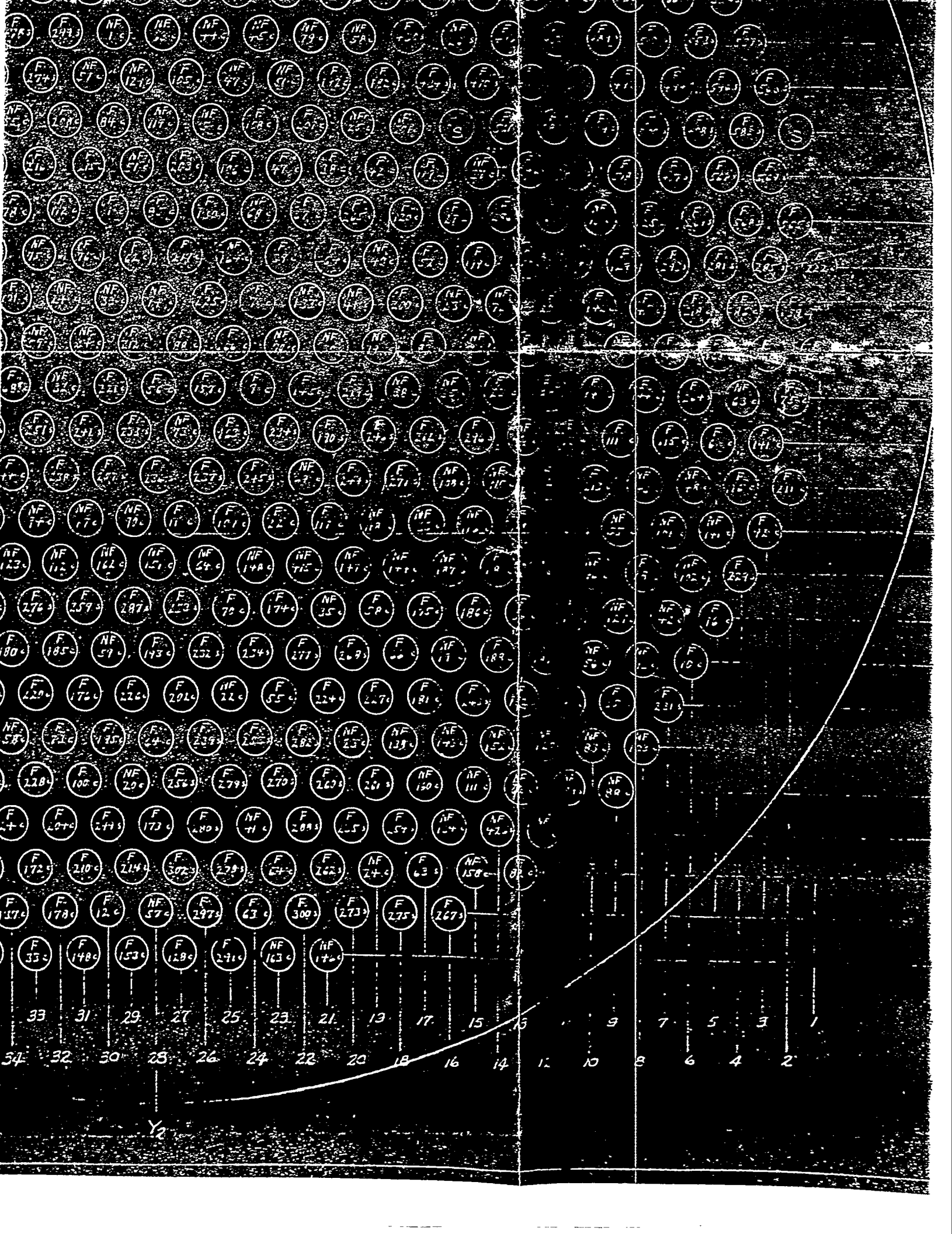
LOCATION OF CAST AND SEAMLESS TUBES IN THE "P" TOP TUBE SHEET ASSEMBLY

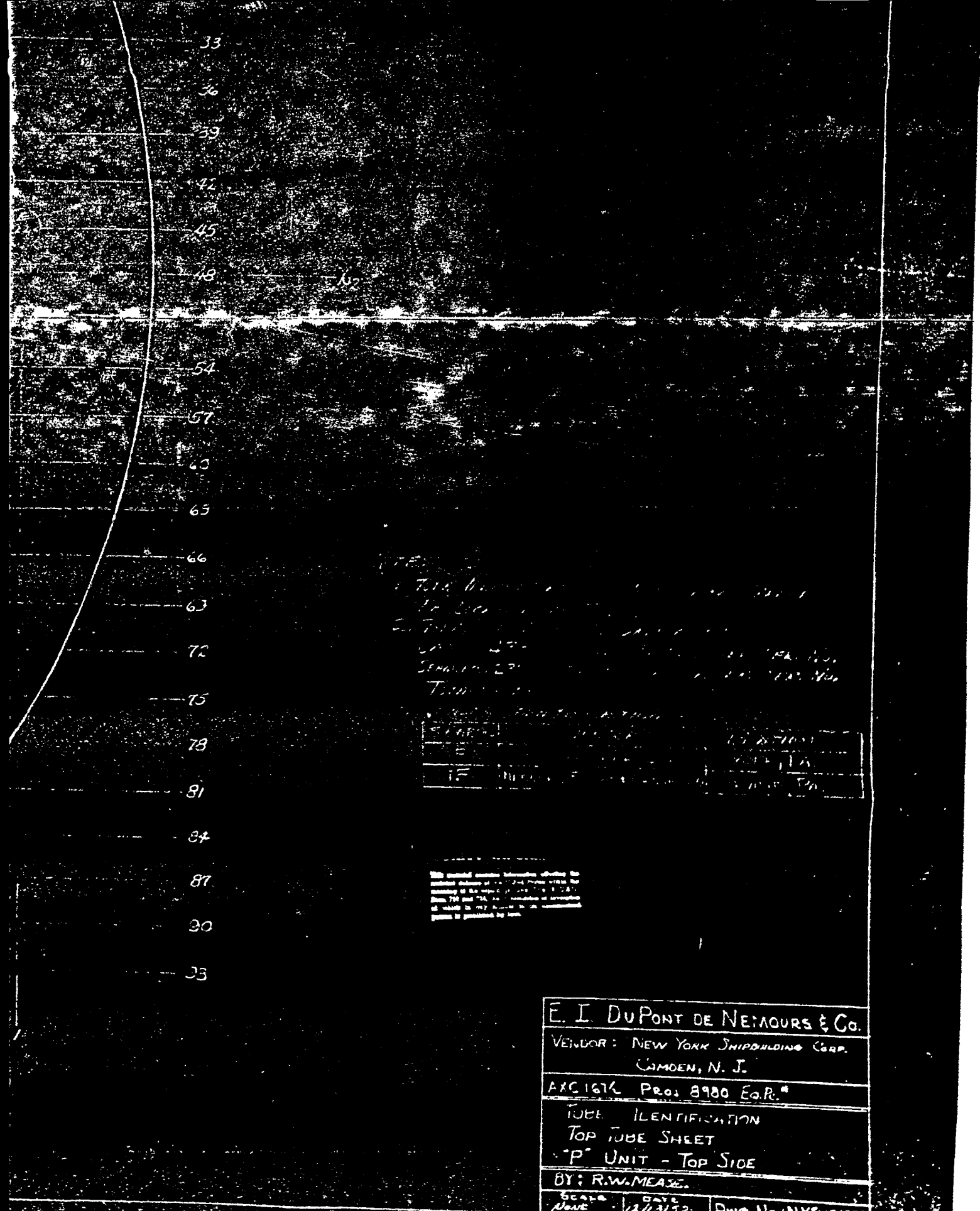

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F 457 S
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F 409 S
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NF 76 C
F 401 S
F 572 S
F 584 S
NF 85 C
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F 526 S
F 473 S
F 389 S
F 523 S
NF 18 C
F 532 S
F 518 S
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F 501 S
F 333 S
F 527 S
F 403 S
F 444 S
NF 21
F 329 S
NF 64 C
NF 44 C
NF 66 C
F 334 S
F 110 S
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NF 122 C
NF 154 C
NF 165 C
NF 132 C
F 447 S
F 335 S
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NF 1 C
NF 23 C
NF 74 C
NF 76 C
NF 79 C
NF 84 C
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F 269 S
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NF 92 C
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E. I. DuPont de Nemours & Co.	
Vendor: New York Shipbuilding Corp. Camden, N. J.	
A.C. 1614 Proj. 8980 Eq. P.O. #	
Tube Identification Top Tube Sheet "P" Unit - Top Side	
By: R.W. Mease.	
Scale None	Date 12/13/52
Dwg No. NYS-12/352	

across three major diameters. Part II-A, Section 5-C, describes the method incorporated to take these measurements. Results of these measurement (before welding large tubes and after welding rod tubes was as follows:

182.530" - Average top side measurement before welding

182.532" - Average Bottom Side Measurement before Welding

(11) Measurements After All Tubes Had Been Welded

All large tubes were welded in the unit, using the same procedure discussed in Part II-A, Section 5-d.

After all large tube welding was completed, measurements were again taken using the procedure discussed in Part VII, Section I, item 7A-(2) e [1]. Results of these measurements for the top and bottom sides after all tube welding was as follows:

182.041" Top Side
181.960" Bottom Side

After all tube welding on the top tube sheet and plenum chamber assemblies was completed, the top and bottom diametral measurements on both were analyzed to determine whether or not all results were within ± 1/32", and if additional shrink welding on either of the units was necessary to bring them within this tolerance. Shrinkage was analyzed in the following manner for "P" unit.

"P" P.C.	"P" T.T.S.
Measurements After All Tube Welding	Measurements After All Tube Welding
182.052" Top Side	182.041" Top Side
181.879" Bot. Side *	181.960" Bot. Side
0.173" Diff.	0.081" Diff.

* Of the four average diametral measurements, this figure was the smallest. All plates must be shrunk within ± 1/32" of this plate.

As pointed out in Part VII, Section I, item 7B-(2), the top side of the "P" plenum chamber was shrunk to match the bottom. This was done before comparing the results of the two sub-assemblies.

"P" P.C.

Measurements After Shrink Welding

181.847" Top Side After Shrink Welding
181.849" Bot. Side Same as Before
0.032" Diff.

By comparing the "P" plenum chamber final shrinkage measurements with the "P" top tube sheet "Measurements After All Tube Welding", it was decided by the du Pont Inspection Department and New York Ship's welding engineer to shrink weld the top tube plate of the top tube sheet. Shrink welding the top plate was done in a similar manner described in Part VII, Section I, item 7B-(2). After this, a comparision was made between the top and bottom side measurements on the plenum chamber and top tube sheet with results as follows:

"P" P.C.		"P" T.T.S.	
181.847"	Top Side After Shrink Welding	181.950"	Top Side After Shrink Welding
181.879"	Bot. Side same as Before *	181.960"	Bot. Side Same as Before
0.032"	Diff.	.010"	Diff.

NOTE: *As stated above, it was desired that all tube plates be shrunk within ± 1/32" of the bottom side of the plenum chamber; therefore, when comparison between the two units was analyzed, the average diametral measurement for this side was chosen as the nominal figure.

It can be seen by analyzing the above results that the smallest diametral measurement (average) subtracted from the largest diametral measurement (avg.) was as follows:

181.960"
181.879"
.081" Largest Diff. Between Any One of the Four Sides

All of the above final diametral measurements and the largest difference between any one of the four (4) sides and the nominal were reported to the du Pont Design Division for their comments. Design accepted these figures as being satisfactory although the desired tolerance was not maintained.

(12) Visual Inspection and Repair of Large and Rod Tube Welding

After all tube welding was completed, New York Ship cleaned

all tube welding and surface plate area on the top side with F.O. 128. Next, large tube and rod tube welding was visually inspected for roll overs, pin holes, cracks, and other mechanical defects according to the rigid inspection procedure outlined in Part VII, Section I, item 6A-(2)f. Repairs were made, re-inspected and accepted.

The unit was turned bottom side up, cleaned with F.O. 128; welding visually inspected, repairs made, re-inspected and accepted. The work and inspection was performed in a similar manner as described above.

(13) Tube Zy-glo Test

All large tubes in the "P" top tube sheet were zy-glo tested in a similar manner to that described in Part VII, Section III, item 14A-(3)a. Circumferential laminations were found on the following tubes:

Tube Number	Type Tube	End of Tube Where Lamination Was Found
X16-Y30	Bearing	Bottom
X16-Y66	Non-Bearing	Bottom
X11-Y81	Bearing	Top

The above listed tubes were removed from the unit and replaced with new ones previously inspected and accepted.

(14) Unit Cleanliness Inspection

As intermediate cleanliness inspection was performed on the unit before fabrication continued. Rags, metal chips, wood and other foreign material was removed by air jetting. After the unit was cleaned and visually inspected, it was accepted and released for further fabrication.

(15) Machining Wrapper Plate Weld Preparation and Gusset Plate Milling

This operation was performed in a similar manner to that described in Part VII, Section III, item 8A.

(16) Fitting End Stiffeners to Gusset Plates and Assembling of Inlet and Outlet Cups

Inspection of fitting and welding end stiffeners and assembling of inlet and outlet cups was performed in a similar manner to that described in Part VII, Section III, item 9A.

(17) Inspection of Spiral Core and Inlet and Outlet Tubes

These inspections were performed in a similar manner to those discussed in section 7A-(16) of this manual. No problems were

encountered and all work was approved.

(18) Preliminary Dowell Cleaning Before Installing Wrapper Plates

Internal cleaning of the "P" top tube sheet before installing wrapper plates was performed in a similar manner to that described in Part VII, Section III, item 10C. However, after cleaning it was noted that rust spots and weld smoke was present in areas located near the outer edges of the top and bottom tube sheets. The contaminated areas were ground and then swabbed with F.O. 128 until clean. Re-inspection for cleanliness proved satisfactory and the unit was released for fitting and welding wrapper plates.

(19) Cleanliness and Visual Inspection of Wrapper Plates

Inspections performed before, during and after welding wrapper plates to the periphery of the "P" T.T.S. were performed in a similar manner to those discussed in Section 7A-(17) of this manual. All results were satisfactory.

(20) Facing Operation

The top tube sheet assembly was set up and leveled top side up under three radial drill presses by New York Ship mechanics and checked by du Pont inspectors using the Wild NIII level and target. This was done in order that the "hour glass effect" (shrinkage) at the weld line (caused from welding tube to tube sheet) on the I.D. of the tubes on the top ends could be reamed to original dimensions, allowing the verticality gage to pass through. No other tubes were reamed other than the "spider web tubes" in this operation.

Next, the unit was turned bottom side up, leveled by New York Ship mechanics and checked by du Pont inspectors using the Wild Level. During the "spider web" tube reaming operation, the location of 12 bearing pads was established from layout by New York Ship layout men on the bottom side of the unit. All layout work was witnessed by a du Pont inspector and approved. The 12 bearing pads were fit, set, tacked welded to layout, fully welded and dressed. Welding was visually examined by du Pont inspectors for evidence of porosity, undercutting, cracks and other mechanical defects. Necessary repairs were made, welding re-inspected and accepted.

The top tube sheet assembly was placed on a 20' mill (top side up) and preparations were made for machining tube ends and the 12 bearing pads. (Only the top ends of the tubes were required to be machined on a top tube sheet assembly). First, the unit was set to the best verticality using the "spider web tubes" for verticality readings. (See Part III, Section II-L, for use of verticality gage) The unit was resting on four blocks while on the mill. The top tube sheet was shimmed at these blocks until

a satisfactory verticality pattern was obtained. Results of these final readings are shown in Sketch #1.

After the verticality of the unit was taken and accepted (with the unit now clamped to mill table), the Wild Level was used to establish the eleveation (or bench marks) of tube ends on the extremities of the X and Y axes and the middle tube. These five reference tubes were: (1) X54-Y48, (2) X15-Y9, (3) X2-Y48, (4) X15-Y87 and (5) X28-Y48. Results are shown in Sketch #2. The mill table was then rotated to each reference tube with a dial indicator affixed to the mill's cutting arm which registered to tube tops. The elevations that were previously established with the Wild Level on tube ends were then duplicated by shimming the unit under the cutting arm. In this manner the twist in the mill table was compensated for so that the established verticalities would be duplicated when the unit placed in a level plane. The unit was then released to the machinist for facing the top tube ends and 12 bearing pads.

First of all, the top tube sheet assembly orientation discs were machined or finished faced to size. Two tools were used for machining the tube ends. The first or lead tube was 1/16" higher than the second tool. The entire machining or facing operation took place using a .060" feed at 45 RPM. Measurements were taken to ascertain the amount of metal removed and the amount to be removed. After the last rough cut was made on the large tube ends, a finishing tool of the square nose type was employed for finish machining the tube ends.

Since the orientation discs were finished machined to a known elevation, they were used as bench marks or reference points for the finish machining of large tubes. In reality, the large tubes were finished machined to the best average elevation between the tube plate and the plane of the finished machined tube ends. The tube length specified on "p" drawings was also taken into consideration. Since the large tube faces on the bottom side were not machined, it was necessary to use, the average tube lengths to satisfy Design's requirements. The bearing pads were faced to the proper distance or drawing specification from the top ends of the tubes on the top side.

The profile of the machined tube faces was checked on the top side of the top tube sheet assembly to see if the tube faces were within drawing tolerance. (See Exhibit #7 for results) An 18" straight edge was positioned on top of the tubes located ~~on top of the tubes located~~ on both the "X" and "Y" axes. Feeler or thickness gages calibrated to .001" were inserted between the face of the straight edge and the machined tube faces to determine the difference in height of the tubes. Next, the distances from the bottom side of the bearing pads to the top of the tubes were measured using a pin gage set at 47.125" and feeler gages.

[redacted]

VERTICALITY MEASUREMENTS

SHEET TTS

DATE AUGUST 18, 1952

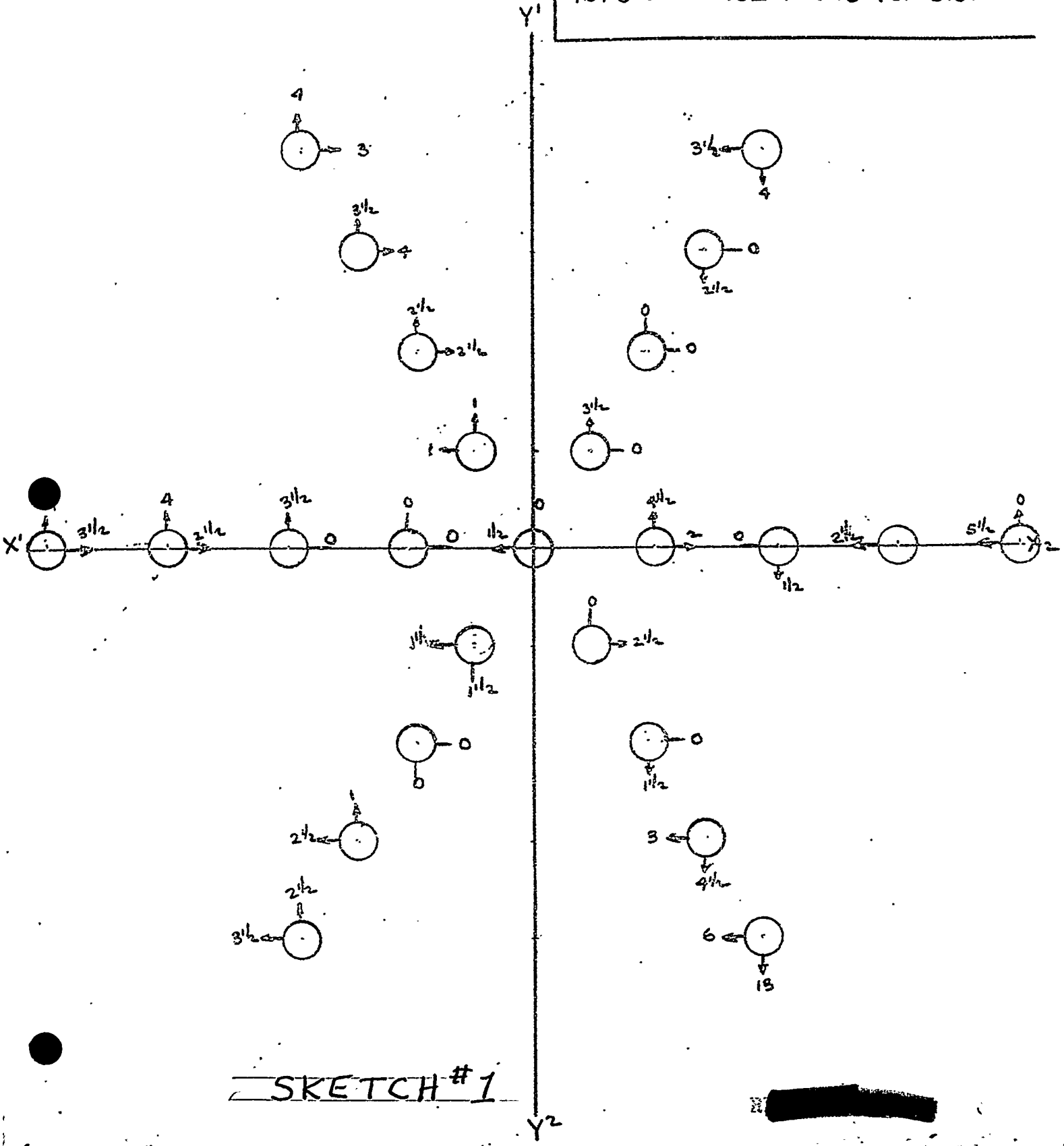
RECORDER PIATEK & LAUGHLIN

INSTRUMENT LAUGHLIN & PIATEK

REPORT # 201-P

NOTE:

VERTICALITY OF LARGE TUBES IN TOP SPECIAL "P" UNIT, SET ON 20 FT BORING MILL. BEFORE MACHINING OF TOPS OF LARGE TUBES TOP SIDE



SKETCH #1

[redacted]

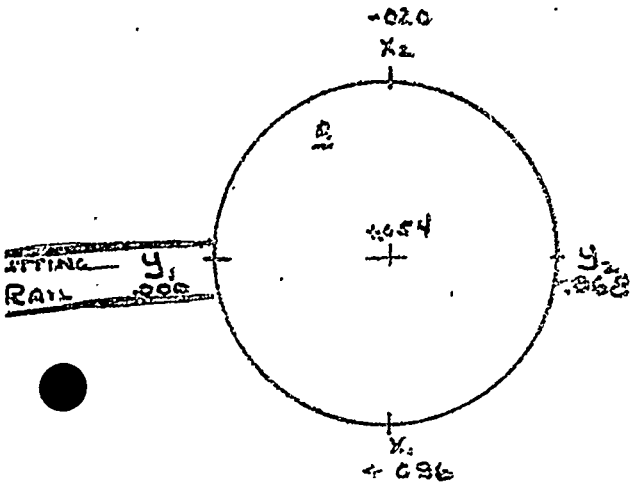
PLAN VIEW

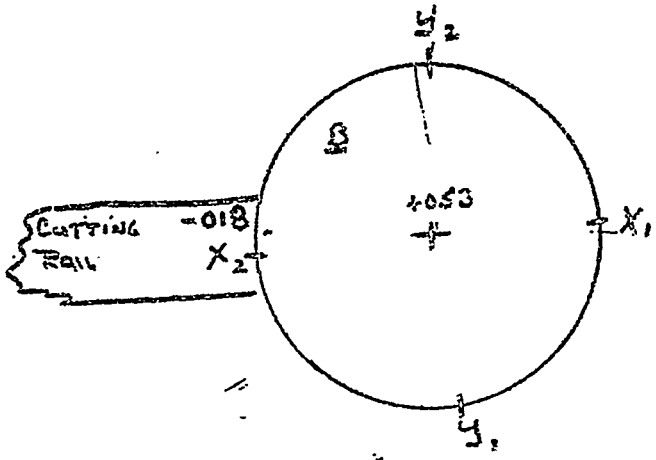
[redacted] TOD SPECIAL "P" UNIT 303

REPORT NO 201-P

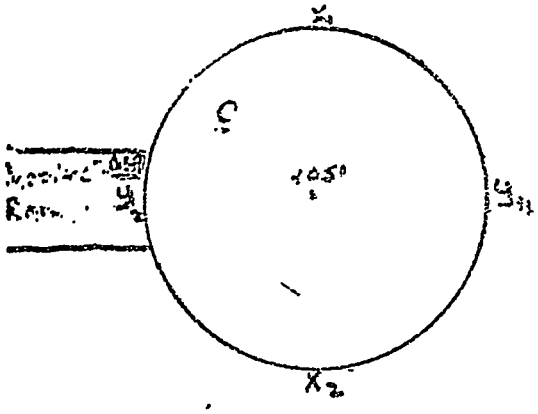
BENCH MARK READINGS OF END TUBES ON X_1, X_2, Y_1, & Y_2 AXIS. THESE READINGS WERE TAKEN WITH WILD LEVEL AND CONVERTED INTO INCHES. THE END TUBES ON THE AXIS WERE ALSO ROTATED UNDER CUTTING SO AS READINGS WITH LEVEL COULD BE TAKEN TO CHECK AGAINST ORIGINAL BENCH MARK READINGS.

A ORIGINAL SET WITH BEST VERTICALITIES

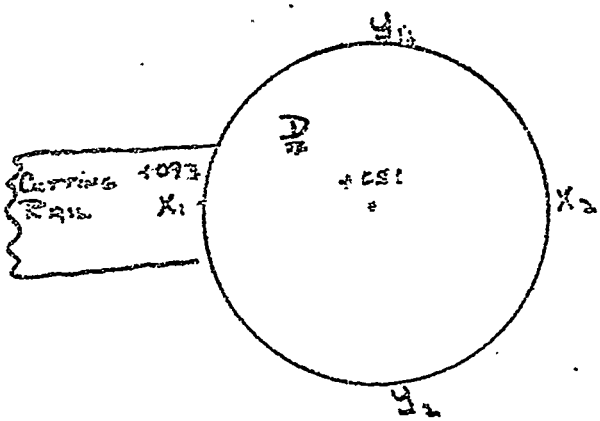




B WITH X_1 UNDER CUTTING RAIL X_2 WAS SHIMMED UP TO GET ABOVE READING



C WITH Y_2 UNDER CUTTING RAIL, Y_1 WAS SHIMMED TO GET ABOVE READING TO CORRESPOND WITH ORIGINAL READINGS



D WITH X_1 UNDER CUTTING RAIL, X_1 WAS SHIMMED UP TO GET ABOVE READINGS.

[redacted]

SKETCH #2

EXHIBIT #7

RESULTS OF MEASUREMENTS TAKEN ON THE "P" TOP TUBE SHEET ASSEMBLY AFTER FACING TUBE ENDS ON TOP SIDE AND 12 BEARING PADS ON BOTTOM SIDE.

E. I. DU PONT DE NEMOURS & CO., INC.

Construction Division

[redacted]

Report Number 204-P

CC: C. E. Buckley, F.P.M.
R. K. Mason, F.P.M.-SRP (3)
H. L. Bunker - J.G. Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
A. H. Hughes
R. H. Potts (4)
C. W. Dunn - File

H82

August 28, 1952
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

TO C. J. [redacted] - M & E FILE

FROM R.H. Potts - H.N. Neicen - I.R. Louder DATE August 24, 1952

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Top Special Tube Sheet EQ.PC.NO. 154-P

DRAWING NOS. W-131365 JOB RATING

VENDOR New York Shipbuilding Corporation LOCATION Camden, N. J.

Part I

Scope: To check the plane of the tubes of the top side of top special after facing.

Part II

To check the distance from bearing pad to top of tubes on top side.
Inspection made on August 24, 1952.

Procedure: Part I - With the 18' 0" straight edge resting first on the X1-X2 axis then the Y1-Y2 axis, feeler gage reading were taken under the straight edge at each tube to determine the clearance between the tops of tubes and the straight edge.
Part II- With the straight edge extending over the edge of the bundle and resting on the tubes, a pin gage was used to measure the distance from the bearing pad to the straight edge (or the tube tops).

Results: Part I - See attached sheets.

Part II - Distance from bearing pad to tube tops measured at X1 and Y2. At X1 distance - 47.117"
At Y2 distance - 47.117"

lmw

[redacted]

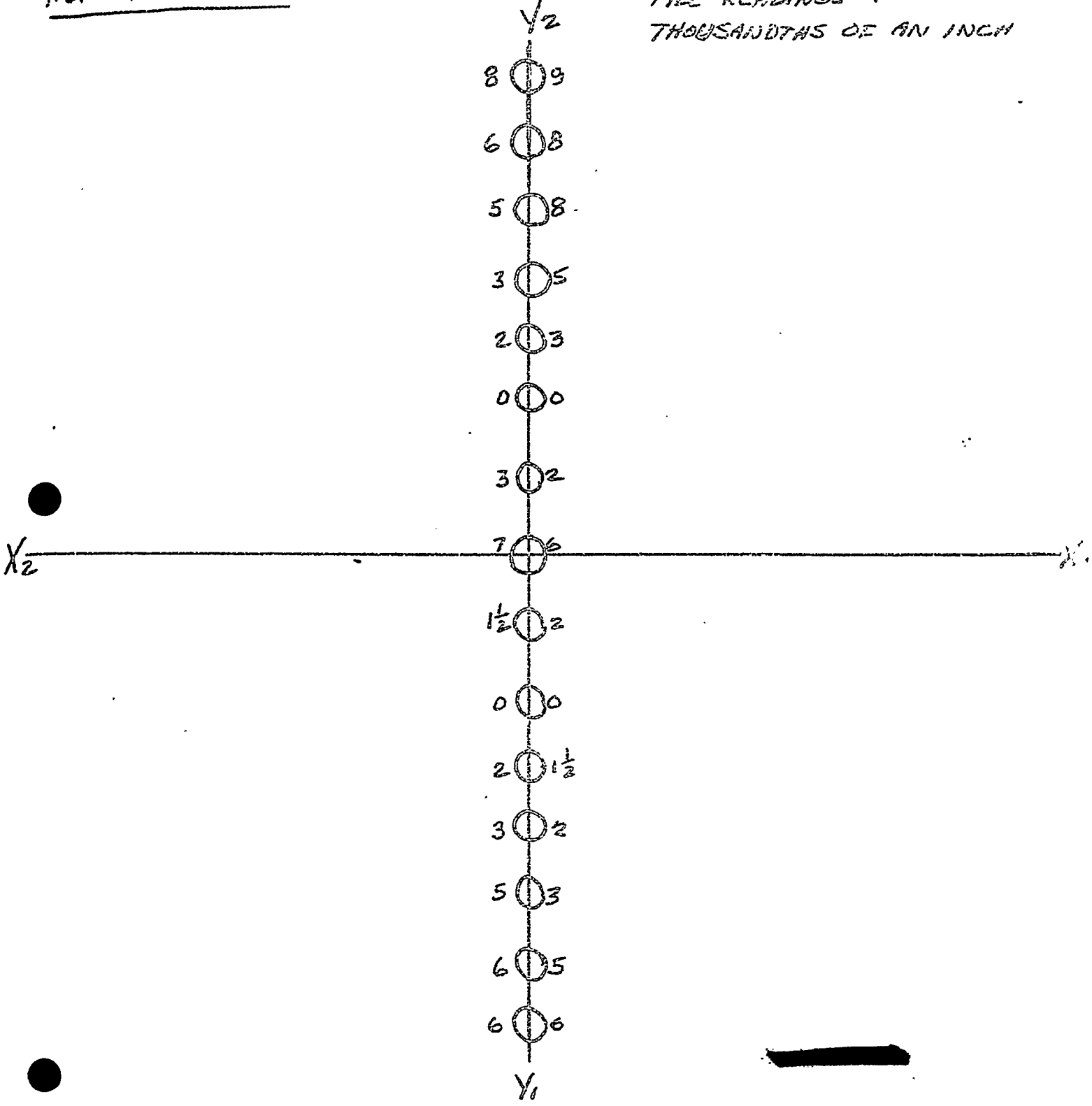
DWG. DIM. - 47½ ± .008

SKETCH - SHOWING SET UP AND CLEARANCE BETWEEN STRAIGHT EDGE AND TUBE TOPS ALONG Y_1 Y_2 AXIS

CLEARANCE MEASURED ON BOTH EDGES OF TUBES UNDER STRAIGHT EDGE

REPORT NO. 204-P

ALL READINGS IN THOUSANDTHS OF AN INCH



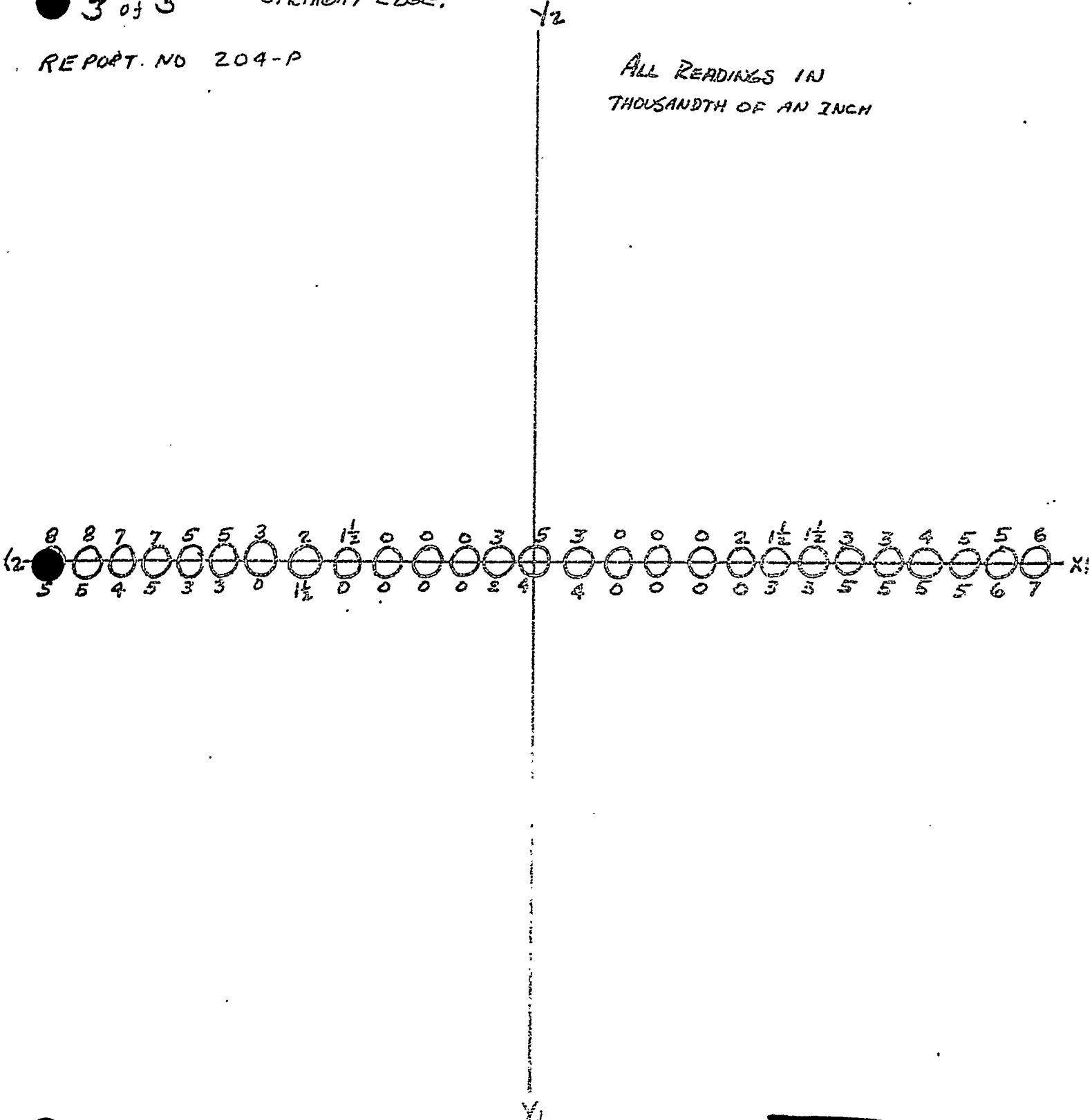
SKETCH SHOWING SET UP AND CLEARANCE BETWEEN STRAIGHT EDGE AND TUBE TOPS ALONG X_1, X_2 AXIS. CLEARANCE MEASURED ON BOTH EDGES OF TUBES UNDER STRAIGHT EDGE.

[redacted]

3 of 3

REPORT NO 204-P

ALL READINGS IN THOUSANDTH OF AN INCH



[redacted]

E. I. DU PONT DE NEMOURS & CO., INC.

Construction Division

Report Number 478-P

CC: H. W. Gosney, F.P.M.
R. K. Mason - D. A. Hauser
Savannah River Plant (3)
R. K. Mason - E.M.Vass-SRP
H. L. Bunker - J. G. Brewer
J. G. Brewer
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R. H. Barto - NYS (3)
J. B. Johnson - File

April 24, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM R.E. Chaney, A.J. Piatek, H.E. Dahlke DATE April 10, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Top Tube Sheet - Bearing Pads EQ.PC.NO. 155-P

DRAWING NOS. W-131365 R. 27 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Inspection performed 4/10/53

Scope:
To determine diametrical dimensions across the twelve (12) bearing pads at the O.D., the diametrical clearance between O.D. of the bearing pads and the O.D. of the tube sheet and the circumferential location of the bearing pads.

Procedure:
Tools: S/S tape S-5757, #4, surface blocks and 6" steel scale.

Method: The diametrical measurements across the bearing pads were made in six (6) directions and at the center of each pad on the O.D.

The diametrical clearance was measured from the center of each pad to the O.D. of the tube sheet.

The circumferential location was made by transferring the ℄'s of each pad to the O.D. of the tube sheet and measuring from ℄ to ℄ individually.

[redacted]

[illegible] INSPECTOR'S REPORT
FROM: Chaney/ Piatek/Dahlke

Report #478-P
Page 2

Results: See attached sheet.

Notes: The diametrical clearance of each pad from the O.D. of the pad to the O.D. of the tube sheet remained constant at 1/2". All pads were spaced 58-3/4" $^{+.0}_{-7/32}$"

All of these dimensions are considered acceptable. (No tolerances are specified on drawing.)

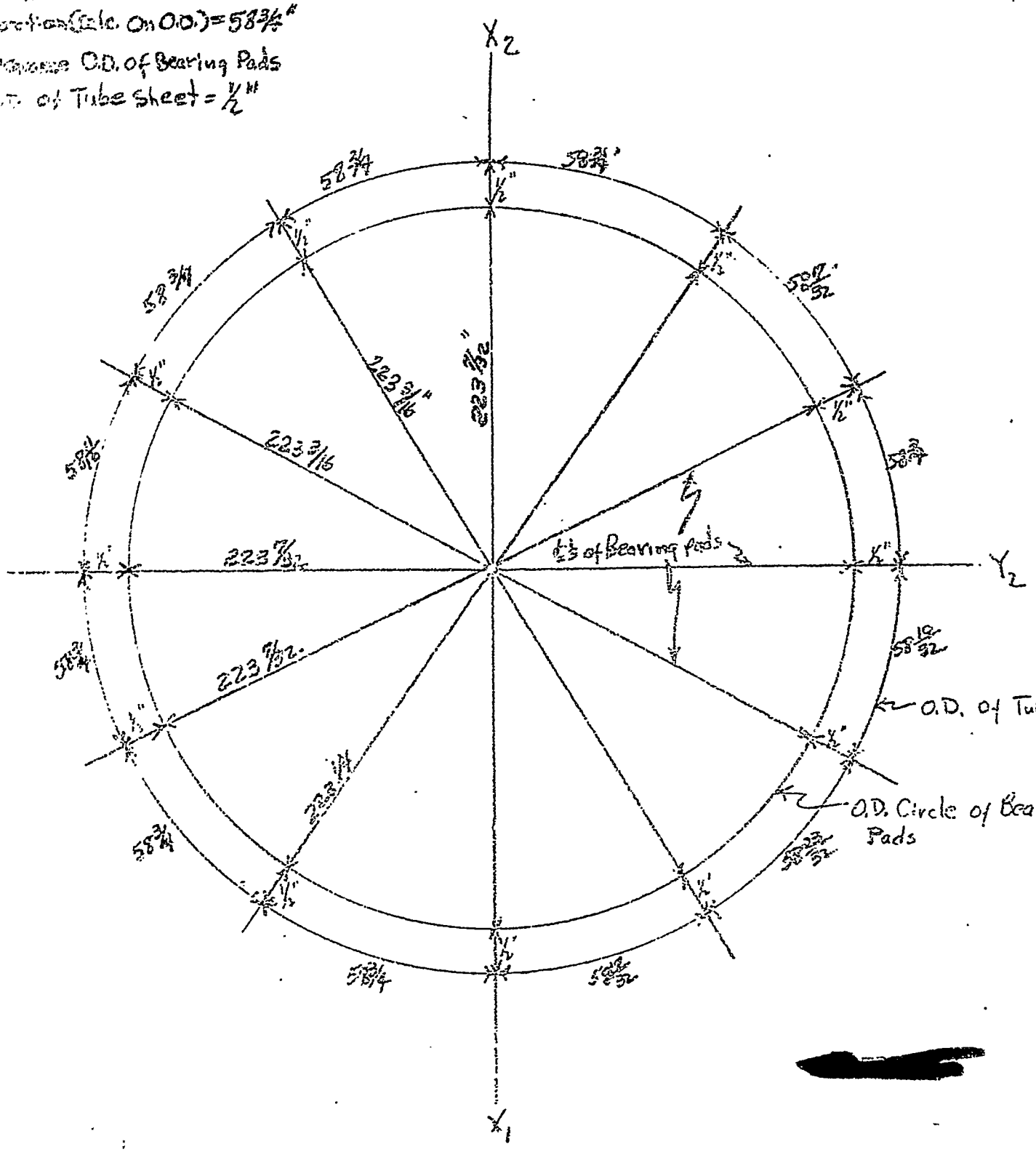
[illegible]
attached.

[redacted]

Report # 478-P

"P" TTS - Bottom Side (As seen from top) - Bearing Pad
Diametral Dimension and Circumferential Location 4-10-53

Des. Diametral (calc.) = 223 1/4"
Dup. Location (Calc. On O.D.) = 58 3/4"
Des. Clearance O.D. of Bearing Pads
To I.D. of Tube Sheet = 1/2"


X2
Y2
X1
Y1
223 3/32"
223 3/16"
223 3/16
223 3/32
223 1/32
223 1/32
223 1/4
1/2"
58 3/4
58 19/32
58 23/32
58 3/4
58 3/4
58 3/4

Sketch #15 in Part II illustrates pictorially how these measurements were taken. For results, see Exhibit #7 presented herewith. After the machined tube faces (top side) and bearing pads had been inspected and accepted for finish and elevation, copper shields were placed over the bearing pads to protect the machined surfaces.

(21) Deburring and Inspection

This operation and inspection was performed in a similar manner to that discussed in Part II-A, Section 10.

(22) Lifting Lug Inspections

Inspection of the four lifting lugs butt welded to prolonged wrapper plates on the top tube sheet was performed in a similar manner to that described in Section 7A-(20) of this manual, except as follows: In lieu of zy-glo testing of welding, dy-cheking method of testing was incorporated into the inspection procedure for this unit. For the procedure used to dy-chek welding, see Part VII, Section I.

(23) Tube Reaming Operation

Using a 18' straight edge and box level, New York Ship mechanics leveled the top tube sheet assembly under three radial drill presses. Inspectors checked the levelness with the Wild NIII Level using the following method: A lighted target (graduated in centimeters) was placed on the center tube (X18-Y28) and read with the Wild level in millimeters. Readings were also taken on the end tubes on the X and Y axes, making a total of five readings. All readings were converted from millimeters to thousandths of an inch. For the unit to be level, all five readings must not deviate more than .015".

After the unit was level, all large and rod tube bores except those previously reamed in the "spider web" pattern, were reamed to the specified diameter at the top weld lines to remove the "hour glass" effect caused by welding. Also, large tube ends were chamfered to 10° and rod tubes to 30°. Chamfers were checked using a plug type chamfer gage. During the reaming operation, the finished bores were spot checked using a standard dial indicator bore gage and ring gage. All tube bores were then visually checked for evidence of tool steps, gouges, rough finishes and other mechanical defects. Defects found were removed either by honing or cloverleafing until the defect was blended into the tube wall.

Before turning the unit bottom side up, the six gas tubes were faced 5-3/8" from the top tube plate. The distance from the top tube plate to the end of each gas tube was measured using a 6" scale graduated in 1/32". All results were satisfactory. In addition, the six gas tube ends were chamfered 1/16" x 10° and then checked

using a plug type chamfer gage and approved.

The top tube sheet was turned bottom side up and leveled in a similar manner described above. All large and rod tubes were reamed from the bottom side in a similar manner to that done on the top side of the unit. In addition, the six gas tubes were faced flush with the bottom tube plate. The inside diameter of the "flushed" gas tube ends were radiused 3/16", inspected and accepted. Also, the welding joining the bottom end of the gas tubes to the bottom tube plate was inspected for porosity and cracks. Defects of this nature discovered by du Pont inspectors were removed by chipping and then re-welded using manual Aircomatic welding machines. All repaired spots were ground smooth, re-inspected and accepted.

After the reaming operation was completed, all large tubes were checked with a 4.377" dia. plug gage which was .003" under the minimum bore size. First, each large tube was plug gaged from the top side of the unit by inserting the gage into the tube approximately two-thirds the way down. This same check was performed on the bottom sides of the unit. The first check revealed that three (3) tubes on the top side and thirty-five (35) tubes on the bottom side failed to receive the plug gage. These tubes were honed, re-gaged and accepted.

The rod tube Bores were checked with a 1.3045" diameter plug gage (.003" smaller than minimum bore size) after reaming to remove bore distortion caused from welding. All rod tubes accepted the gage for the entire length of the tube.

Finally, all large tube and rod tube bore diameters were measured in the X and Y direction at the weld line in the top end of each tube. Measurements were taken using a dial indicator bore gage and ring gage. All results were recorded and accepted as being satisfactory.

(24) Sandblasting and Acid Washing

The unit was prepared for sandblasting outside by bolting wood blanks on tube ends and closing all other openings. Before sandblasting the unit, approximately 15 psi. of air was introduced into the interior to prevent fine grit from entering the assembly. Following sandblasting and acid washing on the top side, the unit was turned over and the bottom side and wrapper plates sandblasted and acid washed. Both sides of the unit and wrapper plates were ferroxyl tested at random spots; contaminated areas re-cleaned by grinding and then re-acid washing until no evidence of free iron was present as determined by the ferroxyl test.

Upon visual examination of tube bores, it was discovered that sand particles were present in numerous tubes. In order to remove

this sand, New York Ship cleaned all large and rod tube bores using CCl_4. All tube bores were re-inspected and found clean.

(25) Individual Tube Hydrostatic Test

Hydrostatic testing of each tube in the "P" top tube sheet was performed in a similar manner to that discussed in Section 7A-(26) of this manual. No leaks were found.

(26) Preliminary Freon Testing Of "P" Top Tube Sheet

The assembly was prepared for freon testing in a similar manner to that described in Section 7A-(25) of this manual. During the test two rod tubes (X32-Y8 and X50-Y32) were found to be leaking. Visual inspection of each tube bore revealed that tack welding of tubes to tube plate on the inside during assembling operations had burned a small hole in the tube wall. These two tubes were blanked off and the remainder of the unit tested. One leak was detected between the weld joining rod tube X39-Y61 to the top tube plate. Also, another leak was detected on the bottom side of the unit in the welding joining rod tube X25-Y47 to the bottom tube plate.

The freon was released from the unit and the two defective rod tubes (X32-Y8 and X50-Y32) were cut out of the unit, replaced with new ones, welded, dressed, inspected and found satisfactory. The other two rod tubes (X39-Y61 and X25-Y47) were repaired by chipping out the defective area and plug welding the spots using manual aircomatic welding machines. These two repaired spots were ground, inspected for weld defects and found satisfactory.

After necessary repairs and replacements had been made, the assembly was subjected to another freon test. No leaks were detected and the unit was released for further testing.

(27) Preliminary Hydrostatic Test

The top tube sheet (top side up) was filled with deionized water, brought up to $52\frac{1}{2}$ psi. gage using a hand pump and held at this pressure for one hour (See photo serial #116, Part II-B, Section II). All shell welding and tube welding was visually inspected for leaks with the aid of a flashlight. No leaks were found and the unit was accepted as being water tight.

After the hydrostatic test was completed, the unit was set up under three radial drills and the two replaced rod tubes were reamed, chamfered and inspected in a similar manner to that described in paragraph (23) above. All inspections were satisfactory.

(28) Inspection of Slots for Thermocouple Clips

Twelve slots located on the bottom tube plate of the top tube

sheet were inspected for location, depth, length and width. The slots were all visually checked for location using du Pont drawing W-133145. They were dimensionally inspected using a 6" scale graduated in 1/64". All slots were within drawing tolerance and accepted.

(29) Chime Ring Inspections

All inspections performed during the fabrication and fitting of chime rings to this unit were performed in a similar manner to that discussed in Part VIII, Section B-9.

(30) Deflector Plate Inspections

The fabrication and machining of the one deflector plate required for this unit was performed in a similar manner to the building of a top tube plate. Pre-assembly deflector plate inspections were performed by du Pont inspectors in a similar manner to those discussed for the top and bottom tube sheets in Part VII, Section I, items 1A, 4A, 5A and 6A.

As shown on du Pont drawing W-114689, thermocouple lead clip holes were added to the "P" units deflector plate. These hole locations were checked with a functional block having two 3/8" diameter studs welded on 1" center to simulate the clips specified on the drawing. All accepted the plug freely and were accepted.

Fit-up of deflector plate to the bottom side of the top tube sheet was inspected in a similar manner to that described in Section 7A-(30) of this manual. All inspections were satisfactory and the deflector plate was accepted and prepared for shipment.

(31) Dowell Cleaning

Since the plenum chamber was not yet ready for line boring and all major fabrication operations on the top tube sheet were completed, it was decided to internally clean the top tube sheet in order to expedite the completion of this unit.

Essentially, the internal cleaning of the "P" top tube sheet assembly was the same as the "R" bottom tube sheet insofar as handling and getting the cleaning solution into and out of the unit for cleansing action (See Part VII, Section III, item 16A-(1).

After the first Dowell cleaning operation, the unit was inspected internally through loading ports with the aid of a flashlight. Loose chips, dirt and other foreign material was found and the first cleaning was rejected. The unit was re-cleaned again in a similar manner referenced above. Another inspection revealed

that the unit was still dirty and was rejected the second time. The unit was recleaned with a solution of 2% caustic soda, steamed and flushed. Another visual inspection revealed that the unit was still dirty. The unit was recleaned by Dowell, steamed and flushed. After cleaning and upon visual examination through loading ports, a residue resembling scale was found. Samples of the residue was obtained and later analyzed by a chemist. The results of this analysis indicated that the residue was not detrimental to the operation of the unit; however, it was desirable that this material be removed as requested by the Design Division. Internal cleaning of the assembly was discontinued at this time until a further study of the cleaning problem could be made and a procedure written that would satisfactorily remove the residue and make for a better unit insofar as internal cleanliness was concerned.

In the meantime, field complaints issued by Operations Department, Savannah River Project, to the du Pont Inspection Department at New York Ship stated that the cleanliness of the "R" plenum chamber interior did not meet their cleaning specifications.

In view of the cleaning problems encountered on the "P" top tube sheet and incoming field complaints pertaining to the same subject, the du Pont Inspection Department immediately took steps to study the cleaning problem and to write the first cleaning procedure used on this project. After the new procedure was written, the "P" top tube sheet was recleaned by Dowell, Inc., following the step by step cleaning procedure formulated by the du Pont Inspection Department. For a resume covering this final cleaning operation, see Section 7B-(39) of this manual.

(32) Re-inspection and Repair of all Tube Welding

A close visual inspection and better control over repairing of large tube and rod tube welding was performed on this unit and also "L" and "C". The need for closer examination and control over repairing of tube welding at this stage of fabrication came about as a result of several things.

First, complaints were received from the field pertaining to tube weld leakage on "R" unit plenum chamber. An inspector from the du Pont Inspection Department at New York Ship was sent to the Savannah River Plant site to investigate the complaints and also to assist in "lofting in" of the "P" main tank. At this time "R" plenum chamber was freon tested and witnessed by the inspector. Two leaks were found on the top side; one in a rod tube overlay and the other in a large tube weld. In addition, two leaks on the bottom side were found; one at a rod tube weld overlapping a large tube weld, and the other in a large tube 1" weld overlay.

However, during the time field complaints were being received pertaining to tube weld leakage, preliminary hydrostatic and freon tests on "p" plenum and top tube sheet (At New York Ship) revealed that tube weld leakage occurred frequently at (1) large tube 1" weld overlay (2) weld roll-over where rod tube and large tube weld joined and (3) roll overs on large tube welds due to lack of fusion.

In view of these findings, a new tube weld inspection procedure was adopted by the du Pont Inspection Department. In this procedure it was requested that New York Ship grind and chip all large tube 1" weld overlay, chip out all weld roll over where rod tube and large tube weld joined, and to chip out all roll overs on large tube welding due to lack of fusion.

NOTE: See following page for remainder of item (32)

(See photo serial #35 and 203 in Part VIII, Section I). Inspectors would visually inspect all tube welding using flashlights and mark the defective weld with chalk. They would stay with the grinders and chippers while repair work was in progress, and re-inspect where necessary. If any weld was ground or chipped to such a degree that it was necessary to re-weld, inspectors were to witness and re-inspect after welding and grinding before accepting same. A final tube weld inspection as discussed above was to be performed after sandblasting both sides of the unit.

The above tube weld repair and inspection procedure was followed on both sides of the "P" top tube sheet assembly until all tube welding met the du Pont Inspection Department's requirements. After all tube repairs were made and accepted, the unit was released for another preliminary freon and hydrostatic test.

(33) Second Preliminary Freon Test

Following all tube weld repairs, the "P" top tube sheet was prepared for another preliminary freon test. The unit was prepared and tested in a similar manner to that described in Section 7A-(25) of this manual. No leaks were found and the unit was released for hydrostatic testing.

(34) Second Preliminary Hydrostatic Test

Due to field complaints pertaining to leaking tube welds on "P" bottom tube sheet and all sub-assemblies for "R" unit, it was decided at New York Ship to incorporate a hammer test prior to line boring of the "P" top tube sheet and on all other subsequent units under fabrication at New York Ship.

The "P" top tube sheet was hammered and hydrostatically tested in a similar manner to that described in Part VII, Section III, item 14C-(2). No leaks were found and the unit was accepted pending a final freon and hydrostatic test just prior to shipping to the plant site.

(35) Large Tube to Rod Tube Ligament Measurements

This inspection was performed on the top side of the "P" top tube sheet assembly. See Part III, Section II-B for a resume of the gages used and interpretation of results. All large tube to rod tube ligament measurements taken on the top side of this unit were accepted by the Design Division as being within tolerance.

(36) Line Boring Operation

The use of the top tube sheet assembly during the line boring of plenum chamber tubes and problems encountered are covered in Part VII, Section I, item 15B. Also, inspection of indexing devices

and establishing of temporary centerlines is discussed in this section.

After the plenum chamber was removed from the line boring set up, the outside diameter of the "P" top tube sheet was measured. Exhibit #8 presented herewith outlines the procedure followed and the results.

(37) Second Major Re-inspection and Repair of All Large Tube Welding

After the line boring operation was completed, the top tube sheet was set up (top side up) on a level platen for a re-inspection of all tube welding.

First, the top side was jetted with air to remove all loose chips, dirt and puddles of oil which had collected on this side during the line boring operation. Next, New York Ship cleaned the top side plate surfaces and all tube welding using F.O. 128. After this, du Pont inspectors visually inspected all tube welding in a similar manner to that described in Section 33 of this manual. Necessary repairs were made, inspected and accepted.

(38) Dowell Cleaning (Continuation of Section #31)

At this time the "L" top tube sheet was re-cleaned by Dowell using the new cleaning procedure written by the du Pont Inspection Department. The scope, procedure and results of this final cleaning by Dowell are covered in Exhibit #9 presented herewith. The final cleaning was successful and the unit was released for further fabrication.

(39) Functional Gaging Prior to Raschig Ring Loading

This inspection is covered in Part VII, Section I, item 16B-(7).

(40) Establishing Final Centerlines for Field Erection Purposes

After functional gaging and before dismantling the plenum chamber and top tube sheet, X and Y axes previously established on the top side of the plenum were transferred to the bottom side of the plenum, top of the top tube sheet and wrapper plates using the Wild T1 theodolite. Part III, Section II-K, describes how this instrument was used to transfer unit centerlines. Sketch #35 in Part VII, Section I, item 15A-(8) illustrates pictorially where these centerlines or axes were established.

(41) Pattern Measurements

After all machining and repair work had been completed on large tubes, pattern measurement were taken to show the position of each

EXHIBIT #8

MEASURING OUTSIDE DIAMETER OF THE "P" TOP TUBE SHEET

ASSEMBLY

E. I. DU PONT DE NEMOURS & CO., INC.

Construction Division

Report Number 407-P

RESTRICTED
SECURITY INFORMATION

CC: H. W. Gosney, F.P.M.
R. K. Mason-K. R. Leifermann-
Savannah River Plant (3)
H. L. Bunker - J. G. Brewer
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F. C. Breuninger
S. R. Cochran (2)
J. B. Johnson - File

February 10, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE
F.J. Jarczynski - H. Dahlke

FROM I. R. Louder - L. W. Mergenthaler DATE February 3, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Top Tube Sheet EQ.PC.NO. 154-P

DRAWING NOS. W-131365 R. 27 JOB RATING

VENDOR New York Shipbuilding Corporation LOCATION Camden, N. J.

Scope: To check the "O.D." of Top Tube Sheet at various points as outlined on attached sketch. This report covers inspection completed on February 2, 1953.

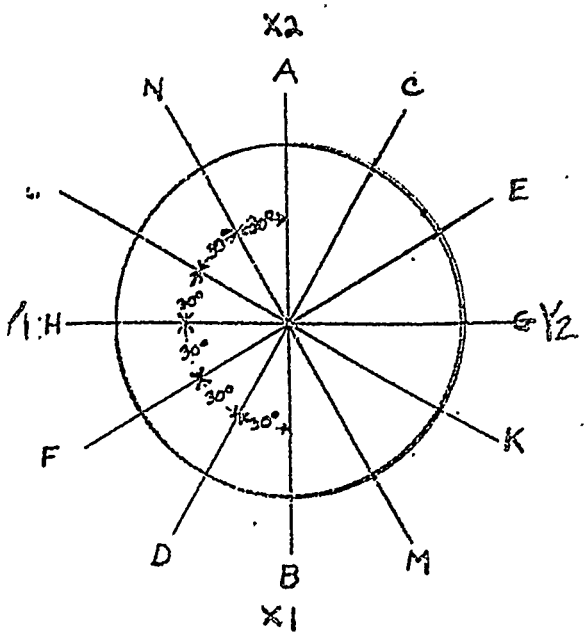
Procedure:
1. The X and Y axes were located.
2. Equidistant points, as indicated on enclosed sketch, were located and used to take diametrical readings. Points were located by measuring an average of 3" counterclockwise from each bearing pad.
3. Holding two 6' steel scales at two opposite points on circumference, each end of each scale protruding over tube sheets (top and bottom) at least 10", and using a 100' steel tape to measure the distance between edges of the steel scales, the diametrical readings were taken at exactly 10" above and below the tube sheets, as outlined on enclosed sketch and the maximum diameters at these points were recorded.

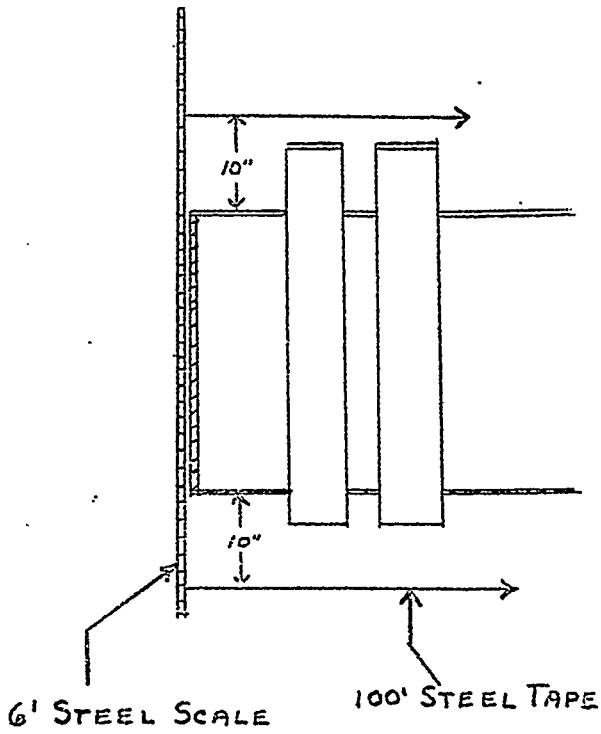
Results:
See attached sheet for listing of dimensions and sketches.
Largest diameter at the top (line M-N) is 224-17/64".
Largest diameter at the bottom (line K-L) is 224-9/32".

lmw

SKETCH - SHOWING POSITIONS & RESULTS OF T.T.S. DIAMETER MEASUREMENTS

Top





TOP MEASURED DISTANCE	BOTTOM MEASURED DISTANCE	AVERAGE MEASURED DISTANCE	DRAWING DIMENSION
A-B = $224\frac{5}{32}$"	A-B = $224\frac{1}{4}$"	A-B = $224\frac{13}{64}$"	$224\frac{1}{4}$"
C-D = $224\frac{7}{32}$"	C-D = $224\frac{15}{64}$"	C-D = $224\frac{15}{64}$"	"
E-F = $224\frac{5}{32}$"	E-F = $224\frac{7}{32}$"	E-F = $224\frac{3}{16}$"	"
G-H = $224\frac{1}{8}$"	G-H = $224\frac{1}{4}$"	G-H = $224\frac{3}{16}$"	"
K-L = $224\frac{7}{32}$"	K-L = $224\frac{9}{32}$"	K-L = $224\frac{1}{4}$"	"
M-N = $224\frac{17}{64}$"	M-N = $224\frac{1}{8}$"	M-N = $224\frac{17}{64}$"	"

EXHIBIT #9

FINAL DOWELL CLEANING OF THE "L" TOP TUBE SHEET ASSEMBLY

E. I. DU PONT DE NEMOURS & CO., INC. Report Number 463-P

Construction Division

[redacted]

CC: H. W. Gosney, F.P.M.
R. K. Mason - D. A. Hauser
Savannah River Plant (3)
R. K. Mason - E. M. Vass- SRP
H. L. Bunker - J. G. Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
J. B. Johnson - File

April 21, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM R. E. Chaney - A. J. Piatek DATE April 7, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Top Tube Sheet EQ.PC.NO. 154-P

DRAWING NOS. W-131365 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Inspection performed 3/12/53 and 3/13/53

Scope:

Internal cleaning of subject unit.

Procedure:

Cleaning solution (by weight):

0.1% Detergent
1.0% Caustic
1.0% Trisodium Phosphate
Remainder - Deionized or distilled water
Temp. - 150°-190°F.

1. Cleaning of gussets and wrapper plates.
   A. Tube sheet horizontal and upside down.
   B. No pot chuck or rolling jig installed.
   C. All openings (approx. 34) in wrapper plate uncovered.
   D. Jetted @ 2300 psi straight in for 5 min. thru every opening using S/S nozzles, twice around.
   E. Drained through 18 perforated outlet tubes & 2" openings.

[redacted]

2. Cleaning between baffle plate and tube sheet

   A. In same position as above
   B. All openings closed in wrapper
   C. Valve on each inlet and outlet tube closed
   D. Fill unit completely
   E. Fed thru one outlet tube at a time for 10 min.
   F. Drained thru mating inlet tube. - These operations (E & F) repeated 18 times.

3. Internal cleaning with solution plus air agitation.

   A. Tube sheet in vertical position held in filling cradle.
   B. All 2" ports closed, except the third "B" port, above the horizontal ℄ on both sides of unit.
   C. The unit was filled, to overflowing, thru the 9 upper half outlet tubes (perforated). The 2 filling ("B") ports were closed and the unit rotated approx. 60°.
   D. Two filling ports were opened on top for vents at this time.
   E. While draining thru the 2" filling ports on the bottom, the level was maintained by filling thru the 9 upper perforated outlet tubes and the solution agitated internally by air thru the 9 lower half outlet tubes simultaneously for 30 min.
   F. Vents were then closed and the bundle rotated 120° (60° on the opposite side of vertical) after which operation (E) was repeated.
   G. The feed was gradually shut off, maintaining constant air agitation, while the unit was completely drained thru the bottom 2" filling ports.

4. Rinsing - using hot distilled water for first rinse and deionized water for second rinse.

   A. Unit in vertical position as in "3".
   B. All openings closed except those filling ports on very top of unit.
   C. Unit completely filled thru 9 upper half perforated outlet tubes.
   D. Unit then drained thru all lower half 2" ports while filling flow maintained for 30 min.
   E. Feed diminished gradually and unit drained completely.
   F. Unit then placed in horizontal position for inspection.

Results:

Wiping thru large filling ports of internal surfaces including tubes, wrapper plates and ports of tube sheet revealed no foreign matter. Visual inspection thru large filling ports and 2" filling ports revealed a slight deposit of detergent on tube walls in the form of a white powdery substance. Other than this, the surfaces appeared clean, and the interior cleanliness of the tube sheet was considered acceptable.

lmw

tube center from the X and Y centerlines. Pattern measurements were taken on the top side only. All measurements were taken using ligament gages. Part II-A, Section 18, describes the manner in which ligament gages were used. Part III, Section II-G, describes how the gages were calibrated and how pattern coordinates were calculated. Sketch #35 in Part VII, Section I, item 16A-(8) illustrates pictorially how X and Y centerlines were established on the top tube sheet assembly for tying in pattern coordinates on the top side of the assembly. For results of pattern measurements taken on the top side of the "P" top tube sheet assembly, see Exhibit #10 presented herewith.

(42) Large Tube Verticality Measurements

The unit was placed on four cast iron pedestals approximately three feet high and then leveled by du Pont inspectors using the Wild NIII level and lighted target. Leveling was done in a similar manner to that described in Section 7A-(21) of this manual.

After the unit was leveled, the verticality of all large tubes were taken using a specially designed calibrated verticality gage which indicates the inclination with the vertical. Readings were recorded in .001 in./ft. For use of verticality gage for determining tube verticality, see Part III, Section II-L. Results of these measurements taken on the "P" top tube sheet assembly were similar to those presented as Exhibit #2 in Section 7A-(22) of this manual and were acceptable by the du Pont Inspection Department.

(43) Internal Drying of "P" Top Tube Sheet

This operation is covered in Part VII, Section I, item 16C-(20).

(44) Raschig Ring Loading

Inspection and filling of the "P" top tube sheet with raschig rings was accomplished in a similar manner to that described in Part VII, Section III, item 17A. Exhibit #11 presented herewith covers the actual loading of this unit as witnessed by a du Pont inspector.

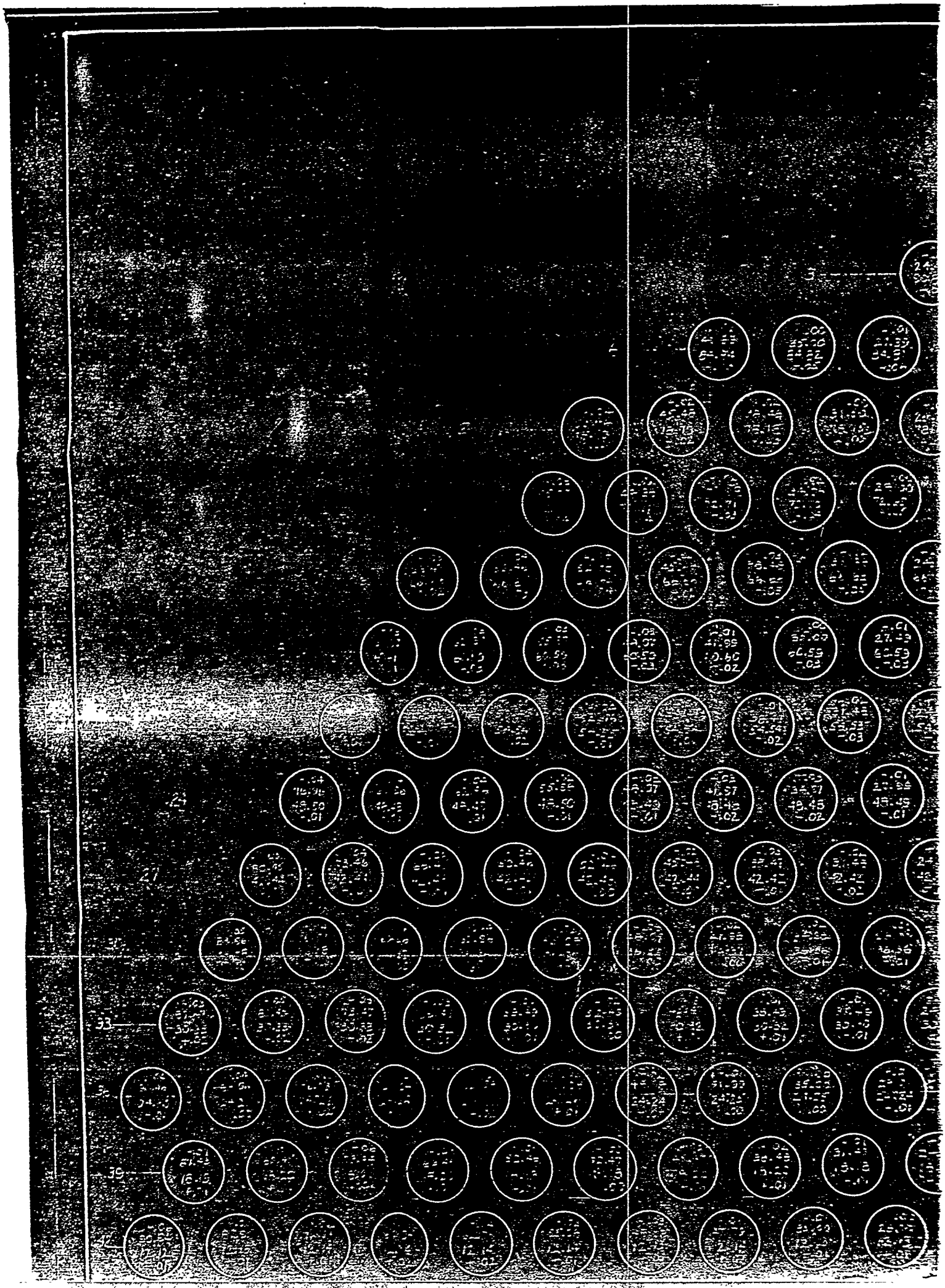
(45) Top Tube Sheet Indexing Devices

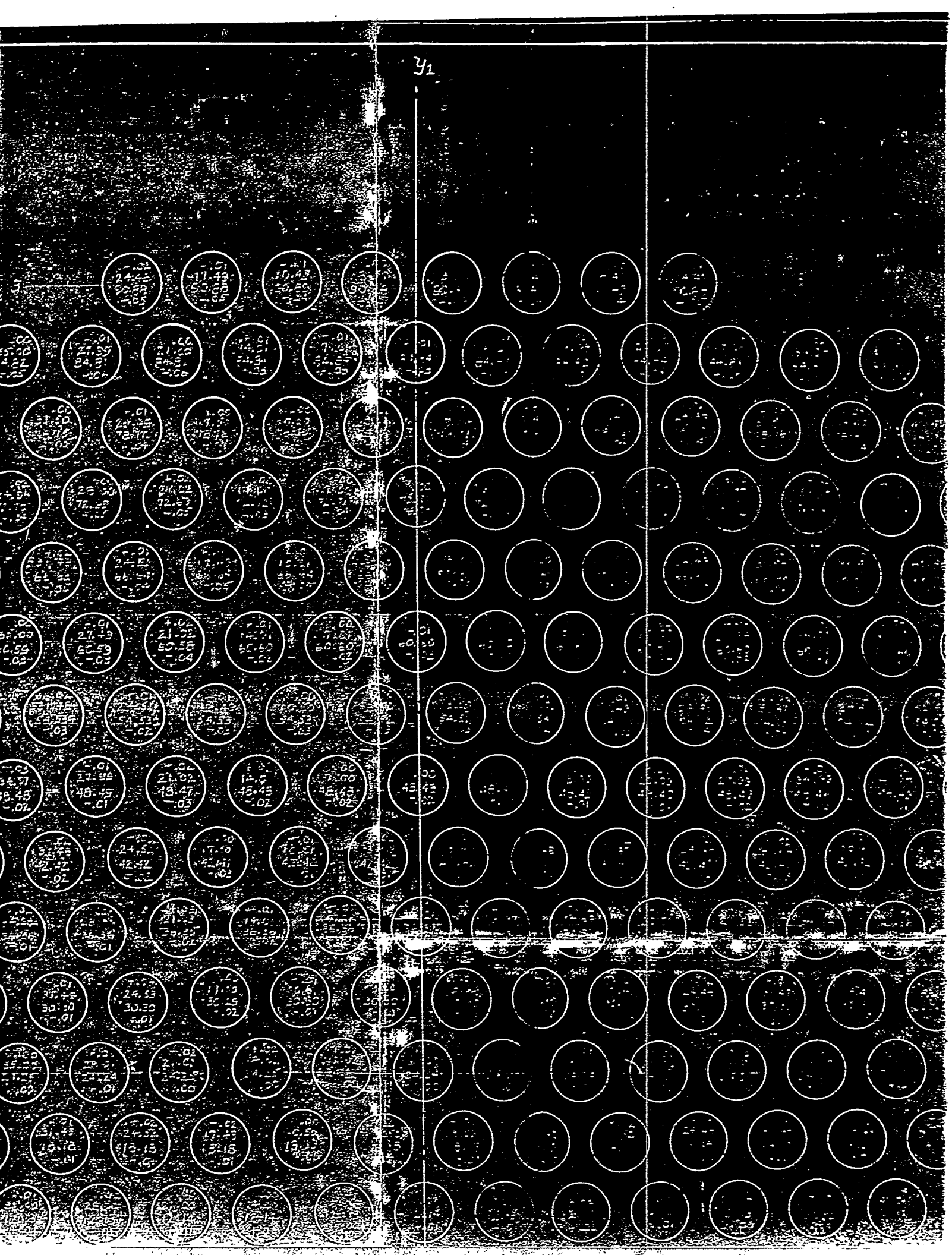
Pre-assembly inspections performed by the du Pont Inspection Department on the three indexing devices required for the "P" top tube sheet were performed in a similar manner to that described in Section 7A-(37) of this manual. Exhibit #12 presented herewith covers all inspections made on the three indexing devices after

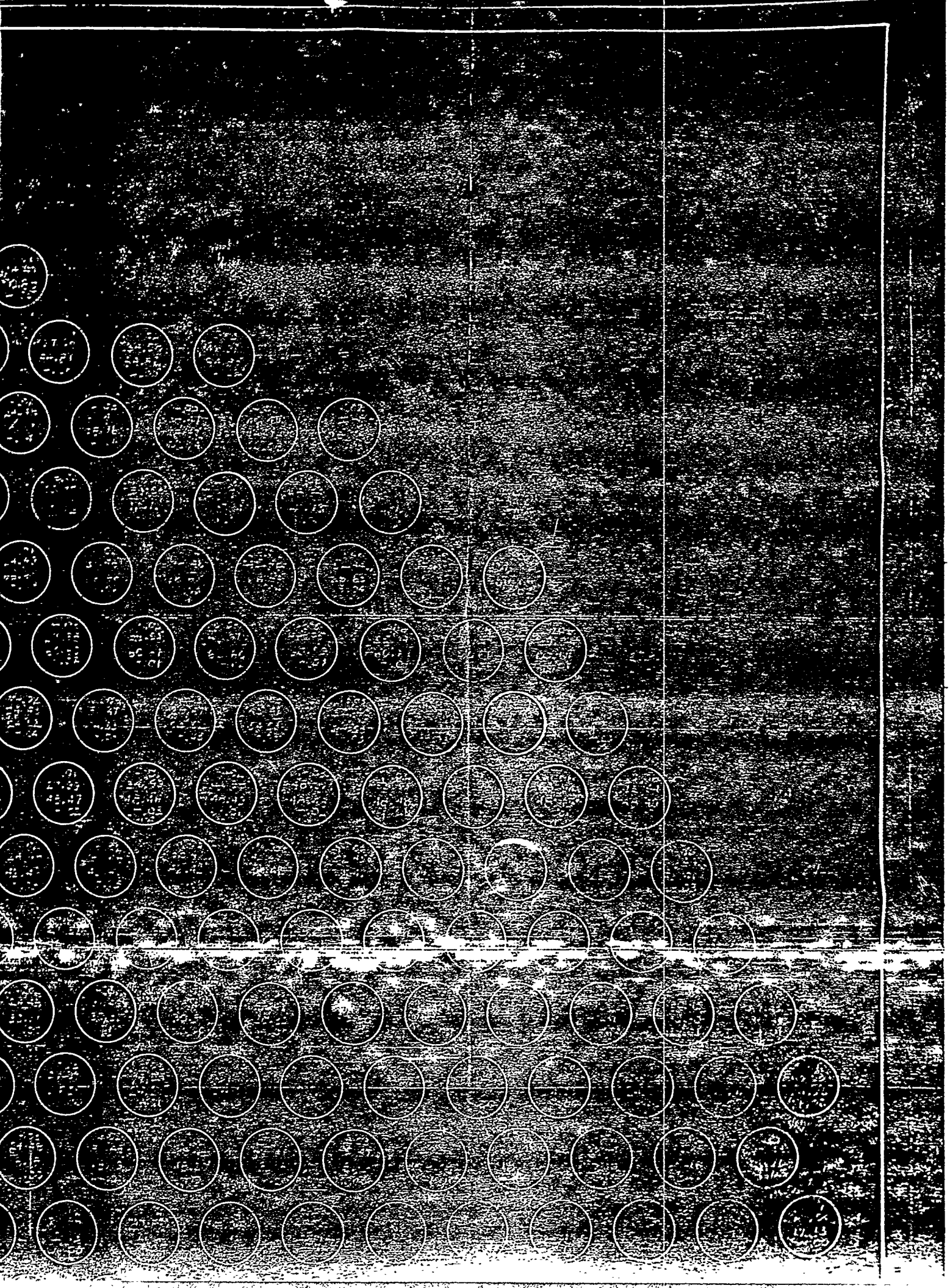
EXHIBIT #10

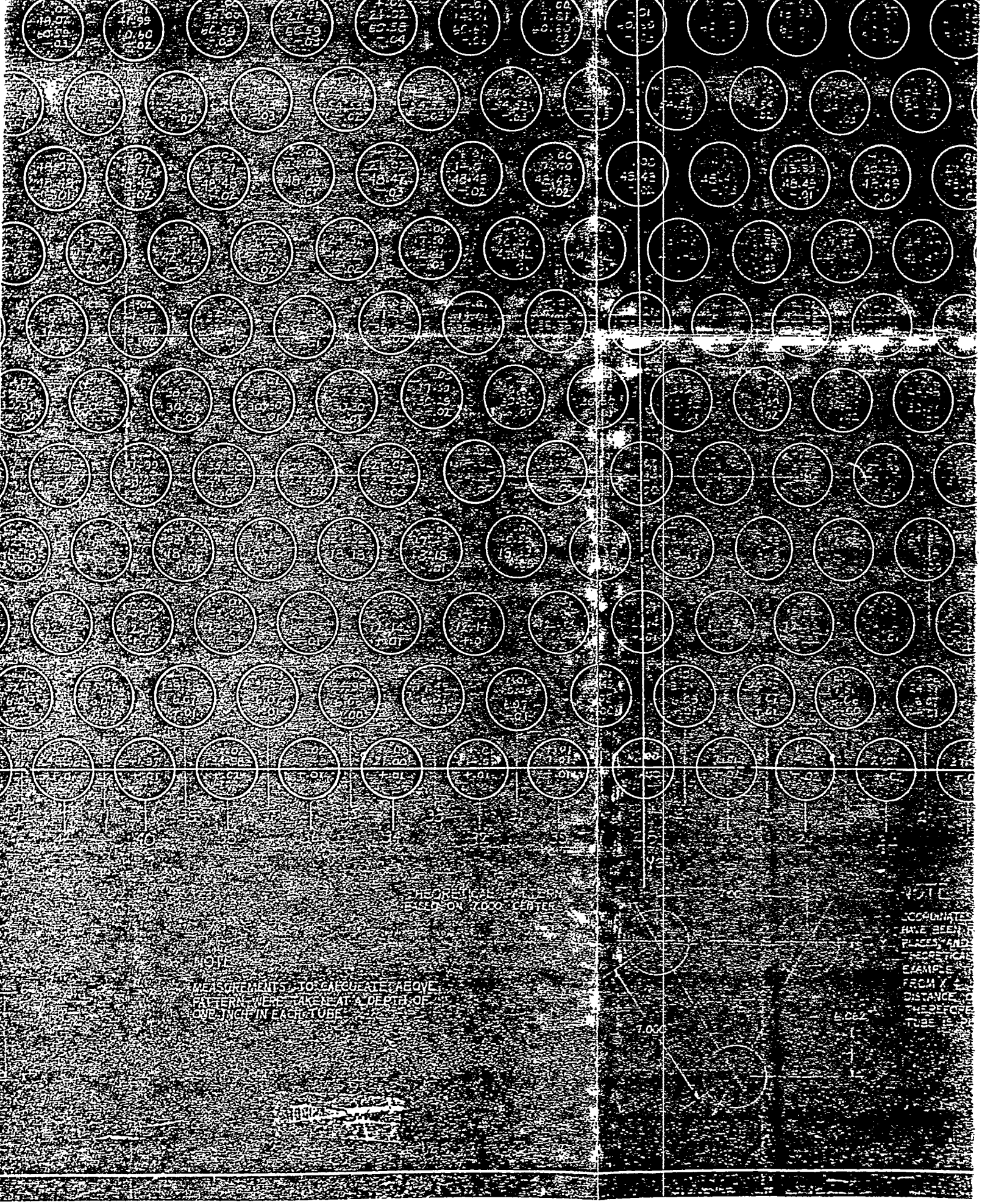
RESULTS OF PATTERN MEASUREMENTS TAKEN ON TOP SIDE OF THE

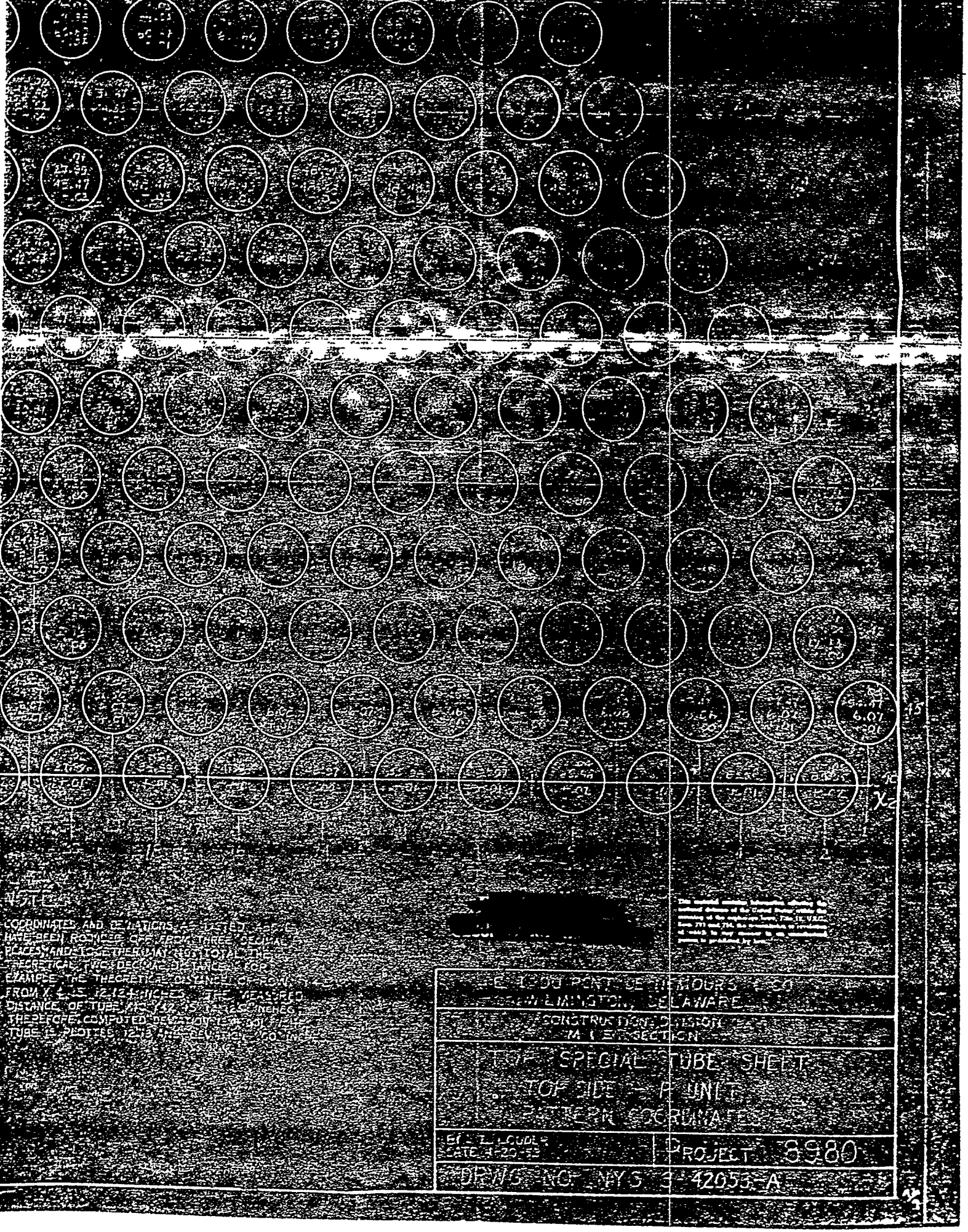
"P" TOP TUBE SHEET ASSEMBLY

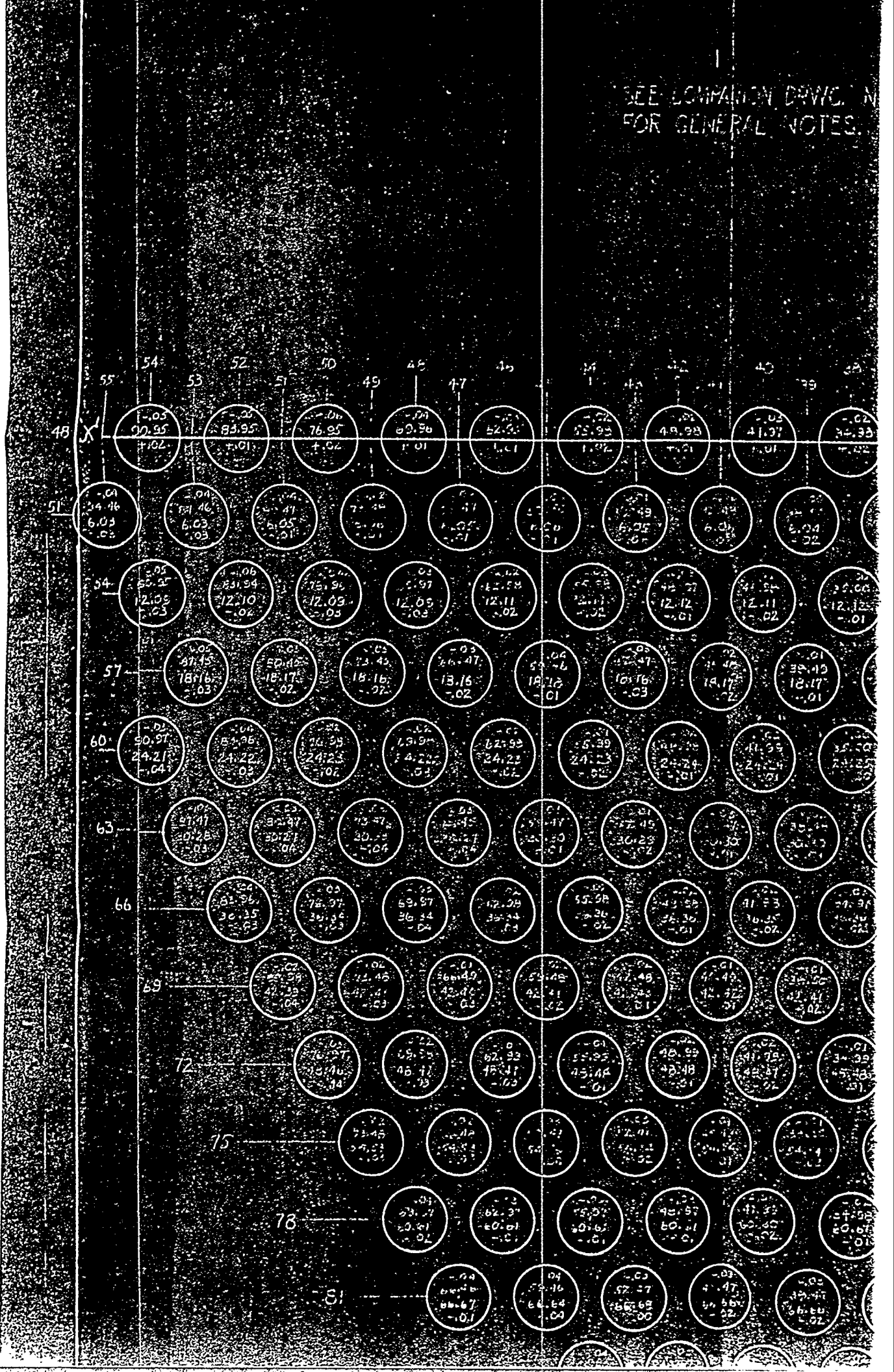


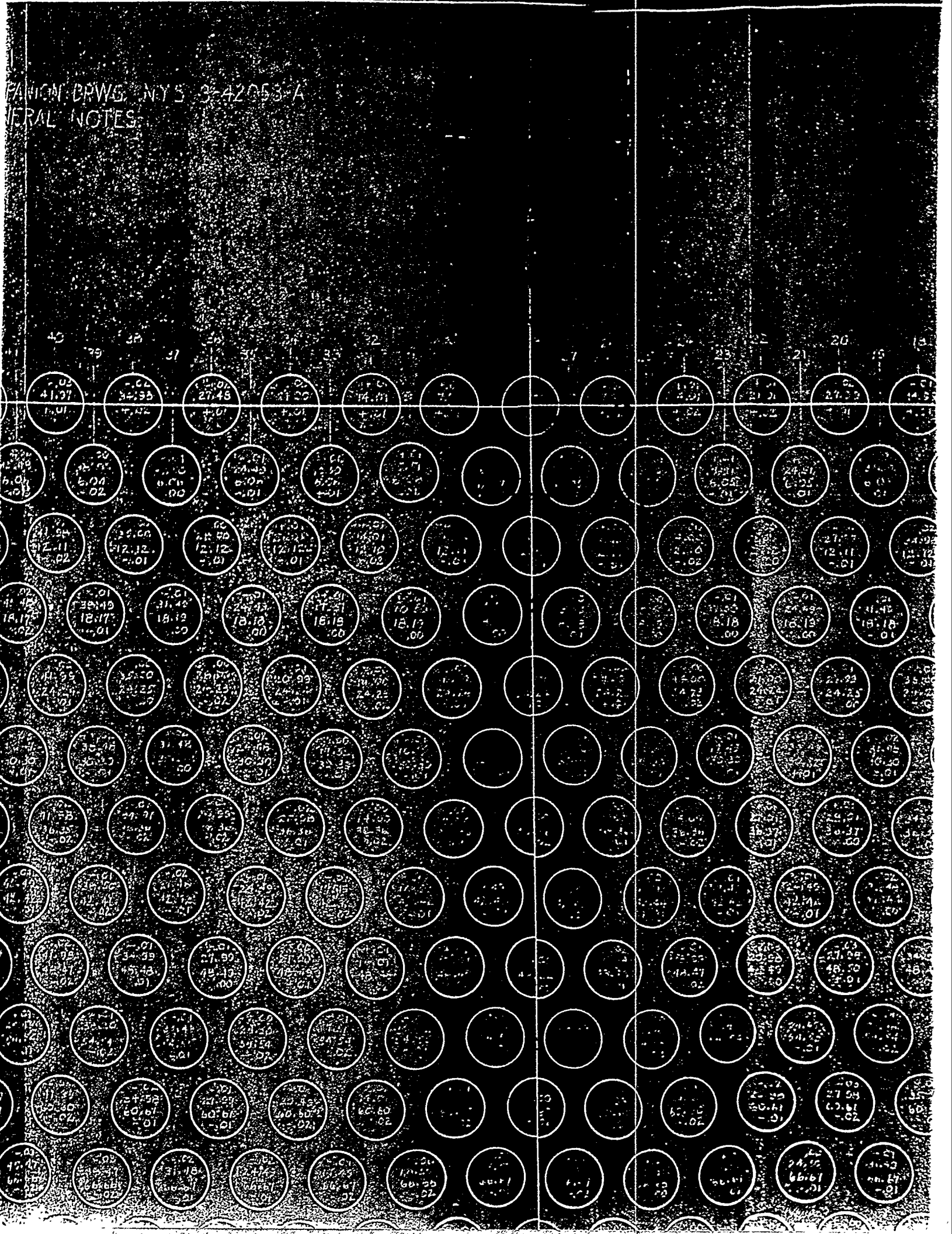

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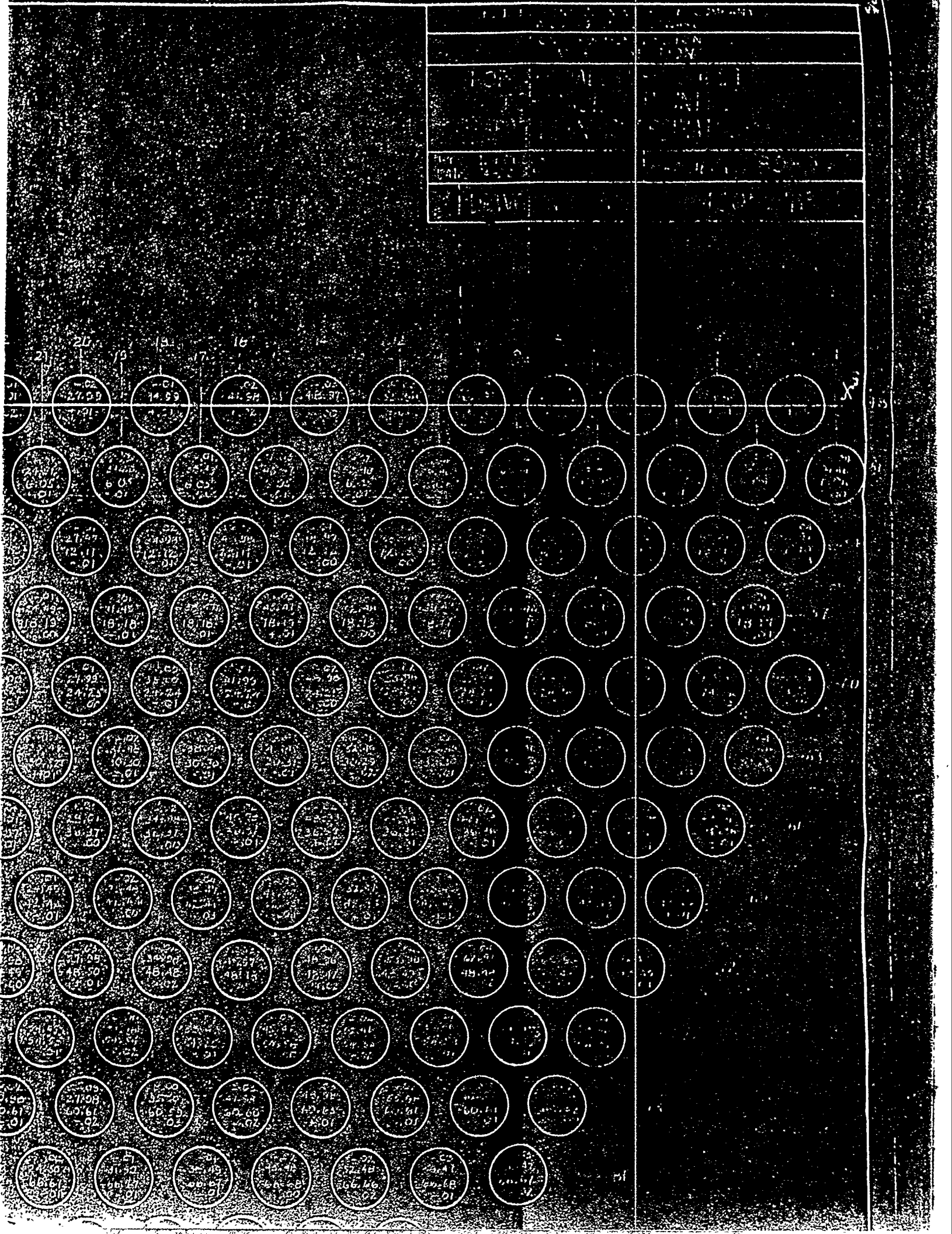


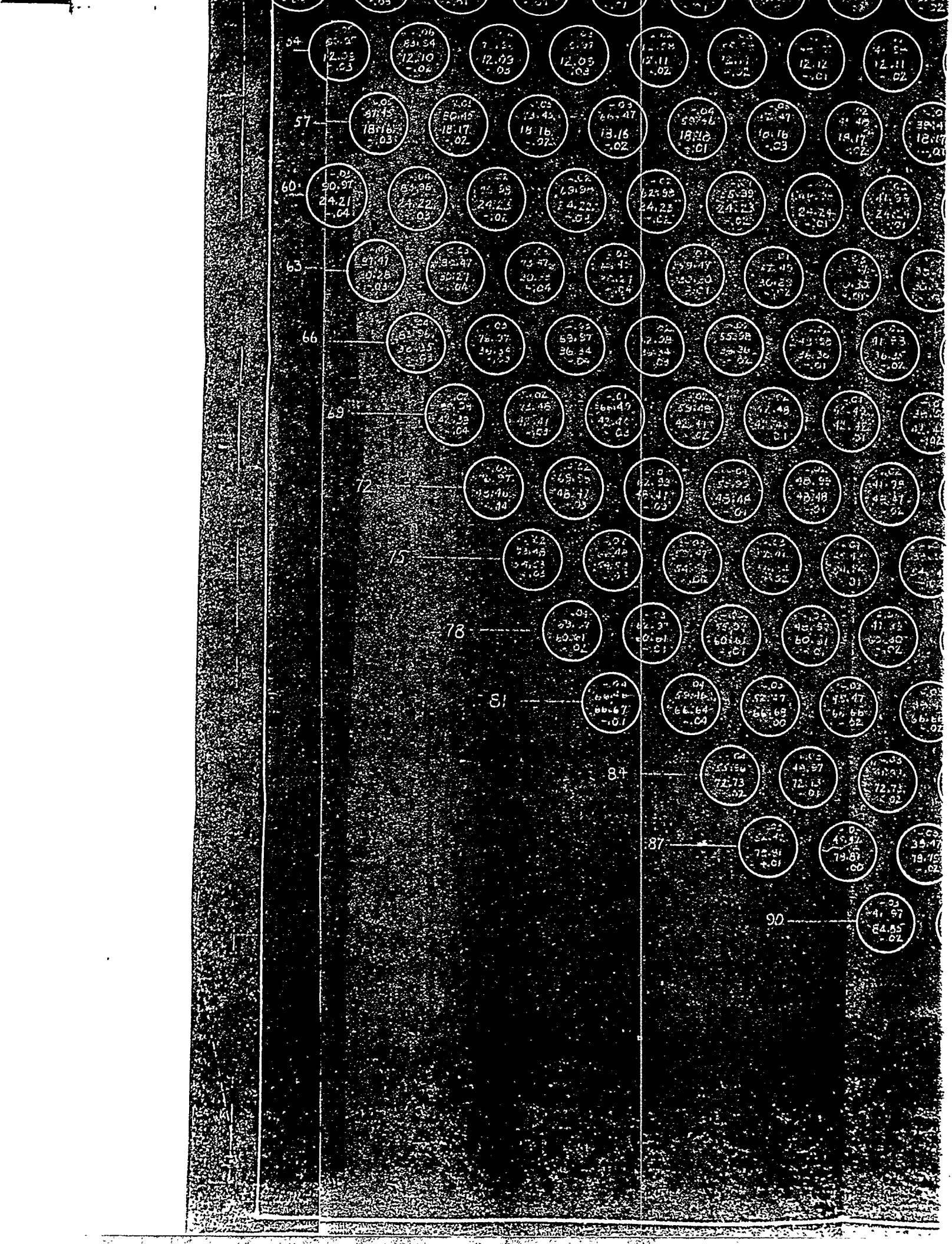

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NOTE
MEASUREMENTS TO CALCULATE ABOVE
PATTERN WERE TAKEN AT A DEPTH OF
ONE INCH IN EACH TUBE

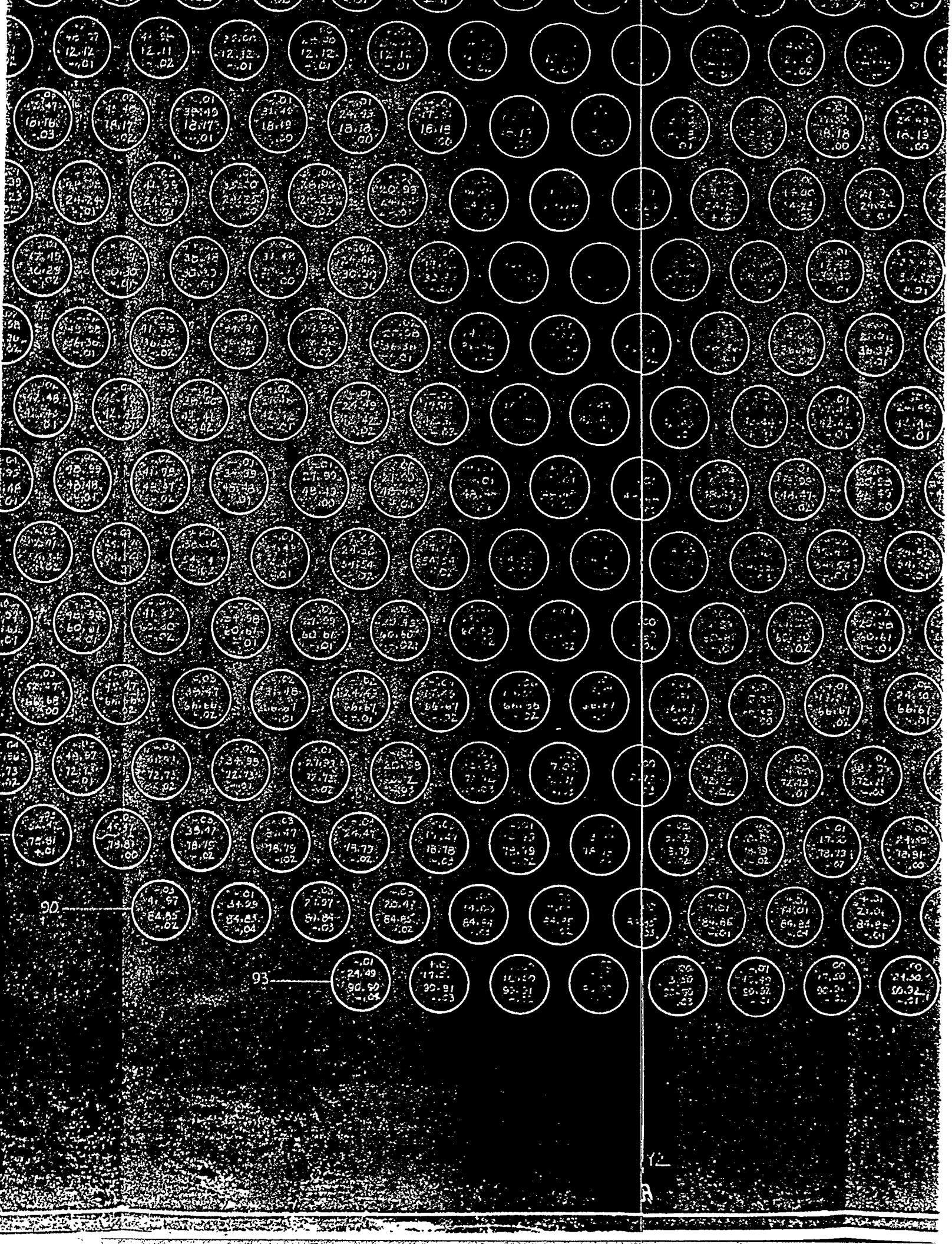

NOTE
COORDINATES AND DEVIATIONS ARE LISTED
HAVE BEEN ROUNDED OFF FROM THREE DECIMAL
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THEORETICAL THIRD DECIMAL FOR
EXAMPLE THE THEORETICAL DISTANCE
FROM Y TO S 12.12 INCHES THE MEASURED
DISTANCE OF TUBE M Y 12.15 INCHES
THEREFORE COMPUTED DEVIATION OF
TUBE IS PLOTTED 12.15 INCHES
E. I. DU PONT DE NEMOURS & CO.
WILMINGTON, DELAWARE
CONSTRUCTION DIVISION
M. E. SECTION
TOP SPECIAL TUBE SHEET
TOP SIDE P UNIT
PATTERN COORDINATES
BY T. L. LOUDER
DATE 4-20-53
PROJECT 8980
DWG. NO. NYS 3-42053-A


SEE CONFIGURATION DRWG. N
FOR GENERAL NOTES.
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PA NION DRWG. NYS 3-42053-A
ERAL NOTES:




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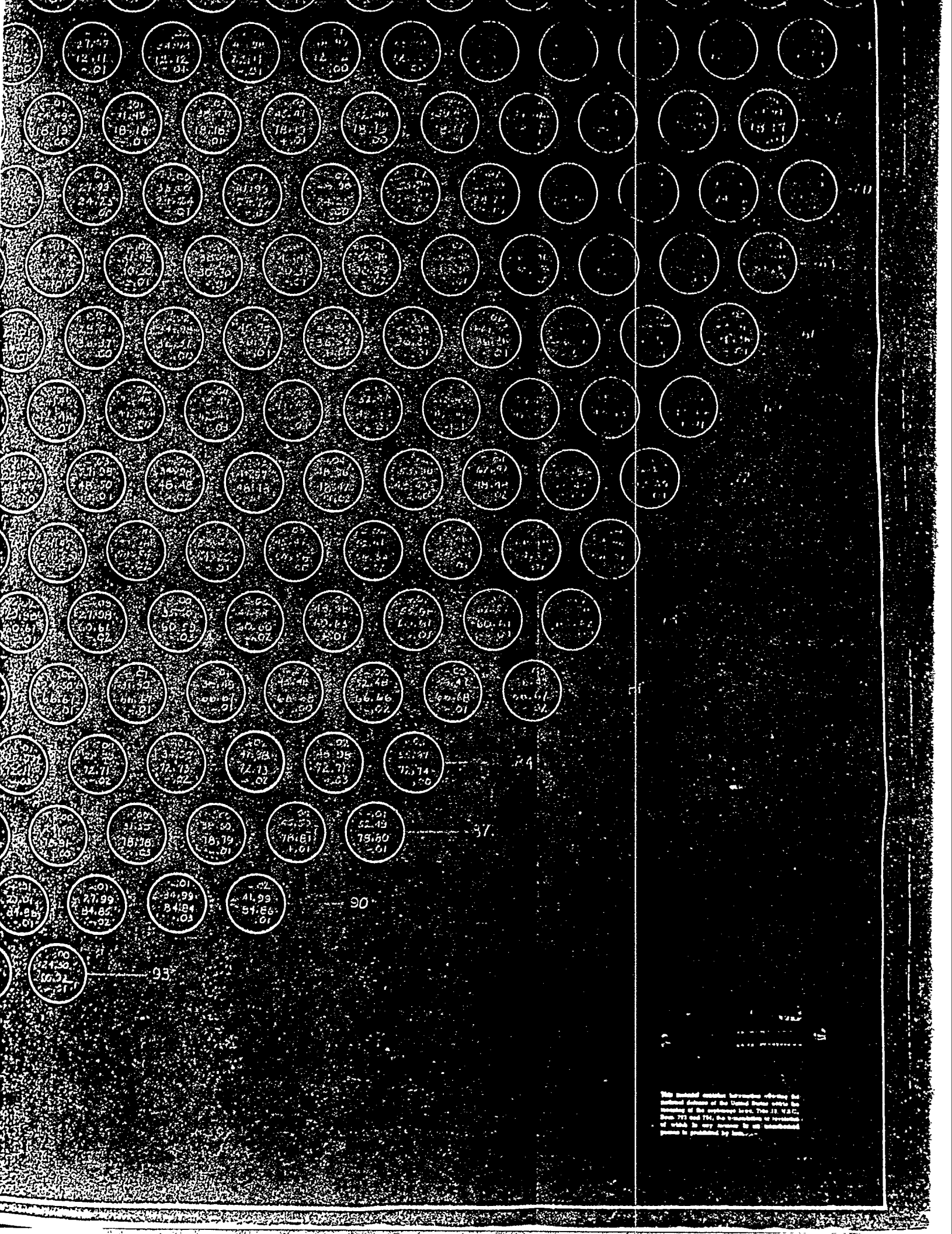

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EXHIBIT #11

RASCHIG RING LOADING OPERATION AND RESULTS

E. I. DU PONT DE NEMOURS & CO., INC.

Construction Division

Report Number 434-P

CC: H. W. Gosney, F.P.M.
R. K. Mason - D. A. Hauser-
Savannah River Plant (3)
R. K. Mason - E. M. Vass -SRP
H. L. Bunker - J. G. Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
J. B. Johnson - File

April 7, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM A. A. Conn DATE March 27, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Top Special Tube Sheet EQ.PC.NO. 154-P

DRAWING NOS. W-131365 R. 27 JOB RATING

VENDOR New York Shipbuilding Corporation LOCATION Camden, N. J.

Scope: Raschig ring loading.

Procedure: Unit was enclosed in loading cradle and lifted to vertical position on rolling bed. Unit was then filled thru 2 main loading ports in side. Ten tons were loaded and unit was rolled to an angle of 60° and then back past center to an angle of 60° or a total of 120°. This rolling was repeated 6 times. Ten tons were added 3 times and above process was duplicated after loading of each 10 tons. Then 5 tons were added for a total of 3 times and unit was rolled after each 5 tons as above. Then 2 tons were added 2 times and unit was rolled after each 2 tons. The unit was then nearly full, so it was hand filled with 1 ton thru both main loading ports and ports "A" & "B". The unit was rolled and filled again with 2 tons, 1200 lbs. Unit was then found to be as full as possible in this position. The main loading ports were closed and welded. The unit was taken down to a horizontal position and the cradle was removed. The loading ports "A" and "B" were opened, and rings were loaded in each port with an air gun until unit was filled. All ports were loaded in the above manner until all were full. Then the ports were closed and welded.

[redacted]

During the entire loading process, filler loading procedure dated January 8, 1952 was adhered to for cleanliness.

Results:

Load No.	Containers Added	Actual poundage at #390 per container
1	50 boxes	19,500
2	50 "	19,500
3	50 "	19,500
4	25 "	9,750
5	25 "	9,750
6	25 "	9,750
7	10 "	3,900
8	10 "	3,900
9	5 "	1,950
10	5 "	1,950
11	3 "	1,170
12	3 "	1,170
13	1 box	390
14	1/4 "	100
Total	262-1/4 boxes	#102,280

Total = 51 tons, 280 lbs.

lmw

EXHIBIT #12

MEASUREMENTS TAKEN ON INDEXING DEVICES AFTER WELDING

TO BOTTOM SIDE OF THE "P" TOP TUBE SHEET ASSEMBLY

E. I. DU PONT DE NEMOURS & CO., INC.

Report Number 477-P

Construction Division

CC: H. W. Gosney, F.P.M.
R. K. Mason - D. A. Hauser
Savannah River Plant (3)
R. K. Mason - E.M.Vass-SRP
H. L. Bunker - J. G. Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
J. B. Johnson - File

April 24, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

TO: C. J. VEITH - M & E FILE
R.E. Chaney, R. H. Potts, R.V. Graham

FROM: H. E. Dahlke, A. J. Piatek DATE: April 9, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Top Special Tube Sheet Indexing Devices EQ.PC.NO. 155-P

DRAWING NOS. W-131417 R. 15 D-110144 R.6 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Inspection performed 4/9/53

Scope:

To determine the maximum radial measurement from the center of the center tube to the outboard edge of the indexing devices. To measure the distance from the outboard edge of the indexing devices to the O.D. of the tube sheet. To measure the circumferential location of the indexing keys with reference to the l_2 axis.

Procedure:

Tools: S/S tape S-5757, ¼ which was compared to a calibrated tape and found to be ⁴.005" off 120" at 120°; a tape holding device and a surface block and a standard bore gage.

Method: The bore was measured in the 3 respective directions, the tape holder clamped on the tape such that the 12" mark coincided with the I.D. of the center tube. The outboard end of the tape was read on the edge of the surface block which was held tight to the outboard edge of the indexing device and tube sheet respectively.

The tape was used to measure from ℄ to ℄ of the indexing devices around the tube sheet and then from ℄ of indexing device to Y_2 axis for circumferential location.

Results:

See attached sheet.

These dimensions are considered acceptable. (No drawing tolerances are given.)

jmw
attach

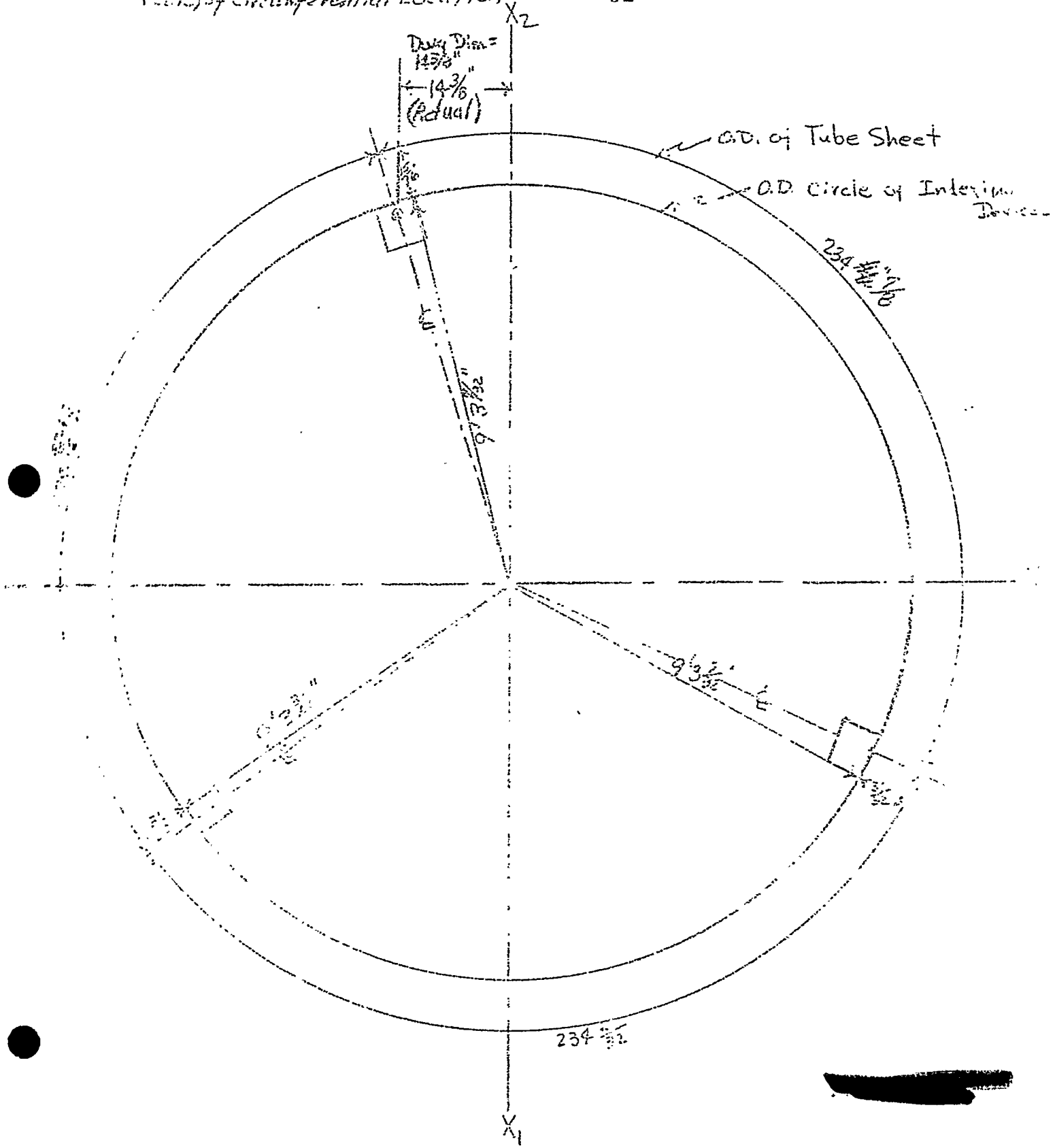
Report #477-D

Bottom Side 4-9-53

Radius & Circumferential Location Of Indexing Devices

Radius ( ) = 9'3 3/16"

Each Circumferential Location = 234 27/32" (on O.D. of Tube Sheet)



they were welded to the bottom side of the top tube sheet assembly. All inspections proved satisfactory and the unit was released for final freon and hydrostatic testing.

(46) Final Freon Test

The "P" top tube sheet assembly was freon tested in a similar manner to that described in Section 7A-(25) of this manual. The top side of the unit was tested first (from underneath) and no leaks were detected. The unit was turned over with the top side up and the bottom side was tested from underneath. During this test, a leak in rod tube weld X16-Y10 was detected. The defect was chipped out, re-welded, inspected and accepted. The unit was subjected to another freon test; no leaks were found and the unit was accepted and released for hydrostatic testing.

(47) Final Hydrostatic Testing

The "P" top tube sheet was hydrostatically tested in a similar manner to that described in Section 7B-(27) of this manual. (Hammer testing is omitted on final test.) No leaks were found and the unit was accepted as being water tight.

(48) Rod Tube Verticality Measurements

The unit was set up on cast iron pedestals (top side up) and leveled in a similar manner described in Section 7B-(42) for taking final rod tube verticalities.

After the unit was leveled, the verticality of all rod tubes were taken using a specially designed calibrated verticality gage which indicates the inclination with the vertical. Readings were recorded in .001 in./ft. For use of verticality gages for determining tube verticality, see Part III, Section II-L, Results of these measurements taken on the "P" top tube sheet assembly were similar to those presented as Exhibit #3 in Section 7A-(22) of this manual and were acceptable by the du Pont Inspection Department.

(49) Functional Gaging of Plenum Chamber and Top Tube Sheet After Filling Top Tube Sheet with Raschig Rings and Tube Repair.

The inspections performed and problems encountered during functional gaging of the plenum chamber and top tube sheet are covered in Part VII, Section I, item 16B-(26).

(50) Final Inspection of Unit and Shipping Gear Installation.

The "P" top tube sheet was removed from the functional gaging set up and suspended over a washing pit for cleaning the outside of the tube bundle. The unit was cleaned as follows:

a. 1% solution of sodium metasilicate was jetted on both top, bottom and wrapper plates.

b. A solution of detergent was jetted on both top, bottom and wrapper plates.
c. The entire unit was rinsed with distilled water.
d. Unit was partially wire brushed to remove traces of contamination on tubes and welding.
e. The entire unit was then acid washed.
f. A visual inspection was made after each of the above cleaning operations.

Results of the above cleaning indicated:

Bottom and wrapper plates satisfactorily cleaned and accepted. The top tube plate and tubes were found to be contaminated with oil and grease; however, re-cleaning was not done due to lack of time.

After the above cleaning operation was completed, wood plugs with an O-ring fitted to its diameter was inserted into the top and bottom end of all large tubes. These were similar in design to those shown in Sketch #38 in Part VII, Section I, item 15 thru 16. In addition, both ends of all rod tubes were plugged with rubber stoppers. A final visual inspection was made to determine if all tubes were "plugged". All inspections proved satisfactory. Then, New York Ship bolted an aluminum disc to each side of the large tube pattern to serve as a protective covering for the tube ends. Handling gear was installed; then, the unit was "pillow cased" with canvas and laced on the outer periphery and made ready for shipping.

The "P" top tube sheet was shipped by tug boat and barge from New York Ship on April 18, 1953, to the Savannah River Plant located in the state of South Carolina.

C. "L" Unit

(1) Gusset Plate Pre-Assembly Inspections:

The pre-assembly gusset plate inspections performed on the "L" top tube sheet were similar to those discussed in Part VII, Section III, item 7A-(1) for the "R" bottom tube sheet. Also, see Part II-B, Section 4A, photo serial number 129 and 130.

(2) Inspections Performed During Assembling of Gusset Plates Into Unit

These inspections were performed in a similar manner to those discussed in Part VII, Section III, item 7A-(2) for the "R" bottom tube sheet. For location of gusset plates (or web plates) see Dwg. 4-2 in Section 7A-(2) of this manual.

(3) Baffle Plate Spacers, Sandblasting, Acid Washing and Ferroxyl Testing

All of these inspections were performed in a similar manner

to that described in Part VII, Section III, Item 7A-3.

(4) Collar Inspections

Inspection of all type collars for the "L" top tube sheet assembly was performed in a similar manner to that described in Section 7A-(4) of this manual.

(5) Verticality Check After Placing Tube Sheets in Circumferented Handling Jig

The inspection was performed in a similar manner to that described in Part VII, Section I, item 7A-(1).

(6) Gusset Plate Welding Inspections

Inspections performed after gusset plates had been fully welded in the "L" top tube sheet were similar to those performed on the "R" bottom tube sheet discussed in Part VII, Section III, item 7A-(6).

(7) Rod Tube Assembly and Welding Inspections

After the tube sheets in the circumferential handling jig had been leveled and mated for best verticality and concurrent with gusset plate welding, pre-machined rod tubes were progressively cleaned with F.O. 128, inserted in the unit and tack welded to the inside of the tube plate.

Upon completion of assembling and tack welding all rod tubes in the unit, tack welding was visually inspected on the outside of the tube where it joined the tube to the inside of the tube plate for evidence of melt downs, under-cutting and other mechanical defects. Also, the I.D. of rod tubes (adjacent to tack weld on O.D.) was checked visually with the aid of a $\frac{1}{4}$" O.D. Lenox Borescope to determine if tack weld burned through tube. As a result of the above inspections, the following listed tubes were found to have weld burn through to I.D. of rod tubes. Icicles of weld were observed on the I.D. of tube adjacent to tack weld on O.D.:

Tube #	Tube #	Tube #	Tube #	Tube #
X16-Y10	X15-Y25	X19-Y31	X21-Y41	X36-46
X43-Y11	X13-Y29	X3-Y35	X46-Y40	X48-50
X28-Y20	X24-Y28	X14-Y34	X49-Y41	X45-49
X39-Y19	X27-Y29	X28-Y34	X44-Y44	X20-50
X20-Y22	X38-Y28	X42-Y34	X41-Y43	X12-52
X23-Y23	X41-Y29	X45-Y35	X16-Y44	X26-52
X34-Y22	X47-Y31	X40-Y38	X13-Y43	X43-53
X37-Y23	X36-Y32	X26-Y38	X8-Y46	X49-55
X43-Y25	X33-Y31	X23-Y37	X11-Y47	X10-56

Tube #	Tube #	Tube #	Tube #
X7-Y55	X46-68	X33-Y73	X21-83
X44-Y58	X32-68	X22-Y74	X32-82
X42-Y62	X18-68	X14-Y76	X35-83
X45-Y62	X15-67	X17-Y71	X44-86
X11-Y61	X10-70	X28-Y75	X30-86
X9-Y65	X13-71	X31-Y77	X27-85
X34-Y64	X27-71	X37-Y72	X18-86
X37-Y65	X38-70	X26-Y80	X20-92
X48-Y64	X36-74	X23-Y79	X34-92
			X29,95

X39-Y5 - Burn through and small hole
X26-Y10 - Burn through
X29-Y11 - Burn through and crack
X35-Y13 - Burn through and small hole
X24-Y14 - Burn through
X21-Y13 - Burn through
X42-Y20 - Burn through and small hole
X32-Y26 - Burn through and crack and hole
X29-Y25 - Burn through and crack
X18-Y26 - Burn through
X31-Y35 - Burn through
X9-Y37 - Burn through

Based on the above findings, the du Pont Inspection Department requested that these tubes be cut out of the "L" top tube sheet and replaced with new ones. New York Ship complied with this request and removed the above listed tubes and replaced them with new ones which were dimensionally inspected and accepted prior to assembling and tack welding them into the unit.

All rod tube tack welds were again checked in a similar manner described above and no defects were found. The unit was then released to New York Ship for fully welding of the rod tubes.

Tubes were fully welded using three Aircomatic tube welders working 120° apart. Tubes were welded in accordance with a sequence set up for keeping distortion to a minimum and unit turned as required to balance welding. Refer to Part VII, Section I, item 7A-(2)a for rod tube welding sequence.

After the rod tubes had been fully welded, the rod tube fillet welds were visually inspected with the aid of a flashlight for cracks, porosity, undercutting and other mechanical defects. Nearly all defects of this nature were removed by grinding. Major defects, such as large cracks or lack of fusion, were repaired by chipping and re-welding using manual Aircomatic welding machines. All spot welding repairs were ground and then re-inspected and accepted.

The 5.005" trepanned holes in the vicinity of the rod tubes were distorted due to rod tube welding and hence would not pass top tube sheet straight tubes. Portable drill presses were set up and all distorted holes were again reamed to original size.

(8) Preliminary Cleaning Prior to Assembling Large Tubes

The unit was placed in a washing pit in an up-right position (slightly inclined to provide drainage) and preparations were made to internally clean the unit to remove dirt, oil, chips and other material that had collected in the unit during fabrication.

Internal cleaning was done by steam jetting all interior surfaces, particularly between the bottom inside tube plate and baffle plate, until all chips, dirt, oil, etc., had been removed. After this, the entire assembly was jetted with high pressure water as a final rinse. The unit was inspected internally and externally and accepted by the du Pont Inspection Department for assembling of large tubes.

(9) Large Tube Assembly

Starting in the center of the unit and working out, pre-inspected large tubes were progressively cleaned with F.O. 128, inserted into the unit from the bottom side (bottom side up) and tack welded to the inside of the top tube plate.

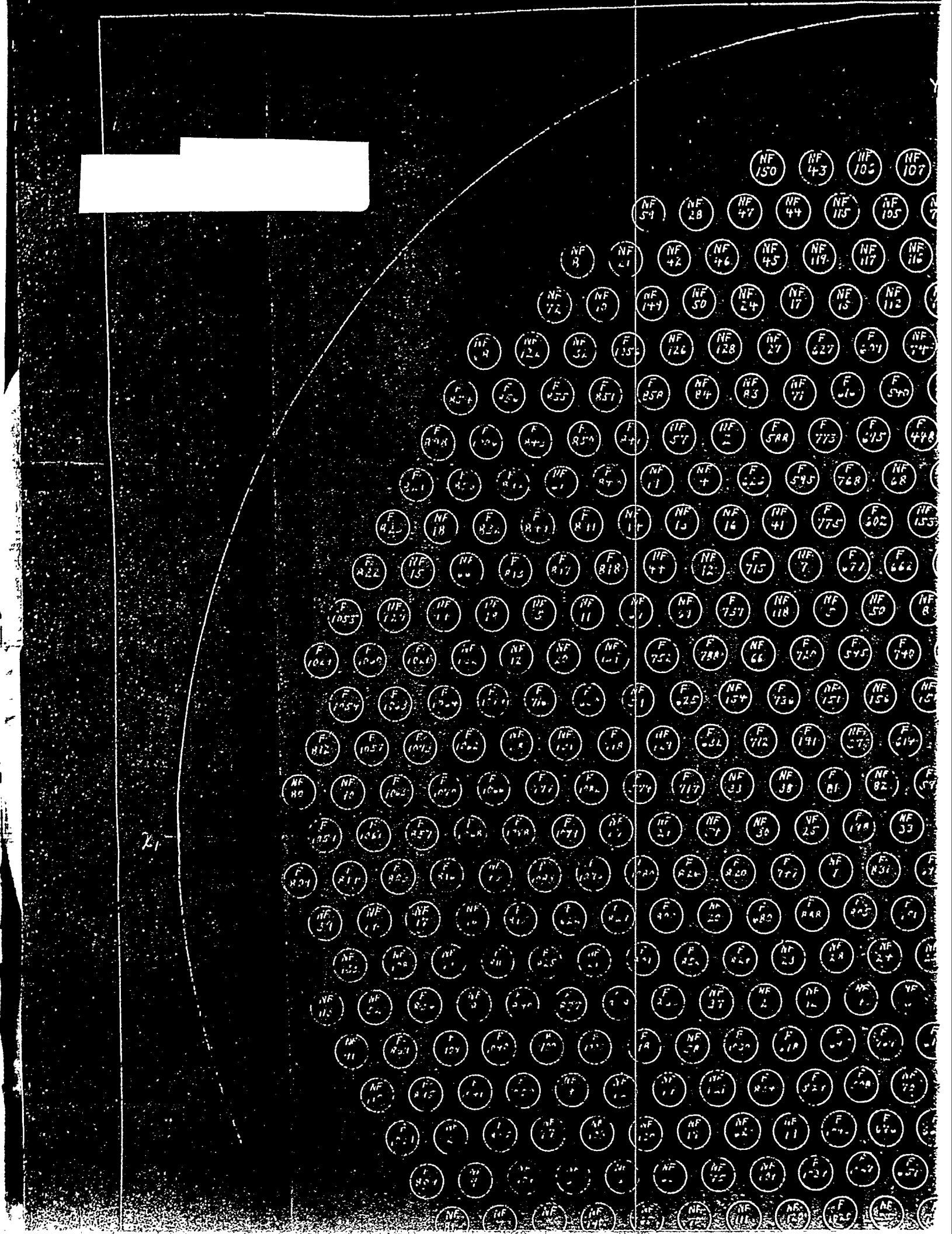
During the tube assembling operation, du Pont inspectors recorded the location of all tubes and type. Large tubes were identified by a serial number stenciled near one of the tube ends. Prior to assembling of tubes into this unit, dimensional inspections performed on the tubes were recorded for each using this numbering system, thereby tying in tubes welded in the unit with their pre-assembly inspection measurements. All of the 673 tubes assembled into this unit were type 304 seamless. For location of seamless tubes in the "L" top tube sheet, see Exhibit #13 presented herewith.

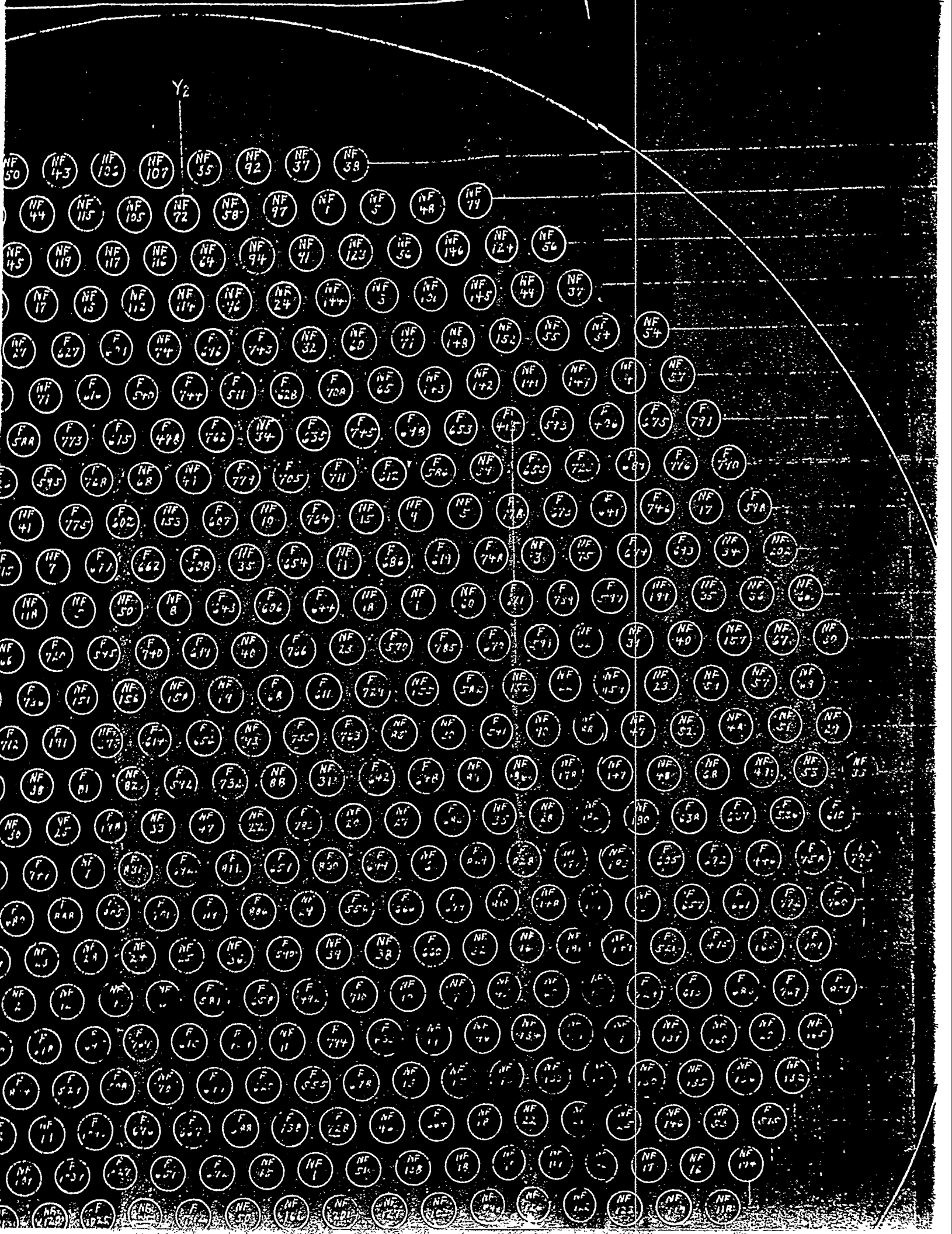
Three large tube holes in the top plate were trepanned 5¼" I.D. instead of 5". In order for the three straight tubes to be welded in these holes (X32-Y48, X33-Y51 and X34-Y54), it was necessary for New York Ship to build up with weld bead on the O.D. for a minimum length of 2" and of thickness sufficient to permit machining to 5½" O.D. After turning the O.D. to size and reaming the weld neck on the I.D., the built up area on each tube was X-rayed. Each tube was hydrostatically tested at 1000 psi. for ten minutes and then dimensionally checked and accepted for welding into the top tube sheet assembly. Exhibit #14 presented herewith covers all inspections made on the three modified tubes and results.

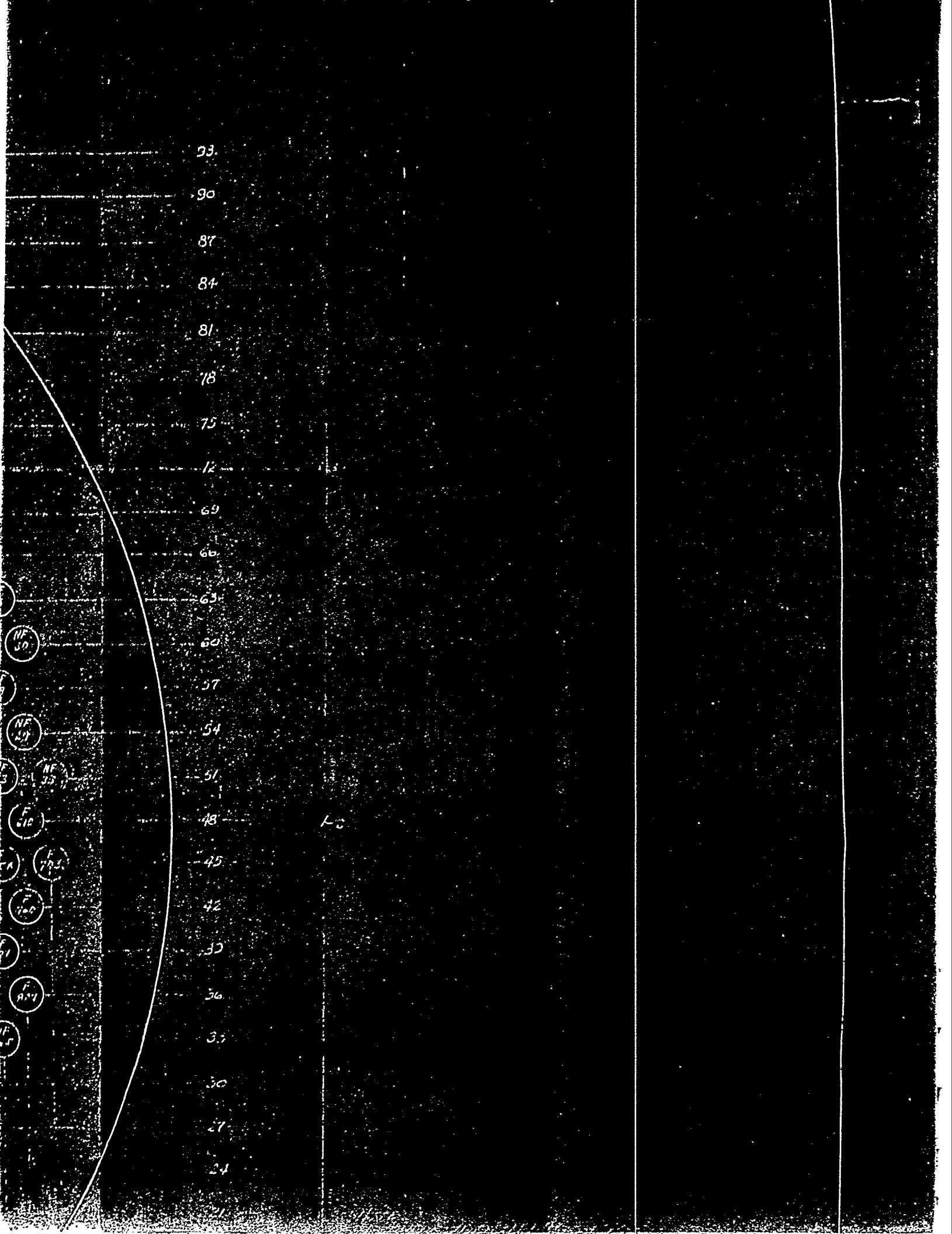
EXHIBIT #13

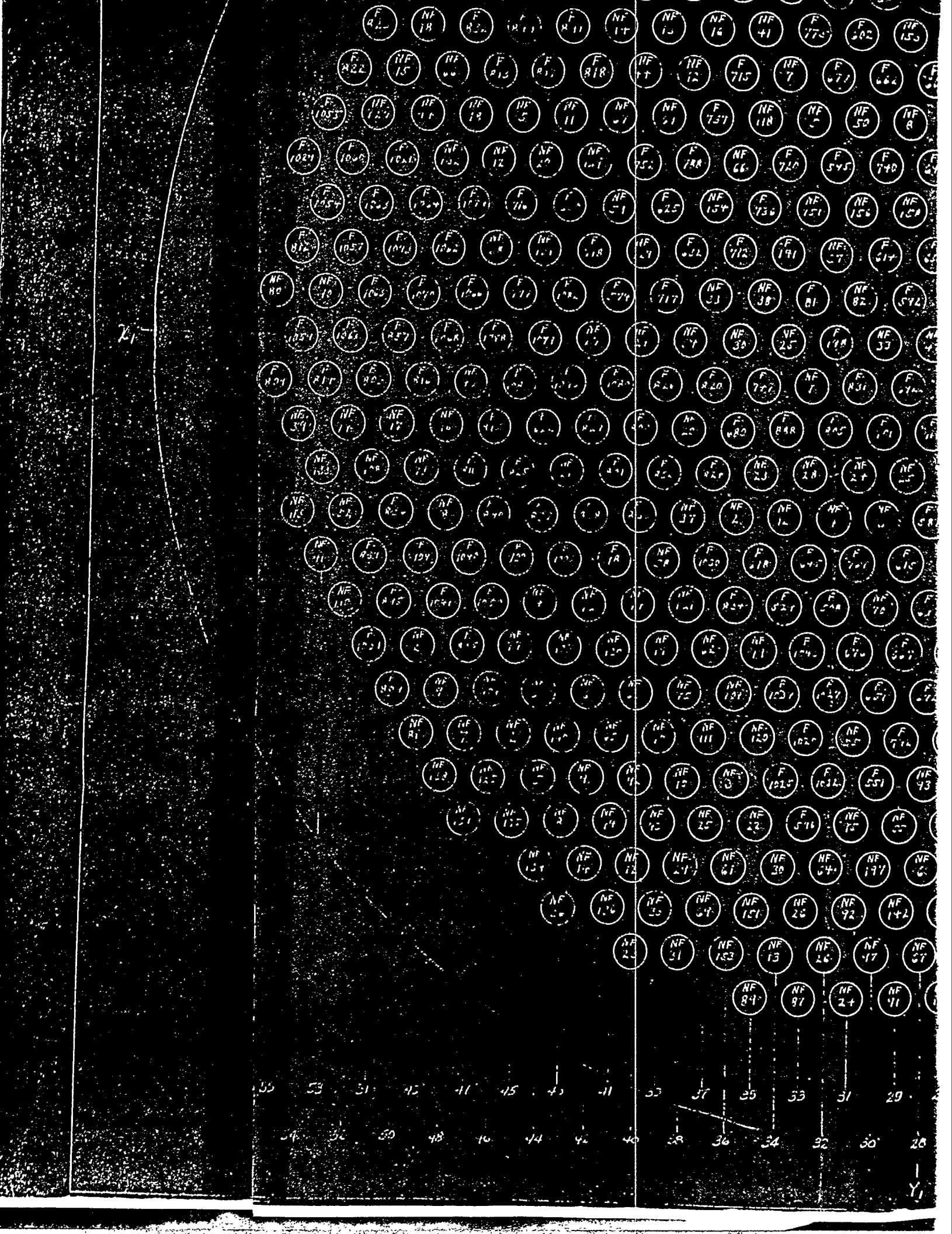
LOCATION OF SEAMLESS TUBES IN THE "L" TOP

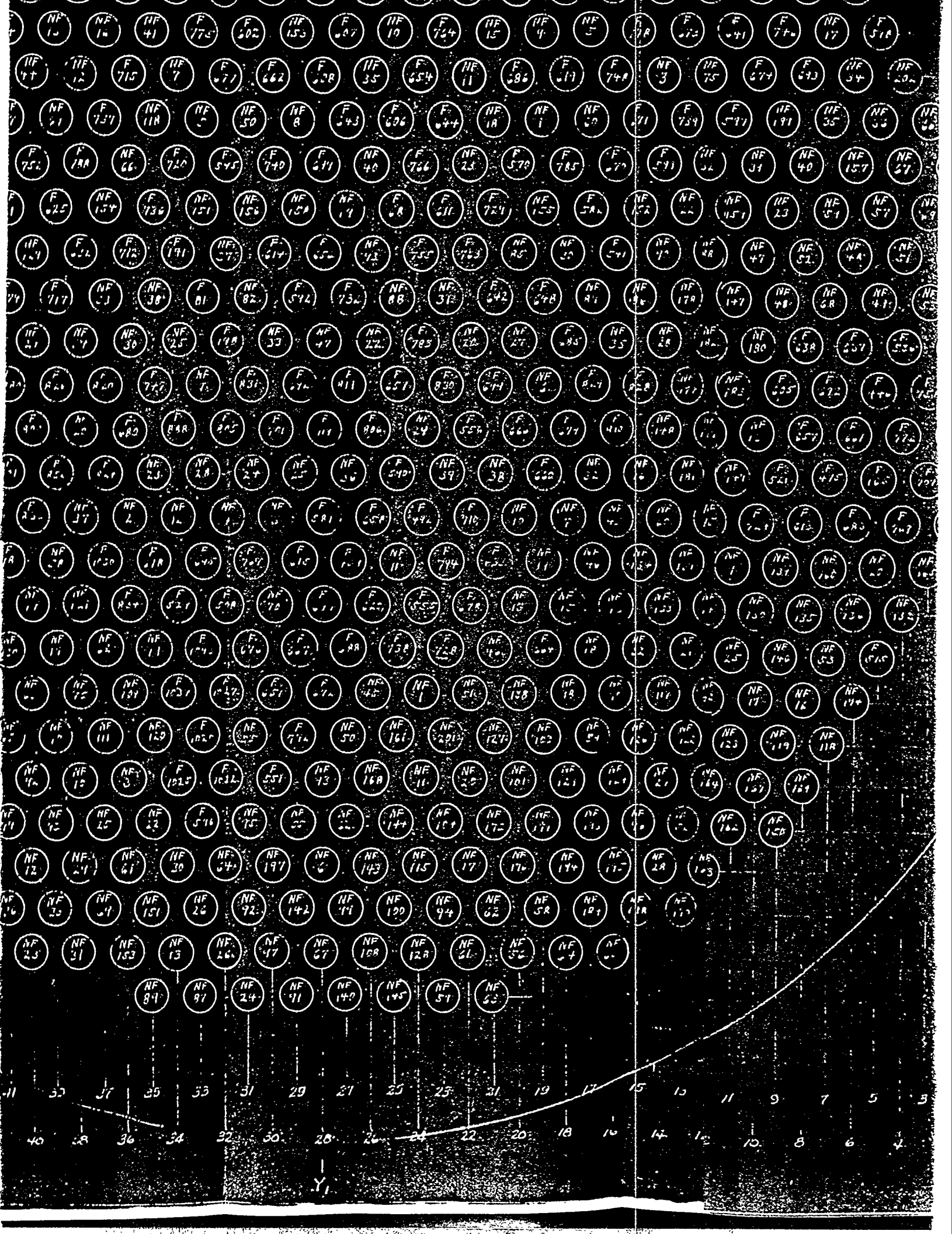
TUBE SHEET ASSEMBLY




Y_2


93
90
87
84
81
78
75
72
69
66
63
60
57
54
51
48
45
42
39
36
33
30
27
24
NF 30
NF 27
NF 33
F 210
F 180
F 150
F 120
F 90
F 60
F 30
L.E.





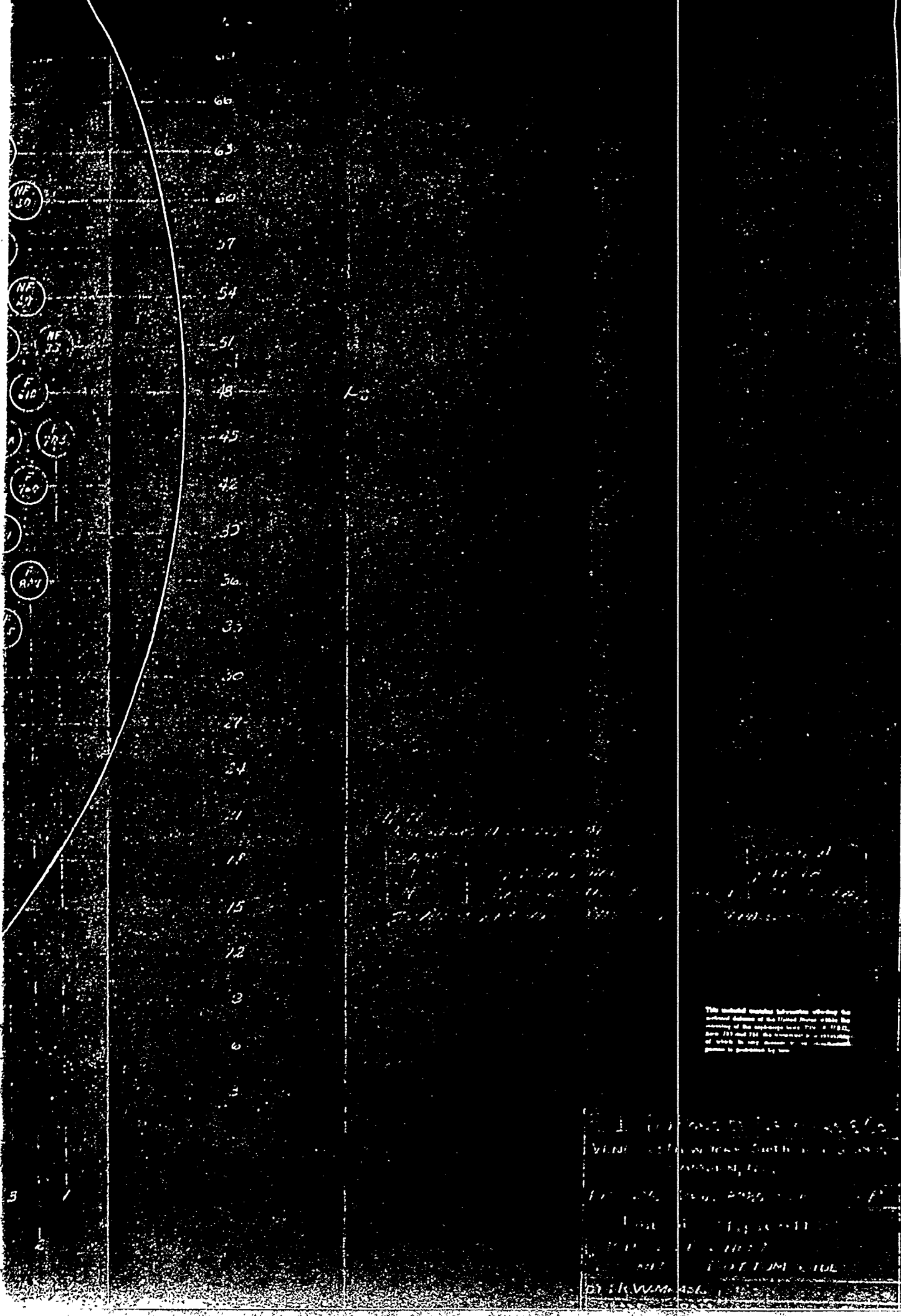

66
63
60
57
54
51
48
45
42
39
36
33
30
27
24
21
18
15
12
9
6
3
NF 30
NF 27
NF 24
F 18
F 15
F 12
F 9
F 6

EXHIBIT #14

RESULTS OF INSPECTIONS PERFORMED ON THESE ROLLED

TOP TUBE SHEET STRAIGHT TUBES

E. I. DU PONT DE NEMOURS & CO., INC.

Construction Division

[redacted]

Report Number 220-L

CC: C. E. Buckley, F.P.M.
R. K. Mason, F.P.M.-SRP (3)
H. L. Bunker - J. G. Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
R. H. Potts (2)
C. W. Dunn - File

September 9, 1952
New York Ship - Camden, N. J.

102

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM D. M. Leland DATE August 22, 1952

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Special Pre-machined Top Tube Sheet Tubes EQ.PC.NO. 154-L

DRAWING NOS. Detail 112765 JOB RATING

VENDOR New York Shipbuilding Corporation LOCATION Camden, N. J.

Scope: Inspection of three (3) special tubes which are to be used in "L" unit top tube sheet in top plate tube holes trepanned ¼" oversize.

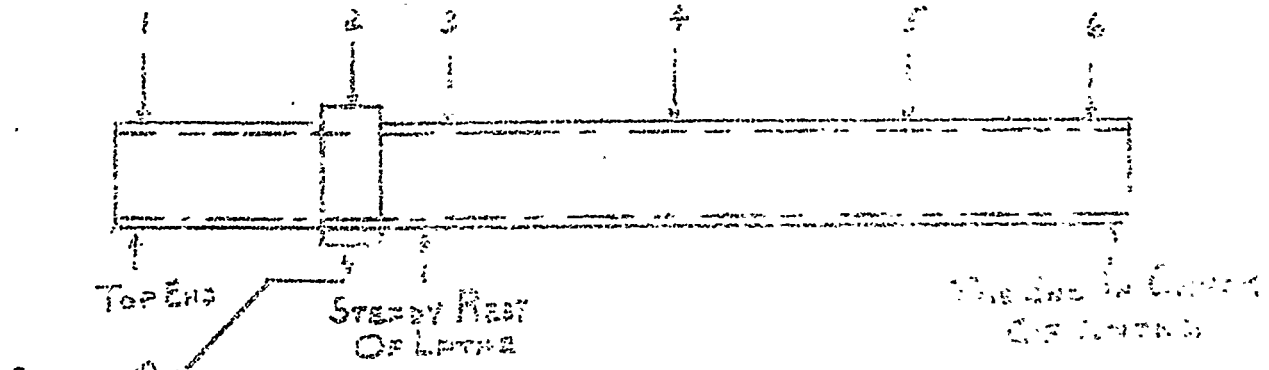
Procedure: These tubes, National Forge numbers 81S, 190S and 191S, were reworked by New York Shipbuilding Corporation by building up a collar of solid weld and then machining this collar to the proper dimensions to fit oversize holes in top plate. After machining, tubes were X-Rayed and hydrostatically tested at 1000 psi for 10 minutes.

Results: See attached sketch.

lmw
Attach.

[redacted]

CAMBER



Tube Number	1	2	3	4	5	6
NF 815	.224"	.002"	.004"	.005"	.005"	.005"
NF 1965	.228"	.004"	.004"	.005"	.002"	.002"
NF 1915	.002"	.0015	.001"	.0025	.0015	.0010

Above Readings Taken With Starrett Indicator

Tube Number	[illegible]	Hydrostatic Test	Cut [illegible] Required	[illegible]
NF 815	[illegible]	OK	[illegible]	[illegible]
NF 1965	OK	OK	[illegible]	[illegible]
NF 1913	OK	OK	[illegible]	[illegible]

During the process of assembling and tack welding large tubes into the "L" top tube sheet, all tack welds were inspected visually and with the aid of a borescope for purposes of determining:

(a) Undercuts of tube wall
(b) Melt down - parent metal and weld metal
(c) Burn throughs - an actual hole thru tube wall

After 212 tubes had been assembled and tack welded in the unit, du Pont inspectors discovered ten tubes having holes burned in the outside tube wall - a result of poor welding technique.

As a result of the above discovery, a back check was executed following the procedure previously outlined above. Those tubes where tack welds could not be observed either visually or with the aid of a borescope were removed from the assembly as a precautionary measure. On the completion of the back check, 88 large tubes were removed. Of the 88 removed, 77 were found to be defective. The remaining 11 tubes (removed in order that all tack welds could be observed) were not defective and were re-assembled in the unit.

The 77 defective tubes removed from the unit were repaired in the following manner, accepted and re-assembled into the unit:

(a) Defects hand ground and tube cleaned before welding.
(b) Defects heli-arc welded.
(c) Excess weld removed by hand grinding.
(d) X-rayed
(e) Hydrostatically tested at 2000 psig. with pressure held for 10 minutes.
(f) Tubes were put back in "L" top tube sheet with identification number on same end as other tubes; however, the tube was rotated such that repaired tack did not fall on same position as when original tack weld was made.

The remainder of tubes were assembled into the unit, tack welded, inspected as previously described and found satisfactory.

(10) Instrument Well Inspections

As shown on du Pont drawing D-110272, three instrument wells were required for the "L" top tube sheet assembly. After fabricating, each well was dimensionally inspected and found within drawing tolerance.

Prior to assembling and welding the three instrument wells into the top tube sheet, each well was freon tested and hydrostatically tested. For freon testing, each well was coupled to a bottle of freon and tested at bottle pressure (which was approximately 100 psi.) for possible leaks. All butt welded joints were checked for leaks using a G.E. Type "H" leak detector. No leaks were found.

Next, each well was filled with water and hydrostatically tested at 2000 psig. for ten minutes. No leaks were found and the instrument wells were accepted for assembling and welding in the top tube sheet assembly.

Instrument wells were assembled and welded in the top tube sheet during large tube assembly operations. After welding wells in the unit, each well was visually inspected on the I.D. with the aid of a ¼" borescope for percent of weld penetration. Results of this inspection are covered in Exhibit #15 presented herewith.

(11) Measurements Before Large Tube Welding to Determine Unit Shrinkage

After all large tubes had been inserted into the unit, aligned and tack welded, initial shrink measurements were taken across three major diameters. Part II-A, Section 5-c, describes the method incorporated to take these measurements. Results of these measurements before welding large tubes and after welding rod tubes was as follows:

182.518" - Average top side measurement before welding
182.542" - Average bottom side measurement before welding

(12) Measurements After All Tubes Had Been Welded

All large tubes were welded in the unit using the same procedure discussed in Part II-A, Section 5-d.

After all large tube welding was completed, measurements were again taken using the procedure discussed in Part VII, Section I, item 7A-(2)a(1). Results of these measurements for the top and bottom sides after all tube welding was as follows:

181.977" - Top Side
182.035" - Bottom Side

After all tube welding on the plenum chamber and the top tube sheet assemblies was completed, the top and bottom diametral measurements on both were analyzed to determine whether or not all results were within ± 1/32", and if additional shrink welding on either of the units was necessary to bring them within this tolerance. Shrinkage was analyzed in the following manner for the "L" Unit.

"L" P.C.		"L" T.T.S.	
Measurements after all tube welding		Measurements after all tube welding	
182.049"	Top Side	181.977"	Top Side
181.948"	Bot. Side	182.035"	Bot. Side
0.101"	Diff.	0.058"	Diff.

EXHIBIT #15

VISUAL INSPECTION OF THREE INSTRUMENT WELLS

FOR WELD PENETRATION

E. I. DU PONT DE NEMOURS & CO., INC.

Report Number 551-L

[redacted] ction Division

CC: J. B. Johnson
R. K. Mason-D.A. Hauser-SRP (3)
R. K. Mason-W.P. Duncan-SRP
H. L. Bunker - J. G. Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
R. V. Graham - File

August 4, 1953
New York Ship - Camden, N. J.

1282

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM J. Ray Stewart DATE April 1, 1953

PROJECT NO. 8980 - PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Instrument Wells in "L" Top Tube Sheet EQ.PC.NO. 154-L

DRAWING NOS. W-133143 - W-133146 D-110272-A Rev. 0 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Scope: Visual inspection of three instrument wells for weld penetration.

Procedure: Each of the three thermocouple wells was visually inspected on the I.D. for weld penetration at two butt welded joints and for weld melt through at brackets located 6" from the bottom end of the well. One butt welded joint was located 3" from the top of the thermocouple well and the other 3" from the bottom end.

A 1/4" borescope was used to determine the degree of weld penetration. This inspection was performed on the "L" top tube sheet with thermocouple wells (3) welded in the top side of the subject unit.

Results: See attached sheet.

Note: These wells were successfully freon and hydrostatically tested prior to installation. Refer to report number 270-L.

Results:

Thermocouple Well number	Condition of weld on I.D. located 3" from top end of thermo. well.	Condition of weld on I.D. located 3" from bottom end of thermo. well.	Condition of I.D. located 6" from bottom end of thermo. well. Brackets welded to O.D. at this location
1	100% penetration on 80% of circumferential weld	100% penetration for 6% of circumferential weld	Melt through around entire circumference
2	100% penetration on 100% of circumferential weld	Could not see (borescope was binding on well I.D. indicating run out on I.D. Probably curved at this location making it impossible to view with 1/4" borescope	Melt through around entire circumference
3	100% penetration on 100% of circumferential weld	100% penetration on 80% of circumferential weld	Melt through around entire circumference

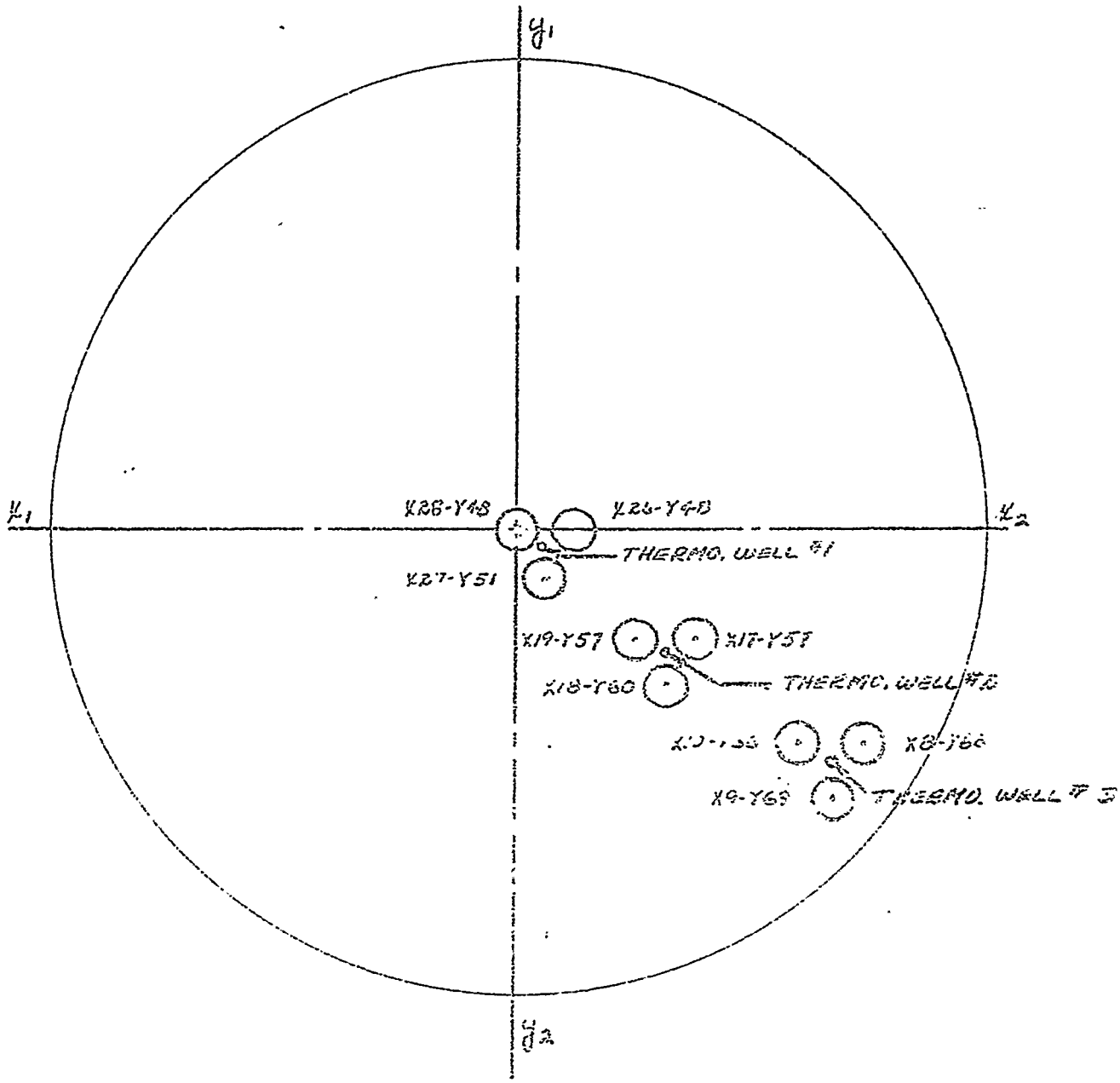
Note: For locations of three thermocouple wells see attached sketch.

lmw
attach.

SKETCH:

Report # 551-L

LOCATION OF THERMOCOUPLE WELLS
TOP TUBE SHEET "L" UNIT - TOP SIDE



* Of the four diametral measurements, this figure was the smallest. All plates must be shrunk within + 1/32" of this plate.

Both sides of the plenum chamber and top tube sheet were shrunk weld in a similar manner described in Part VII, Section I, item 7B-(2). After this, a comparison was made between the top and bottom side measurements on the plenum chamber and top tube sheet with results as follows:

"L" P.C.		"L" T.T.S.	
181.958"	Top Side	181.944"	Top Side
181.980"	Bot. Side	181.960"	Bot. Side
0.022"	Diff.	0.016"	Diff.

All of the above final diametral measurements were reported to the Design Division for their comments. Design accepted these figures as being satisfactory.

(13) Visual Inspection and Repair of Large Tube and Rod Tube Welding

This inspection was performed in a similar manner to that described in Section 7B-(12) of this manual.

(14) Unit Cleanliness Inspection

An intermediate cleanliness inspection was performed on the unit before fabrication continued. Rags, metal chips, wood and other foreign material was removed by air jetting. After the unit was cleaned and visually inspected, it was accepted and released for further fabrication.

(15) Machining Wrapper Plate Weld Preparation and Gusset Plate Milling

This operation was performed in a similar manner to that described in Part VII, Section III, Item 8A.

(16) Fitting End Stiffeners to Gusset Plates and Assembling of Inlet and Outlet Cups

Inspection of fitting and welding end stiffeners and assembling of inlet and outlet cups was performed in a similar manner to that described in Part VII, Section III, Item 9A.

(17) Inspection of Spiral Core and Inlet and Outlet Tubes

These inspections were performed in a similar manner to those discussed in Section 7A-(16) of this manual. No problems were encountered and all work was approved.

(18) Preliminary Dowell Cleaning Before Installing Wrapper Plates

The "L" top tube sheet was cleaned internally by Dowell, Inc. of Wilmington, Delaware, following the procedure written by the du Pont Inspection Department presented herewith as Exhibit #16. Exhibit #17 presented herewith covers the visual inspection performed by members of the du Pont Inspection Department and the results.

(19) Cleanliness and Visual Inspection of Wrapper Plates

Inspections performed before, during and after welding wrapper plates to the periphery of the "L" top tube sheet, were performed in a similar manner to those discussed in Section 7A-(17) of this manual. All results were satisfactory.

(20) Facing Operation

Inspections performed before, during and after facing tube ends on the top side and the 12 bearing pads on the bottom side were similar to those covered in Section 7B-(20) of this manual. Final results of the "L" top tube sheet facing operation are presented herewith as Exhibit #18.

(21) Deburring and Inspection

This operation and inspection was performed in a similar manner to that described in Part II-A, Section 10.

(22) Lifting Lug Inspections

Inspection of the four lifting lugs butt welded to prolonged wrapper plates on the top tube sheet was performed in a similar manner to that described in Section 7B-(22) of this manual.

(23) Tube Reaming Operation

This operation and inspections performed were done in a similar manner to that described in Section 7B-(23) of this manual. Results of this inspection were all satisfactory.

(24) Rod Tube Verticality Measurements

The unit was set up on cast iron pedestals (top side up) and leveled in a similar manner described in Section 7B-(43) for taking final rod tube verticalities.

After the unit was leveled, the verticality of all rod tubes were taken using a specially designed calibrated verticality gage which indicates the inclination with the vertical. Readings were reco ded in .001 in./ft. For use of verticality gages for determining tube verticality, see Part III, Section II-L. Results of these measurements taken on the "L" top tube sheet assembly were similar

EXHIBIT #16

CLEANING PROCEDURE FOR TOP TUBE SHEET ASSEMBLY

BEFORE INSTALLING WRAPPER PLATES

E. I. DU PONT DE NEMOURS & CO., INC.

Construction Division

Serial Number 219

CC: H. W. Gosney, F.P.M. (2)
R. K. Mason, F.P.M.-SRP (3)
H. L. Bunker - J. G. Brewer
H. B. Gage
J. A. Collins
C. J. Veith
L. H. Arning
J. F. Elliot
Dowell Inc. (2)
S. R. Cochran (2)
J. B. Johnson - File

July 7, 1953
New York Ship - Camden, N. J.

MEMORANDUM

TO: R. H. BARTO - J. W. REID (5)
NEW YORK SHIPBUILDING CORP.
CAMDEN, NEW JERSEY

FROM: J. B. JOHNSON - R. V. GRAHAM RVG

CLEANING PROCEDURE BOTTOM AND TOP
TUBE SHEET ASSEMBLY BEFORE WRAPPER
PLATES INSTALLED

The following procedure supersedes the cleaning procedure on the same subject serial number 206 and is essentially the same with a few additions and corrections.

Install raschig ring loading cradle.

Set up vertically.

Cleaning solution will be by weight:

0.1% Deterger
Remainder - Deionized water
Temperature 150° - 190°F.

Jet using stainless steel nozzle upper 60° for 15 minutes

Rinse with manual hose using hot deionized or distilled water, upper 60° for 15 minutes.

Jet additional 120° each side with cleaning solution for 1 hour keeping hot rinse water hose on upper 60°.

[redacted] each side with hot deionized or distilled water [redacted] upper 60° for 1 hour.

[redacted] either way, jet with detergent, original bottom 60° [redacted] rinse same area for 15 minutes.

[redacted] hour.

[redacted] be sure to cover area between top sheet and baffle as [redacted] baffle and bottom sheet area.

[redacted]

EXHIBIT #17

INSPECTION AND RESULTS AFTER CLEANING THE "L"

TOP TUBE SHEET ASSEMBLY

E. I. DU PONT DE NEMOURS & CO., INC. Report Number 597-L

Construction Division

[redacted]

CC: J. B. Johnson
R. K. Mason-D.A.Hauser-SRP (3)
R. K. Mason-W.P.Duncan-SRP
H. L. Bunker-J.G.Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
R. V. Graham - File

September 18, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM A. A. Conn - W. J. Laughlin DATE Jan. 24, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Top Tube Sheet EQ.PC.NO. 154-L

DRAWING NOS. W-133143 Rev. 8 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Scope: Cleaning of top tube sheet before installation of wrapper plates.

Procedure: The raschig ring loading jig was installed on the above unit. The unit was then hung in a vertical position above the cleaning pit. The top section, approx. 60 degrees of the circumference was washed down with a detergent furnished by the Dowell Corp. The nozzles used throughout this process were of stainless steel. A jet force of 500 pounds pressure on the main line from the truck was used in the process. After washing this section for 15 minutes, it was rinsed with distilled water at a temperature of 160°F. The flow of clean water continued in this section throughout the complete wash and rinse process. Each 120° section was then washed down for 15 minutes. After the complete unit was washed in this manner, it was rinsed completely using distilled water, 1/2 hour for each 120° section. The cleaning procedure followed in this cleaning process was "Cleaning procedure bottom tube sheet and top tube sheet assembly before wrapper plate installation" dated 12/12/52.

[redacted]

[redacted]

FIELD INSPECTOR'S REPORT
FROM: Conn/Laughlin

Report # 597-L
Page 2 of 2

Results: The unit was rejected once by H. E. Dills as the unit was still full of weld smoke. The unit was again cleaned using the above procedure in the areas where weld smoke was found. The second check was taken using aclean, lintless cloth and found to be clean. Some discoloration was noted on the tube sheets, but it would not rub off on the cloth. The check was taken and passed on 1/23/53. The cleanliness was passed by W. J. Laughlin on this date.

lmw

[redacted]

EXHIBIT #18

INSPECTIONS PERFORMED BEFORE AND AFTER FACING TUBE ENDS ON THE TOP SIDE OF THE "L" TOP TUBE SHEET ASSEMBLY

E. I. DU PONT DE NEMOURS & CO., INC.

Report Number 431-L

Construction Division

[redacted]

CC: H. W. Gosney, F.P.M.
R. K. Mason - D. A. Hauser - Savannah River Plant (3)
R. K. Mason - W. P. Duncan - SRP
H. L. Bunker - J. G. Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
J. B. Johnson - File

April 7, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM R. H. Potts, Jr. DATE February 14, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Top Special Tube Sheet EQ.PC.NO. 154-L

DRAWING NOS. W-133143-R8 JOB RATING

VENDOR New York Shipbuilding Corporation LOCATION Camden, N. J.

Scope: To take verticality and accept for setting up on 20' boring mill for facing tube ends.

Procedure: Using the verticality gage, the verticality of each tube in the spider web pattern was taken and recorded.

The bench marks were then taken with the Wild Level and marked on the tube to be repeated using a dial indicator clamped to the boring machine cutting arm.

Results: See attached sheet.

lmw
attach.

[redacted]

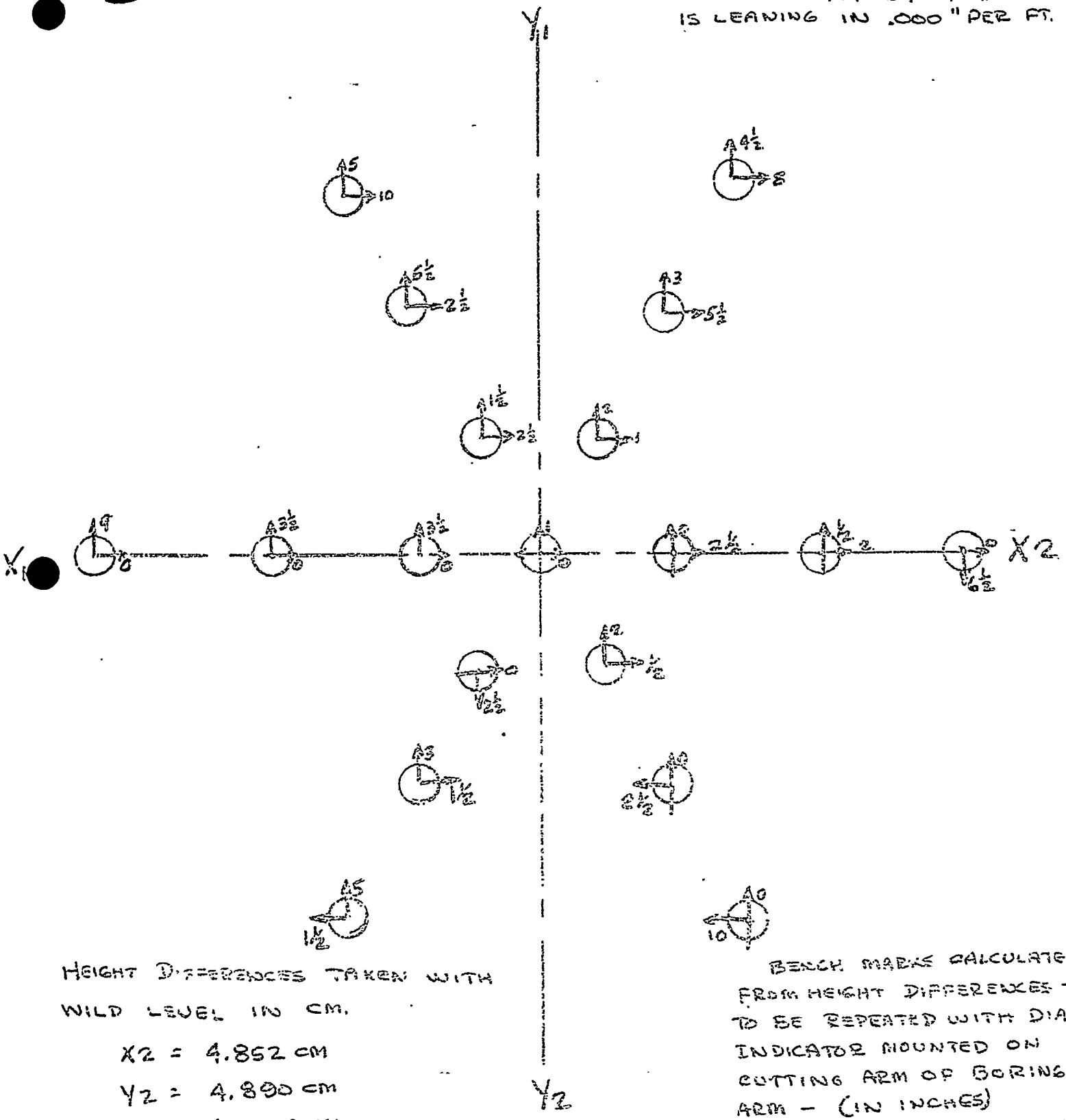
TOP TUBE SHEET "L" UNIT

DATE 2/19/53

TOP SIDE UP

Report #431-L

ALL MEASUREMENTS SHOW AVERAGE VERTICALITY AND DIRECTION TOP OF TUBE IS LEANING IN .000" PER FT.



HEIGHT DIFFERENCES TAKEN WITH WILD LEVEL IN CM.

X2 = 4.852 cm

Y2 = 4.890 cm

Y1 = 4.706 cm

X1 = 4.990 cm

BENCH MARKS CALCULATED FROM HEIGHT DIFFERENCES — TO BE REPEATED WITH DIAL INDICATOR MOUNTED ON CUTTING ARM OF BORING ARM — (IN INCHES)

X2 = +.000" Y1 = -.057"

Y2 = -.015" X1 = +.054"

[redacted]

E. I. DU PONT DE NEMOURS & CO., INC.

Report Number 435-L

Construction Division

[redacted]

CC: H. W. Gosney, F.P.M.
R. K. Mason - D. A. Hauser
Savannah River Plant (3)
R. K. Mason -W.P. Duncan-SRP
H. L. Bunker - J. G. Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
J. B. Johnson - File

April 7, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM A.J. Platek, H. E. Dills DATE March 17, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AJG-167½

EQUIPMENT Top Special Tube Sheet EQ.PC.NO. 15A-1

DRAWING NOS. W-132142 R. S JOB RATING

VENDOR New York Shipbuilding Corporation LOCATION Camden, N. J.

This is a report on the measurements taken on top and bottom side of unit after the tubes and bearing pads were faced off on the 20 ft. boring mill. Inspection started 2-11-53 and completed 2-19-53.

A. Profiles of tops of tubes were taken with a 18" ft. straight edge and feeler gages.

(1) Top Side

The straight edge was placed first on the row of tubes on the X_1-X_2 axis and then on the row on the Y_1-Y_2 axis. Feeler gages were then inserted between the straight edge and top of tubes to determine clearance between the straight edge and the top of tubes.

B. Measurement from tops of tubes to bottom of bearing pads.

(1) The straight edge was moved to a postion were it was extending out over the unit on one side. A block was set under the pad and jacked up flush with the bottom of the pad.

[redacted]

A pin, 47.125" in length, was placed between the straight edge and the block. By inserting feelers between the pin and the straight edge, the exact length from top of [illegible] to bottom of bearing pad was determined. This was done on all 12 bearing pads.

(2) The finish on the bottom of all 12 bearing pads was determined with a profilometer.

Results:

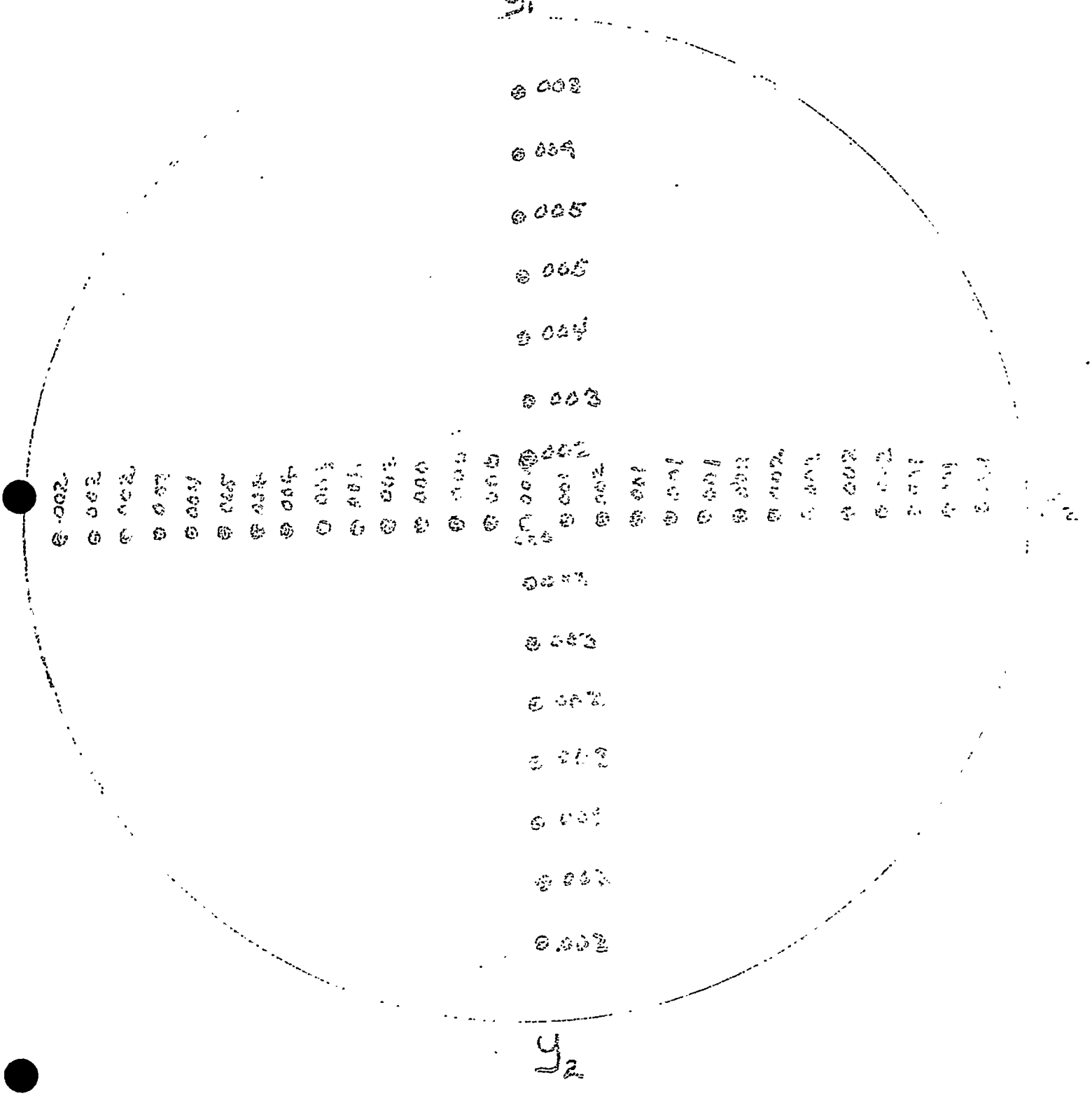
(1) See attached sketch

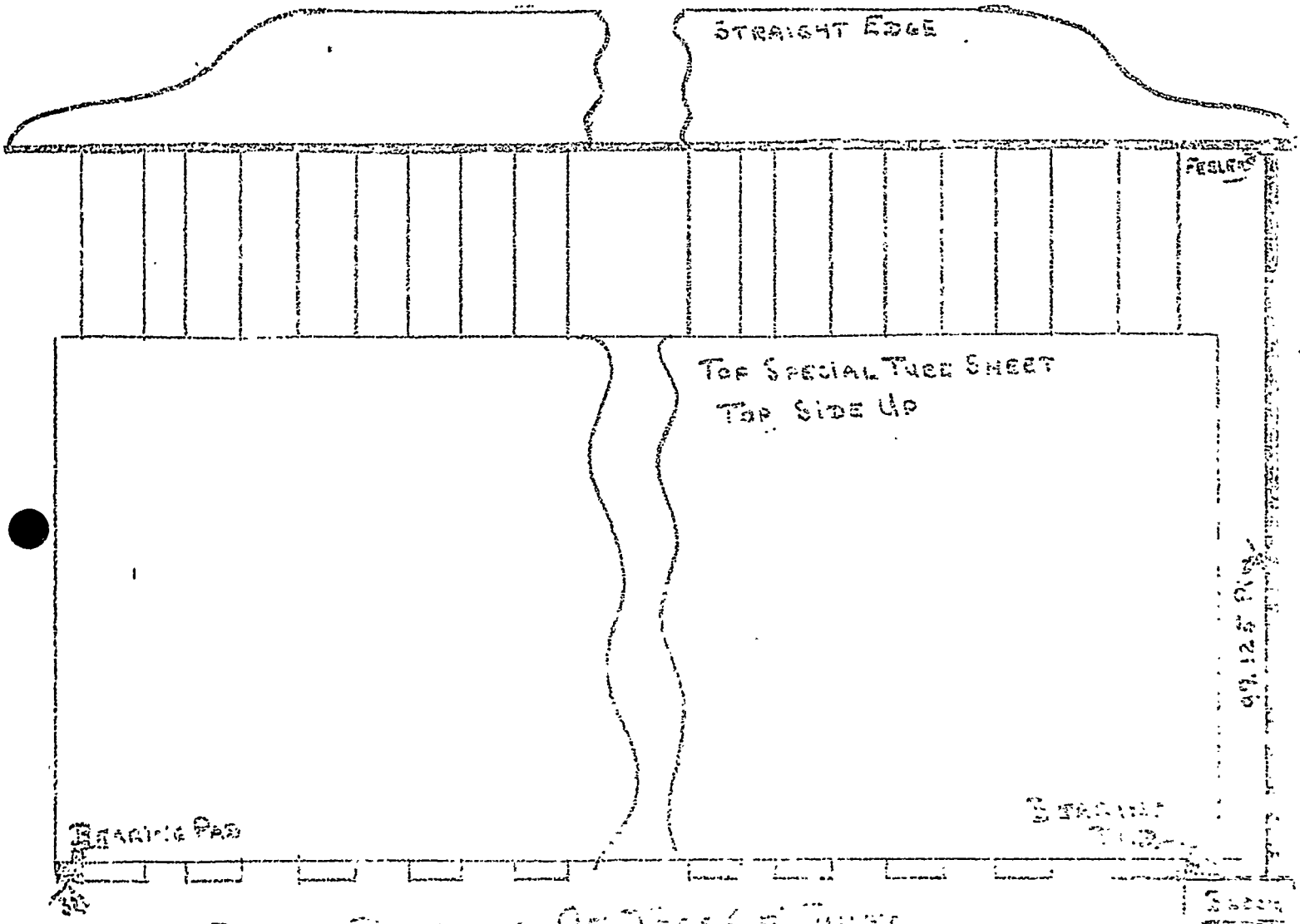
(2) (1) 147.129 to 47.135 (BP 47.125 ± .005)

(2) RMS finish of all 12 pads (20 to 30) (BP 32 RMS)

lmw
Attach.2

PROFILE RESULTS ALL TRAVERSES / 1 THOUSANDTH Ø.A.L.





PROFILE READINGS OF TUBES AT TUBES
D STRAGE MEASURED FROM TOP OF TUBES TO BOTTOM OF

to those presented as Exhibit #3 in Section 7A-(22) of this manual and were acceptable by the du Pont Inspection Department.

(25) Chime Ring Inspections

After fabricating chime rings for the "L" top tube sheet, they were sandblasted, acid washed and accepted. Exhibit #19 presented herewith covers these two operations along with the inspection results.

Fitting of chime rings to this unit was performed in a similar manner to that described in Part VIII, Section 9-B. For results of these inspections, see Exhibit #20 presented herewith.

After the chime rings were removed from the unit, it was requested by the du Pont Inspection Department that New York Ship zy-glo the 1" edges of chime ring plates for evidence of laminations. The request was complied with and all plate edges were zy-glo tested. A du Pont inspector witnessed the operation. No laminations were found.

The chime rings were accepted by the du Pont Inspection Department and released to New York Ship for boxing and shipping to the plant site.

(26) Sandblasting and Acid Washing

The "L" top tube sheet was sandblasted, acid washed and inspected in a similar manner to that described in Section 7B-(24) of this manual.

After the above operations were completed and approved, du Pont inspectors again visually inspected all tube welding on both sides of the unit in a similar manner to that described in Section 7B-(12) of this manual.

(27) Preliminary Freon Testing of the "L" Top Tube Sheet

The assembly was prepared for freon testing in a similar manner to that described in Section 7A-(25) of this manual. It was necessary to freon test this unit three times before all leaks were found and repaired. Exhibit #21 presented herewith covers all three tests and necessary repairs made before the unit was free from leaks.

(28) Preliminary Hammer and Hydrostatic Testing of the "L" Top Tube Sheet

The "L" top tube sheet was hammered and hydrostatically tested in a similar manner to that described in Part VII, Section III, item

EXHIBIT #19

SANDBLASTING, ACID WASHING AND INSPECTION OF

CHLMB RINGS AFTER FABRICATION

...EMOURS & CO., INC. Report Number 608-L

...tion

[redacted]

CC: J. B. Johnson
R. K. Mason-D.A.Hauser-SRP (3)
R. K. Mason-W.P.Duncan-SRP
H. L. Bunker-J.G.Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
R. V. Graham - File

September 23, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

...- M & E FILE

...Cochran DATE August 22, 1953

...760 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Top Tube Sheet Chime Rings EQ.PC.NO. 154-L

DRAWING NOS. W-133142 Rev.C JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Chime rings were sandblasted on 8/21/53, and passivated on 8/21/53 and 8/22/53.

Visual inspection after sandblasting was performed by A. J. Piatek. All surfaces were free of scale, grease, and dirt. The 16 sections of the rings were then released for passivation.

Rings were visually inspected and ferroxyl tested after passivating with a solution containing 2% hydroflouric and 13% nitric acid as follows:

1. Four (4) sections by D.M.Leland on 8/21/53.

2. Eight (8) sections by E.E.Chaney on 8/22/53

3. Four (4) sections by A. J. Piatek on 8/22/53.
(Sixteen (16) are required)

Final results indicated rings to be free of oil, grease, dirt and free iron.

lmw

[redacted]

EXHIBIT #20

DIMENSIONAL AND VISUAL INSPECTION OF FIT-UP OF CHIME RINGS AND BRACKETS TO WELDED BOTTOM SIDE OF THE "L" TOP TUBE SHEET ASSEMBLY

E. I. DU PONT DE NEMOURS & CO., INC.

Construction Division

Report Number 558-L

CC: J. B. Johnson
R. K. Mason-D.A.Hauser-SRP (3)
R. K. Mason-W.P.Duncan-SRP
H. L. Bunker - J.G.Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
R. V. Graham - File

[redacted]

August 6, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM D. M. Leland DATE July 8, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Top Tube Sheet Chimes EQ.PC.NO. 154-L

DRAWING NOS. W-133142 Rev. 0 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Scope: The dimensional and visual inspection of fit-up of chime rings and brackets.

Procedure: With the top tube sheet placed bottom side up, the chime rings and brackets were assembled into a unit using 1 1/8" diameter bolts and nuts. The unit was then placed on the tube sheet in the proper location, and the brackets were tack welded. The chime rings were then removed, and the brackets were welded. The chime rings were re-assembled to check fit after brackets were welded.

Results: See attached sheet for dimensions. Tolerances on these dimensions are not specified; they are considered satisfactory. The visual inspection of fit-up of chime rings in position was satisfactory.

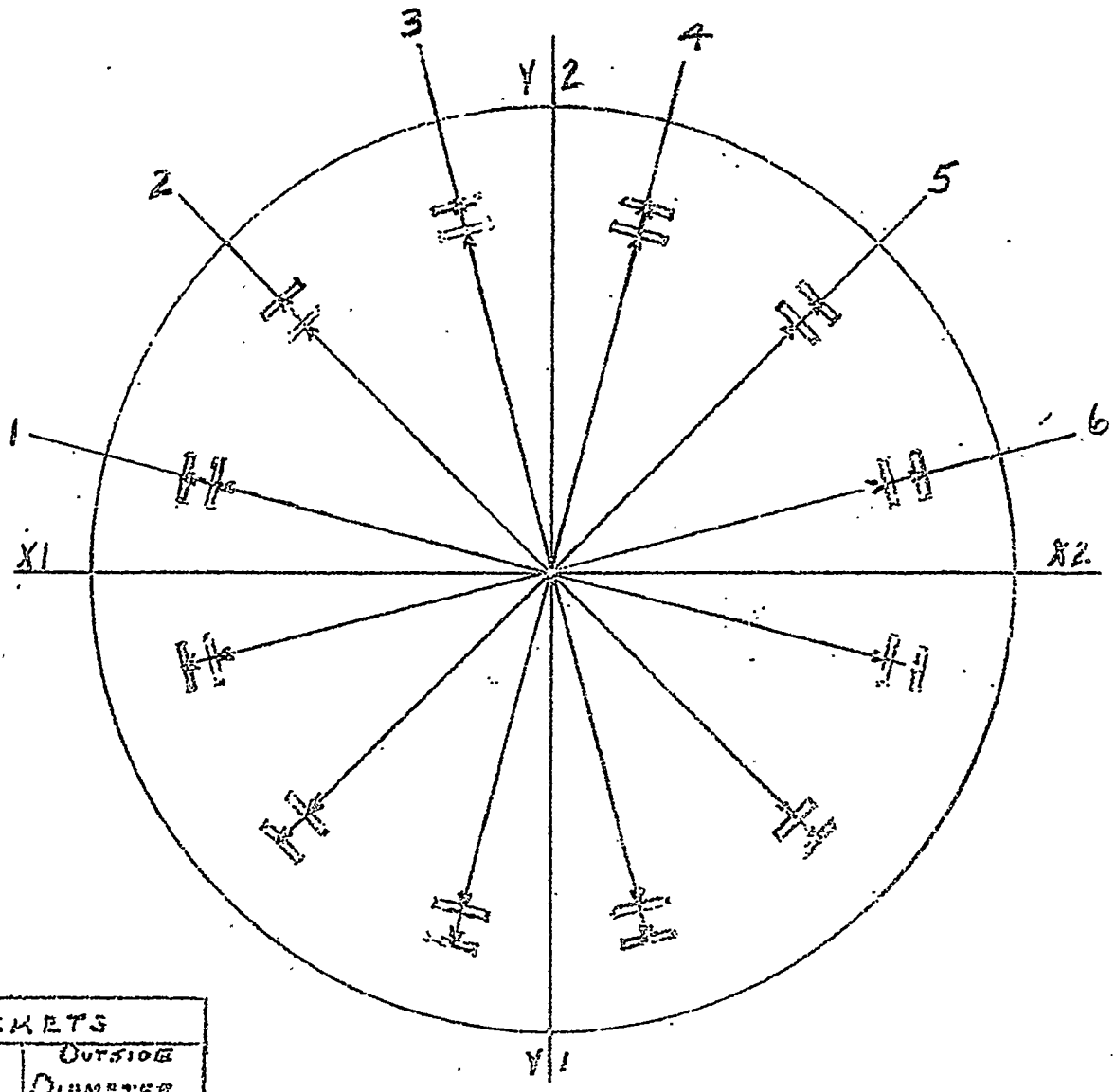
lmw
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[redacted]

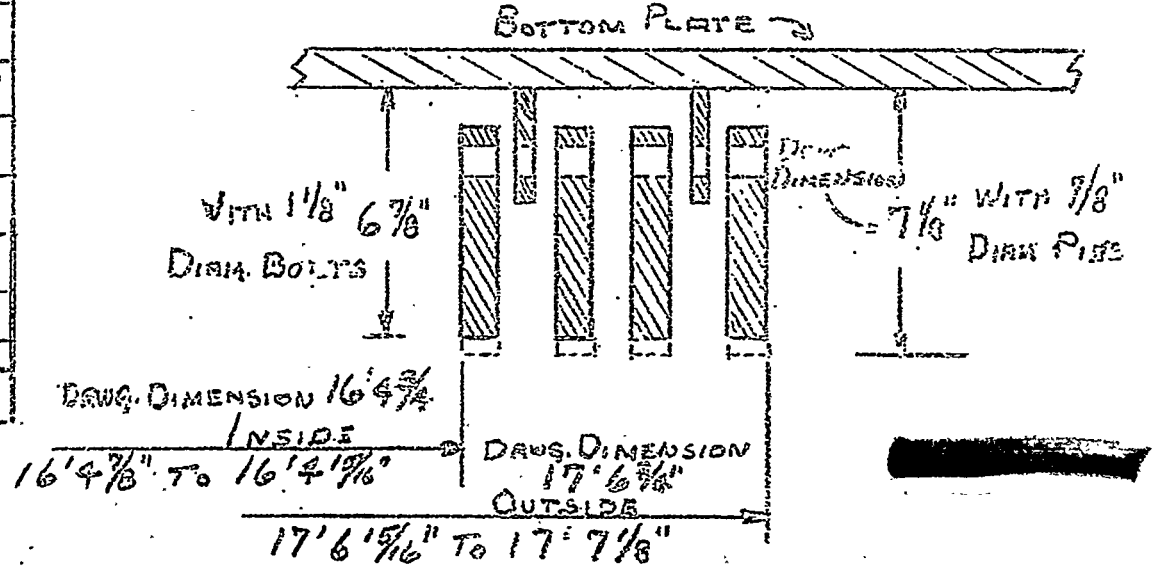
Report No. 558-L

CHIME RINGS & BRACKETS "L" UNIT

INSIDE, OUTSIDE DIAMETERS & VERTICAL MEASUREMENTS



	BRACKETS	
No	INSIDE DIAMETER	OUTSIDE DIAMETER
1	16' 7 7/16"	17' 4 1/2"
2	16' 7 7/16"	17' 4 7/16"
3	16' 7 7/16"	17' 4 1/2"
4	16' 7 7/16	17' 4 7/16"
5	16' 7 3/8"	17' 4 3/8"
6	16' 7 7/16"	17' 4 1/2"
DRWG. DIMENSION		
16' 7 1/4"		17' 4 1/2"



D. M. LEWIS

EXHIBIT #21

PRELIMINARY FREON TESTING OF THE "L" TOP TUBE SHEET

E. I. DU PONT DE NEMOURS & CO., INC. Report Number 552-L

Construction Division

[redacted]

CC: J. B. Johnson
R. K. Mason-D.A.Hauser-SRP (3)
R. K. Mason-W.P.Duncan-SRP
H. L. Bunker - J.G.Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
R. V. Graham - File

August 5, 1953
New York Ship - Camden, N. J.

1187

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M&E FILE

FROM R. H. Potts DATE April 16, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Top Tube Sheet EQ.PC.NO. 154-L

DRAWING NOS. W-133143 Rev. 8 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Preliminary Freon Test

Scope: To freon test assembly including all welding for leaks on "L" top tube sheet.

Procedure: Twenty pounds by weight of freon was put inside unit and the pressure was raised to 35 psi. G. E. Leak Detectors set at medium sensitivity were used to check for leaks.

Results: On 4/11/53 Inspectors tested entire unit and found 3 leaks; top side welds on rod tube X15 Y53, and X17 Y35 and weld on large tube X52 Y66 on bottom side. On the 2nd shift, weld on tube X52 Y66 was repaired and re-checked.

On 4/15/53 top side repairs were made and top side tested again and weld on large tube X32 Y12 was found to leak.

On 4/16/53 weld on tube X32 Y12 was repaired and the entire unit was retested. No leaks were found.

Inspection dates: 4/11/53 to 4/16/53 - accepted 4/16/53.

Inspectors making test: Heist, Dahlke, Jarczynski, Conn and Potts.

lmw

[redacted]

14C-(2). No leaks were found and the unit was accepted as being water tight subject to a final hydro test after loading unit with raschig rings. Exhibit #22 presented herewith covers the scope, procedure and results of this inspection.

(29) Large Tube Verticality Measurements

Verticality of all large tubes were taken in a similar manner to that described in Section 7B-(43) of this manual. All results were approved.

(30) Miscellaneous Dimensional Inspections Performed on the "L" Top Tube Sheet Prior to Line Boring

Just prior to the line boring operation, the following dimensional inspections were performed on the top tube sheet assembly:

a. Inside diametral distance between lifting lugs. See Exhibit #23, report number 555-L presented herewith for procedure and results.

b. Radial measurements taken on top and bottom plates referencing from center tube in unit. See Exhibit #23, report number 641-L for procedure and results.

c. Measuring O.D. of top tube sheet. See Exhibit #23, report number 554-L for procedure and results.

(31) Pattern Measurements

Just prior to line boring, pattern measurements were taken to show the position of each tube center from the X and Y centerlines. These measurements were taken on the top side only. All measurements were taken using ligament pages. Part II-A, Section 18, describes the manner in which ligament gages were used. Part III, Section II-G, describes how the gages were calibrated and how pattern coordinates were calculated. Sketch #35 in Part VII, Section I, item 16A-(8), illustrates pictorially how X and Y centerlines were established on the top tube sheet assembly for tying in pattern coordinates on the top side of the unit. For results of pattern measurements on the top side of the "L" top tube sheet assembly, see Exhibit #24 presented herewith.

(32) Line Boring Operation

The use of the top tube sheet assembly during the line boring of plenum chamber tubes and problems encountered are covered in Part VII, Section I, item 15C.

EXHIBIT #22

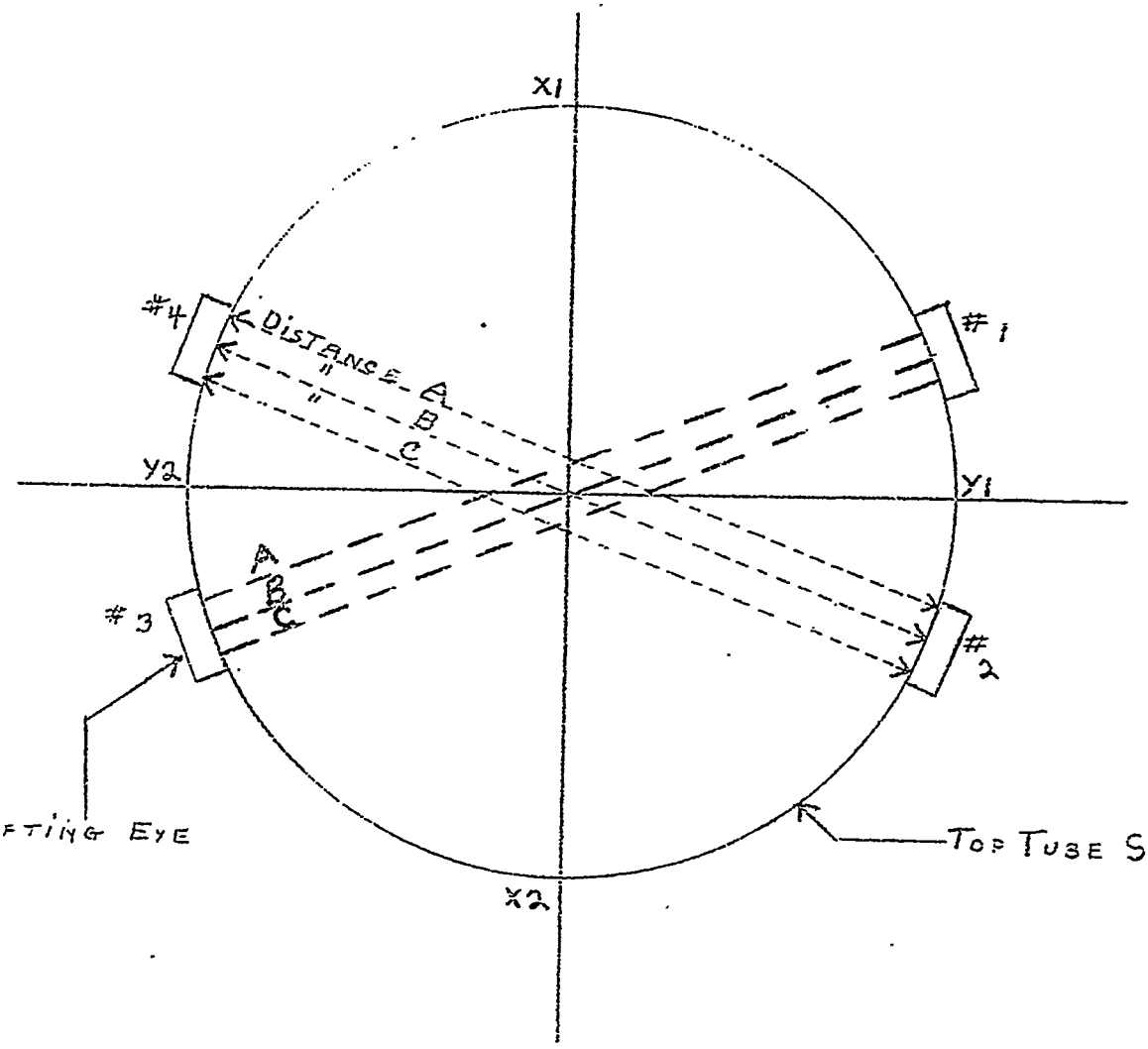
PRELIMINARY HAMMER AND HYDROSTATIC TESTING OF

THE "L" TOP TUBE SHEET

[redacted]

Report No. 555-L

SKETCH: SHOWING DIAMETRICAL MEASUREMENTS BETWEEN TOP TUBE SHEET LIFTING EYES.



LIFTING EYE #	DISTANCE LINE	MEASURED DISTANCE	DRAWING DIMENSION
1 TO 3	A	$219\frac{11}{32}$"	$220\frac{3}{8}$"
"	B	$220\frac{1}{32}$"	"
"	C	$219\frac{11}{32}$"	"
2 TO 4	A	$219\frac{5}{8}$"	$220\frac{3}{8}$"
"	B	$220\frac{1}{4}$"	"
"	C	$219\frac{5}{8}$	"

[redacted]

E. I. DU PONT DE NEMOURS & CO., INC.

Report Number 641-L

Construction Division

[redacted]

CC: J. B. Johnson
R. K. Mason-D.A.Hauser-SRP (3)
R. K. Mason-W.P.Duncan-SRP
H. L. Bunker-J.G.Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
R. V. Graham - File

October 7, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE
R.E.Chaney - C.H.Heist

FROM A.A.Conn - R.R.Baker DATE April 25, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Top Special Tube Sheet EQ.PC.NO. 154-L

DRAWING NOS. W-133143 Rev. 8 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Inspection performed 4/25/53

Scope: To determine radial measurements of top and bottom plates of subject unit, from the center of the center tube prior to line boring operation.

Procedure:
Using a centering device, a 25' S/S tape and a combination square, the plates were measured from the I. D. of the center tube to the O.D. of the plates at eight (8) intervals, including the axes. The radius of the center tube was added to each measurement to obtain the distance as described above.

Results:
See attached sheet.

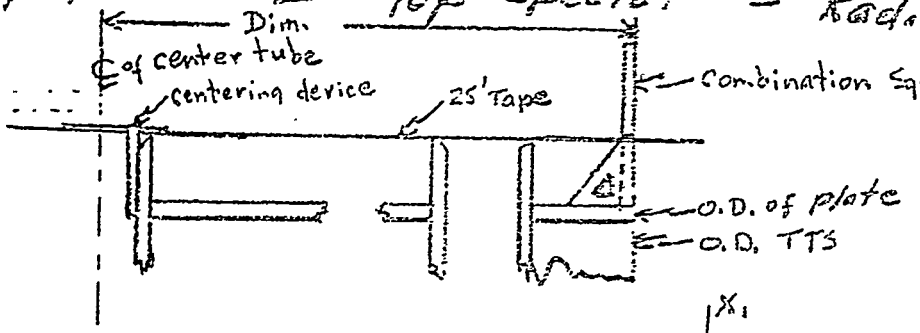
Note: Drawing does not specify tolerance for this dimension.

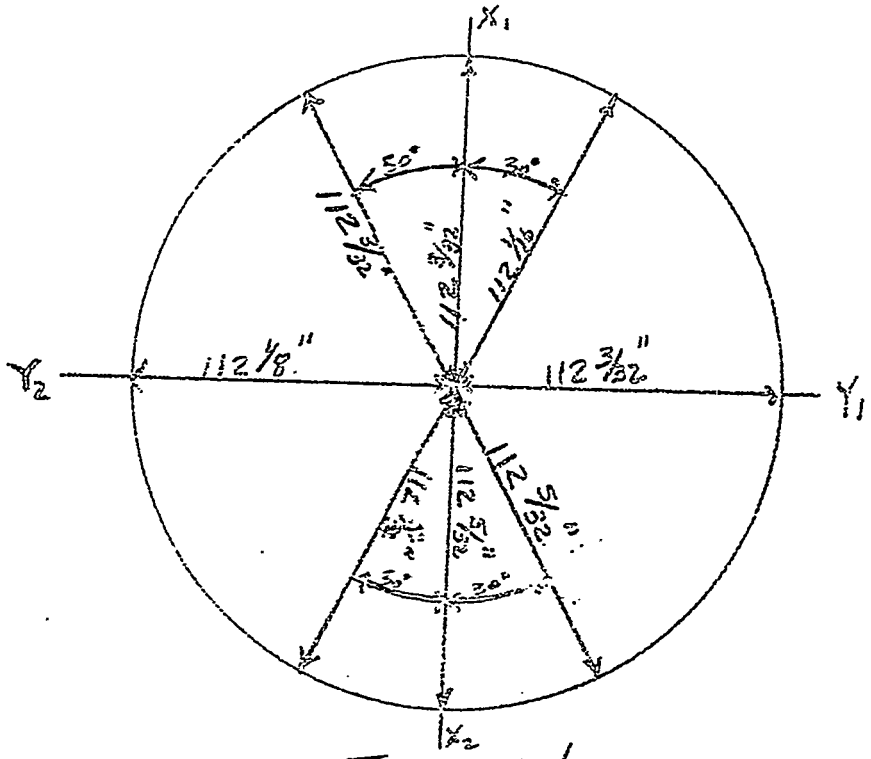
lmw
Attach.

[redacted]CR

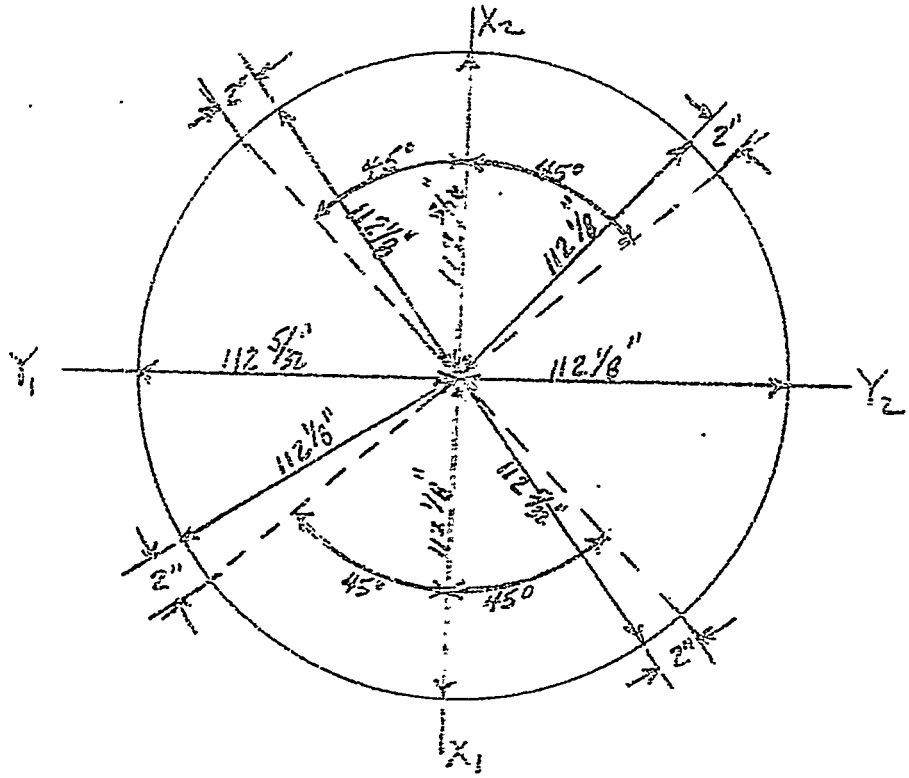
#13-453 "L" Top Special - Radial Measurements

Report #641-L





Top plate



Bottom Plate (Looking From Top)

E. I. DU PONT DE NEMOURS & CO., INC. Report Number 554-L

Construction Division

[redacted]

CC: J.E.Johnson
R.K.Mason-D.A.Hauser-SRP (3)
R.K.Mason-W.P.Duncan-SRP
H.L.Bunker-J.G.Brewer
J.G.Brewer
H.E.Gage
F.C.Breuninger
S.R.Cochran (2)
R.H.Barto-NYS (3)
R.T.Graham-File

August 5, 1953
New York Ship - Camden, N. J.

707

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM F.J.Jarczynski - C. H. Heist DATE April 22, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Top Tube Sheet EQ.PC.NO. 154-L

DRAWING NOS. W-133143 Rev. 8 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

This report covers the final inspections completed on April 20, 1953.

Scope: To check the O.D. of top tube sheet at various points as outlined on attached sketch; and to check the circumference of the top tube sheet at three points around the wrapper plates.

Procedure:

1. The X & Y axes were located.
2. Equidistant points, as indicated on enclosed sketch, were located and used to take diametrical readings. Points were located by measuring an average of 3" counterclockwise from each bearing pad.
3. Holding two 6' steel scales at two opposite points on circumference, each end of each scale protruding over tube sheets (top and bottom) at least 10", and using a 100' steel tape to measure the distance between edges of the steel scales, the diametrical readings were taken at exactly 10" above and below the tube sheets as outlined on enclosed sketch and the maximum diameters at these points were recorded.
4. Using a 100' steel tape, circumferential readings were taken at 3 points (top, middle and bottom) around the wrapper plates of the top tube sheet.

BY [redacted]

[redacted]

FIELD INSPECTOR'S REPORT
FROM: Jarczynski/Heist

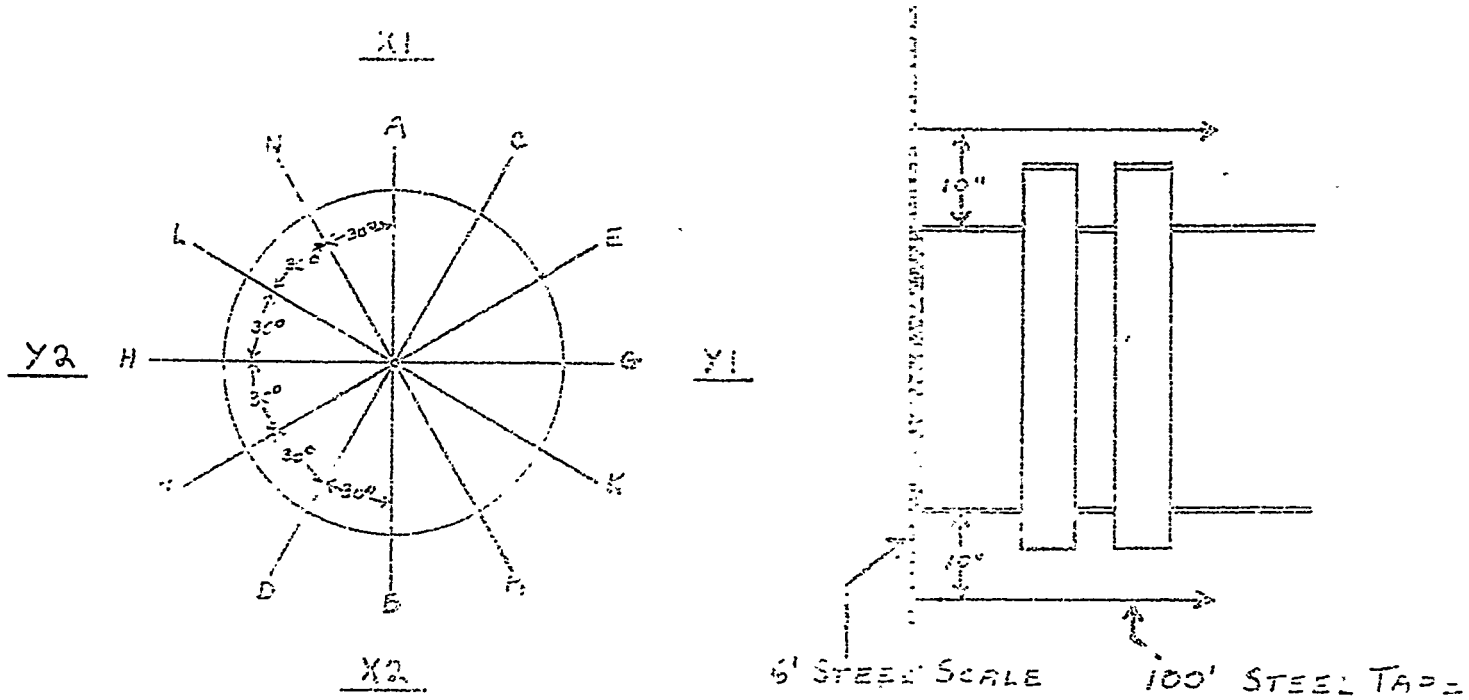
Results: See attached sheet for listing of dimensions and sketches.
Largest diameter at the top (line C-D) is 224 17/64".
Largest diameter at the bottom (lines C-D and M-N) is 224 5/16".

Note: Tolerances on these dimensions are not specified.

lmw
attach.

[redacted]

SKETCH - SHOWING POSITIONS & RESULTS OF T.T.S. DIAMETER & CIRCUMFERENTIAL MEASUREMENTS.



TOP MEASURED DISTANCE	BOTTOM MEASURED DISTANCE	AVERAGE MEASURED DISTANCE	DRAWING DIMENSION
A-B = 22 4 5/16"	A-B = 22 4 3/16"	A-B = 22 4 1/4"	22 4 1/4"
C-D = 22 4 13/16"	C-D = 22 4 5/16"	C-D = 22 4 9/16"	"
E-F = 22 4 7/16"	E-F = 22 4 1/16"	E-F = 22 4 1/4"	"
G-H = 22 4 1/2"	G-H = 22 4 1/16"	G-H = 22 4 5/16"	"
K-L = 22 4 3/16"	K-L = 22 4 1/16"	K-L = 22 4 1/8"	"
M-N = 22 4 17/16"	M-N = 22 4 5/16"	M-N = 22 4 3/8"	"

CALCULATED CIRCUMFERENCE (USING 224 1/4" DIA.) = 704 1/2"

CIRCUMFERENCE MEASUREMENTS		
TOP	704 31/64"	TAKEN 1" DOWN FROM TOP
MIDDLE	703 17/64"	TAKEN 15" DOWN FROM TOP
BOTTOM	704 7/16"	TAKEN 1" ABOVE BOTTOM WELD

E. I. DU PONT DE NEMOURS & CO., INC.

Construction Division

Report Number 553-L

CC: J. B. Johnson
R. K. Mason-D.A.Hauser-SRP (3)
R. K. Mason-W.P.Duncan-SRP
H. L. Bunker-J.G.Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
R. V. Graham - File

[redacted]

August 5, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM R.R.Baker, R.E.Chaney, F.W.Meaes, C.H.Heist DATE April 18, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Top Special Tube Sheet EQ.PC.NO. 154-L

DRAWING NOS. W-193143 Rev. 8 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

Preliminary

Scope: To hydrostatically and hammer test the "L" top special tube sheet. Started 4/17/53 and completed 4/18/53. (This is a preliminary test; the assembly will be retested at a later date.

Procedure: The unit, top side up, was filled with deionized water and the pressure was raised to 52 psi and checked 1 hour later. The pressure was then lowered to 37 psi. A drop hammer was then used at approximately 9" intervals on the top side of the sheet to hammer test the unit. The impact pressure of the drop hammer on the unit was equal to a swinging blow of a ten (10) pound hammer. After the hammer test was completed at 37 psi pressure, the unit was relieved of the pressure and the water drained to a level 2" below the top plate. A complete hammer test was again applied to the top side using the same procedure as above. (This latter hammering was done as an aid in cleaning.) After the second hammer test was completed, the unit was filled with water and the pressure raised to 52 psi. The top side was then checked for leaks. A six (6) pound hammer was used on the wrapper by NYS workers on the wrapper plates. All hammer blows were adjacent to the welds.

[redacted]

FIELD INSPECTOR'S REPORT
TEAM Baker/Chaney/Mease/Heist

After the inspection was completed, the unit was turned over, bottom side up. A complete hammer and pressure test was applied to the bottom side using the same procedure as above except the 52 psi test was made the final step.

Results: No leaks were found after a visual inspection by the named inspectors.

In-

EXHIBIT #23

MISCELLANEOUS DIMENSIONAL INSPECTIONS PERFORMED

OF THE "L" TOP TUBE SHEET PRIOR TO LINE BORING

E. I. DU PONT DE NEMOURS & CO., INC.

Construction Division

[redacted]

Report Number 555-L

CC: J. E. Johnson
R. E. Mason-D.A.Hauser-SRP (2)
R. E. Mason-W.P.Duncan-SRP
H. L. Bunker-J.C.Brewer
J. C. Brewer
H. E. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
T. V. Graham - File

August 5, 1953
New York Ship - Camden, N. J.

1537

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM F. J. Jarczynski - C. H. Heist DATE April 23, 1953

PROJECT NO. 8980 PLANT Savannah River ORDER NO. AXC-167½

EQUIPMENT Top Tube Sheet Lifting Eyes CO.PO.NO. 154-L

DRAWING NOS. W-133143 Rev.8 -W-133144 Rev.C JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, N. J.

This report covers inspection completed on April 20, 1953

Scope: To measure the inside to inside diametrical distance between lifting eyes located at 180° opposite positions on the circumference of top tube sheet.

Procedure: A 100' steel tape was used and pulled tight to measure the distance (at 3 points, top center and both top sides) between the inside edges of opposite lifting eyes.

Results: See attached sheet for sketch and dimensions.

Note: Tolerance on this dimension is not specified.

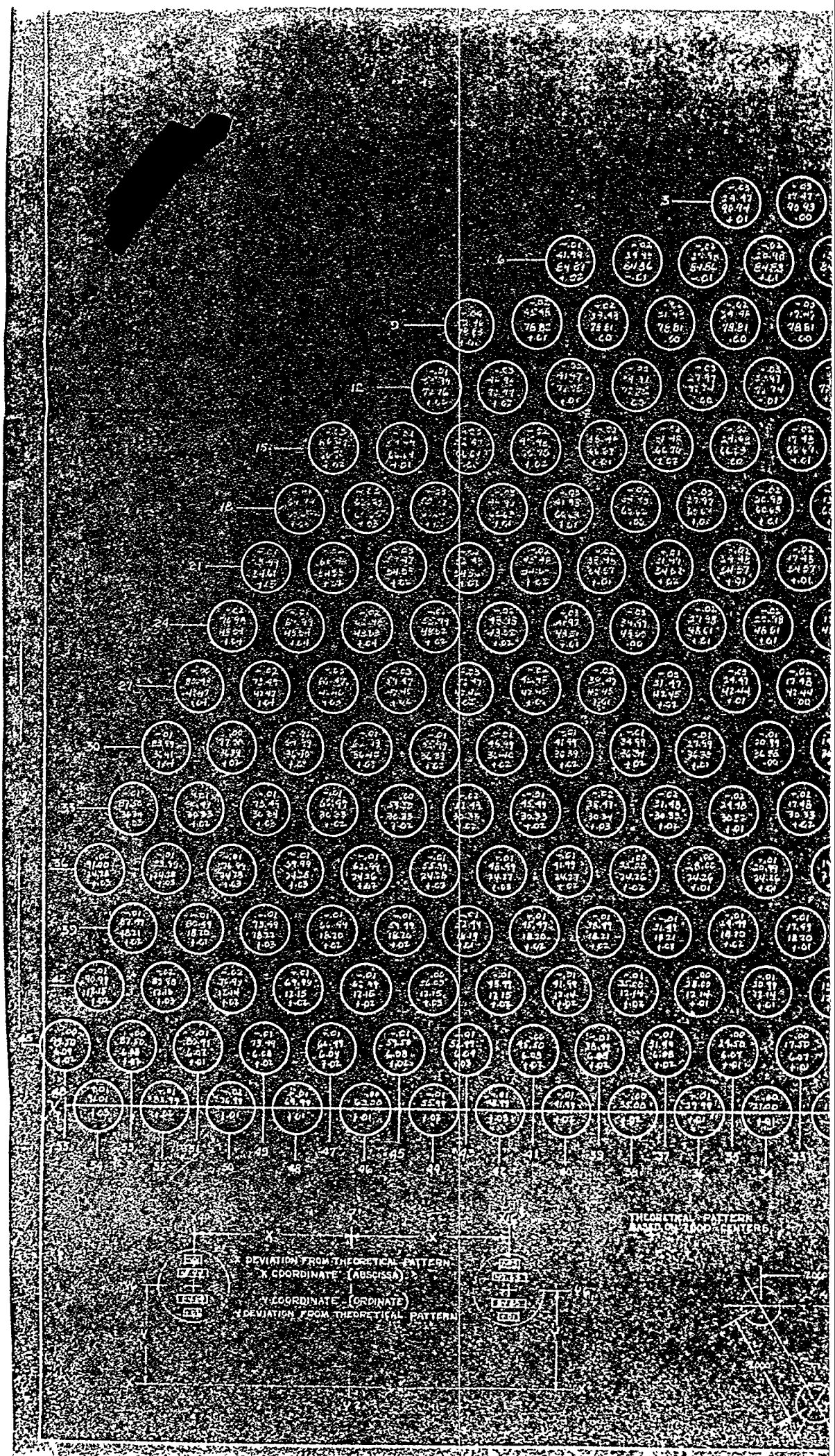
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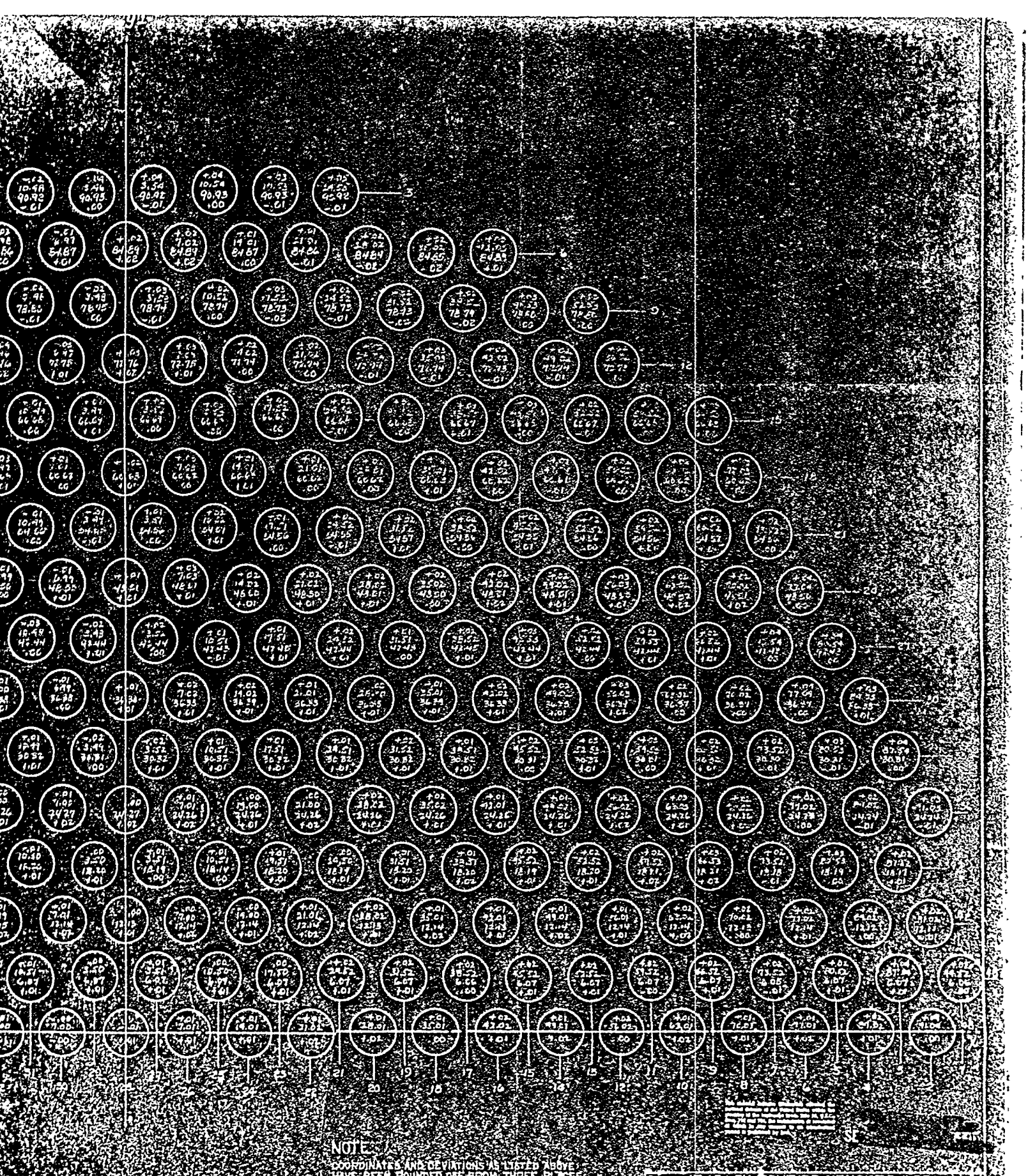
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EXHIBIT #24

RESULTS OF PATTERN MEASUREMENTS TAKEN ON TOP SIDE

OF THE "L" TOP TUBE SHEET ASSEMBLY


X DEVIATION FROM THEORETICAL PATTERN
X COORDINATE (ABSCISSA)
Y COORDINATE (ORDINATE)
Y DEVIATION FROM THEORETICAL PATTERN
THEORETICAL PATTERN BASED ON 2000 CENTERS



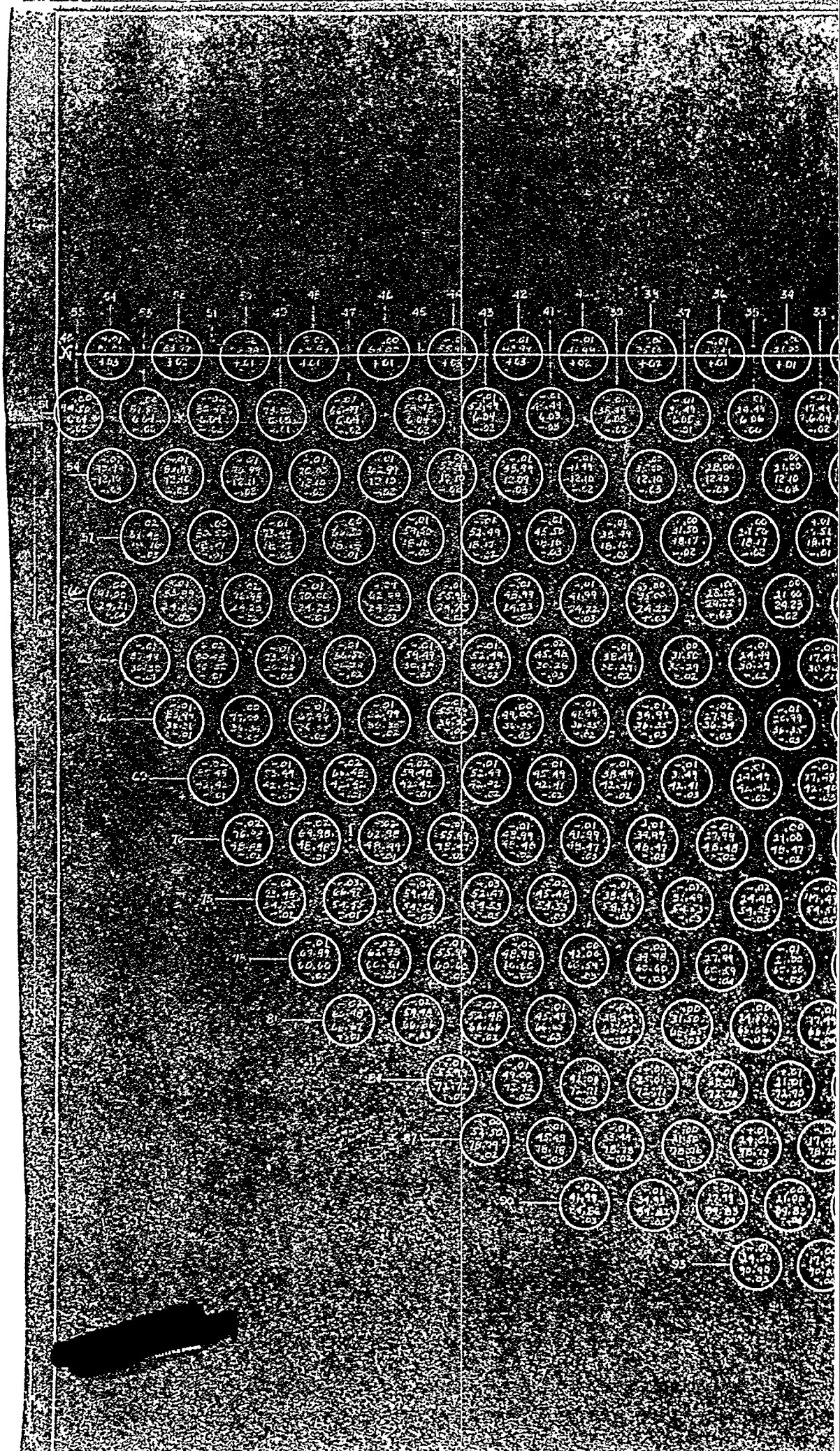
ALL TUBE MEASUREMENTS TAKEN "I" DOWN

NOTE:
COORDINATES AND DEVIATIONS AS LISTED ABOVE HAVE BEEN ROUNDED OFF FROM THREE PLACES AND TOGETHER MAY NOT TOTAL THE THEORETICAL TWO DECIMAL DISTANCE. FOR EXAMPLE, THE THEORETICAL DISTANCE FROM ONE TUBE TO ANOTHER IS 15.37 INCHES. THE MEASURED DISTANCE OF THESE TWO TUBES IS 15.37 INCHES. THEREFORE, COMPUTED DEVIATIONS FROM THESE TUBES IN PLATE COORDINATES AND DEVIATIONS MAY NOT TOTAL.

E. I. DU PONT DE NEMOURS & CO.
WILMINGTON, DELAWARE
CONSTRUCTION DIVISION
M.I.E. SECTION

TOP SPECIAL TUBE SHEET
TOP SIDE - 5 UNIT
PATTERN COORDINATES

DRAWING NO.
DATE | NO. SHEETS | SHEET

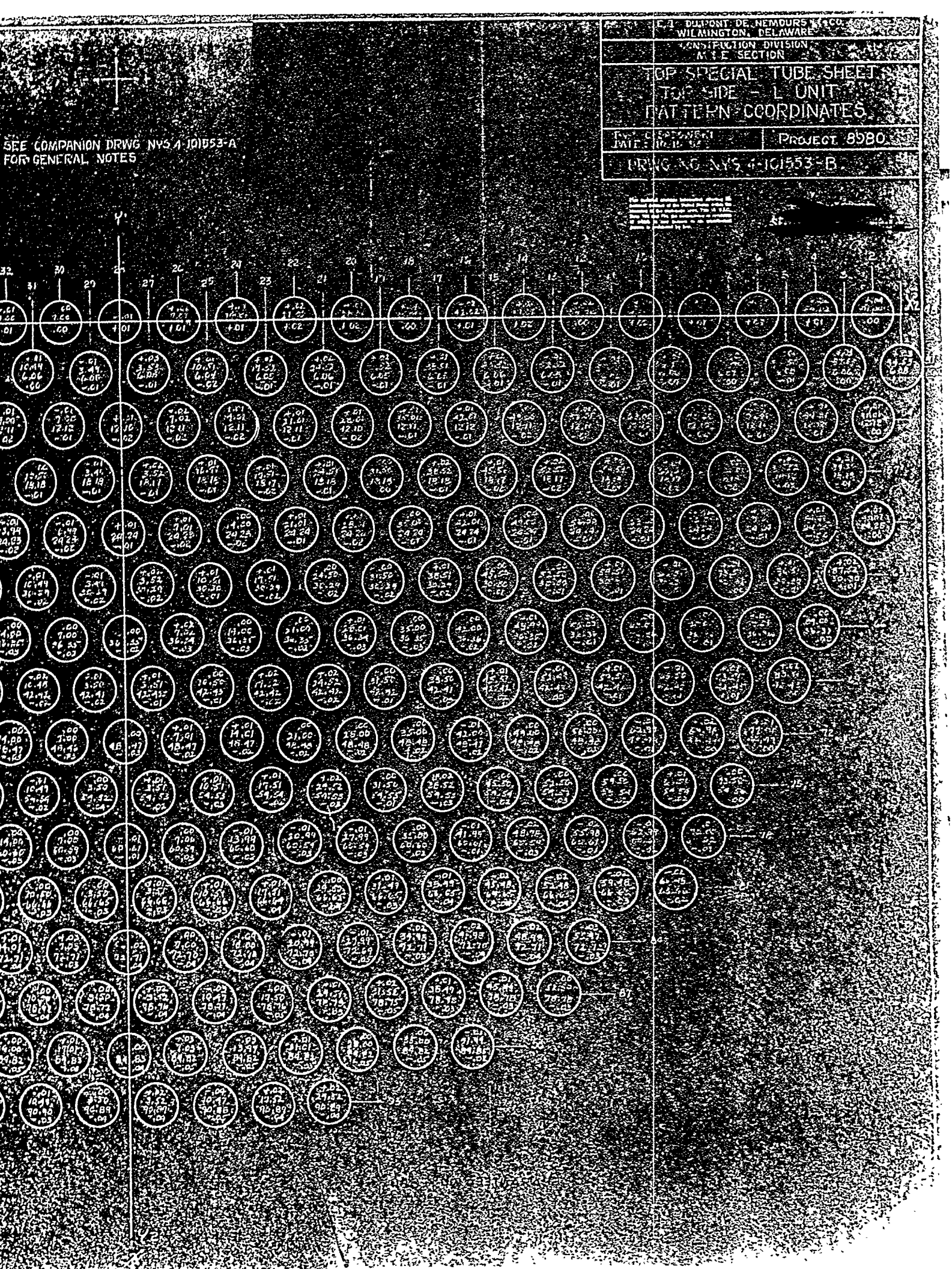


E. I. DUPONT DE NEMOURS & CO.
WILMINGTON, DELAWARE
CONSTRUCTION DIVISION
M & E SECTION

TOP SPECIAL TUBE SHEET
TOP SIDE - L UNIT
PATTERN COORDINATES

TYPE OF DRAWING	PROJECT 8980
DRWG NO NYS 4-101553-B	

SEE COMPANION DRWG NYS 4-101553-A
FOR GENERAL NOTES



(33) Deflector Plate Inspections

The inspections performed during fit-up of deflector plate to the bottom side of the top tube sheet and the discrepancies found are covered in Exhibit #25, report number 598-L presented herewith. Final cleaning and inspection is covered in report number 604-L included in Exhibit #25.

(34) Final Dowell Cleaning Operation

Prior to loading raschig rings in the top tube sheet, Dowell, Inc., Wilmington, Delaware, chemically cleaned the interior of the assembly.

Two washes and inspections were required and the results were as follows:

a. First Cleaning Operation

A procedure written by the du Pont Inspection Department was used by Dowell to internally clean the unit. Exhibit #26 presented herewith covers the step by step procedure used by Dowell to clean the assembly.

After the first cleaning, examination of the interior thru "A" and "B" inspection ports and the 4" loading ports located near the X_2 axis revealed oil on wrapper plates, caustic remains, and an excessive amount of grime and metal chips at the 4" draining hole locations. The unit was rejected as a result of the above condition.

b. Second Cleaning Operation

In the meantime, it was decided by the du Pont Inspection Department to re-study the first cleaning operation and prepare a new cleaning procedure for Dowell. The new cleaning procedure was written and give to Dowell for re-cleaning the assembly again. Exhibit #27 presented herewith covers the revised cleaning procedure. The unit was re-cleaned by Dowell and accepted as being clean for raschig ring loading. For final results of this cleaning operation as observed by a du Pont inspector, see Exhibit #28 presented herewith.

(35) Internal Drying of the "L" Top Tube Sheet

This operation is covered in Part VII, Section I, item 16-(20).

(36) Raschig Ring Loading Operation

Inspection and filling of the "L" top tube sheet with raschig rings was accomplished in a similar manner to that described in

Part VII, Section III, item 17.

The assembly was filled with a total of forty-eight (48) tons and one thousand three-hundred and ten pounds (1310) of raschig rings.

After the raschig ring operation was completed, the assembly was placed in a horizontal position and a profile of tube ends on the top side was taken. This was done in order to determine how much the added weight of raschig rings deflected the tube bundle. The scope, procedure and results of this inspection are covered in Exhibit #29 presented herewith. All measurements were satisfactory and accepted by the du Pont Inspection Department.

(37) Final Freon and Hydrostatic Tests

The unit was subjected to a final freon and hydrostatic test, respectively. These two tests were performed in a similar manner discussed in Sections 7B-(23) and (25). No leaks were found in either test.

(38) Inspection of Instrument Lead Tubes

Nine rod tubes in the "L" top tube sheet assembly were modified and identified as instrument lead tubes. Drawings W-133141-R2 and W133143-R8, details "A" and "B", respectively, show proper machining to bottom ends of these tubes. All inspections were similar to those performed on the "R" top tube sheet discussed in Section 7A-(38) of this manual. Exhibit #30 presented herewith covers all measurements and results of the nine modified rod tube inspections.

(39) Top Tube Sheet Indexing Devices

Pre-assembly inspections performed by the du Pont Inspection Department on the three indexing devices required for the "L" top tube sheet were performed in a similar manner to that described in Section 7A-(37) of this manual. Exhibit #31 presented herewith covers all inspections made on the three indexing devices after they were welded to the bottom side of the top tube sheet assembly.

Also, included in Exhibit #31 are the final circumferential measurements and bearing pad location inspections. All inspections covered in this exhibit were considered satisfactory and accepted.

(40) Large Tube to Rod Tube Ligament Measurements

This inspection was performed on the top side of the "L" top tube sheet assembly. See Part III, Section II-B for a resume of the gages used and interpretation of results. All large tube to

EXHIBIT #25

"L" UNIT DEFLECTOR PLATE INSPECTIONS

E. I. DU PONT DE NEMOURS & CO., INC. Report Number 598-L

Construction Division

CC: J. B. Johnson
R. K. Mason-D.A.Hauser-SRP (2)
R. K. Mason-W.P.Duncan-SRP
H. L. Bunker - J. G. Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
R. V. Graham - File

September 18, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - M & E FILE

FROM A. A. Gonz -E.J. Jarczynski DATE August 4, 1953

PROJECT NO. 6980 PLANT Savannah River ORDER NO. AEC-1674

EQUIPMENT Deflector Plate EQ.PO.NO. 154-1

DRAWING NOS. D-114689A-Rev.2S & D-114685-Rev. 3 JOB RATING

VENDOR New York Shipbuilding Corp. LOCATION Camden, New Jersey

Scope:
To determine [illegible] deflector plate and top tube sheet.

Procedure:
The deflector was bolted to the bottom of the top tube sheet with 8 bolts. These bolts screwed into blind holes on the bottom sheet of the top tube sheet. The holes were checked visually for location and line up with top tube sheet holes. The thermocouple clip holes were checked using a plug with a center attachment and measuring from 2 of large tube holes to 2 of these clip holes. A standardized tape was used in all measurements.

Results:
The deflector plate was placed on bottom of the top tube sheet, and the line up of the holes were checked. During this fit-up an extra rod tube hole was discovered at X40,Y30 position and a rod tube hole missing at position X25,Y19. This condition was corrected on 7/9/53 by welding X40,Y30 and drilling the missing hole at X25,Y19. The plate was then checked for location of 147 pairs of thermocouple clip holes. Of the 147 pairs, 15 pairs were found to be out of location to drawing tolerances from 1/16" to 1/8". Two pairs X1,Y2L and X3,Y3L were found in error on the 1" center to center distance between the holes. One pair was found to be

FIELD INSPECTION REPORT
FROM: Conn/Jorczynski

Results continued:

out of location 5/8". In a telephone conversation between R. V. Graham, Tech. Inspector at New York Shin and R. J. Hunn of Design, all holes were in acceptable position except AA,Y51 - Y3, Y51 and X51,Y63. These holes were corrected by plugging and welding on 7/9/53 and re-drilled at proper locations. The plate was re-checked and accepted on 7/9/53.

lmm

[redacted]

[redacted] Report Number 674-1

[redacted] Division

[redacted]

J. B. Johnson
R. K. Mason-D.A.Hauser-SIO
R. K. Mason-W.T.Duncan-SIO
K. L. Bunker-J. G. Brewer
J. G. Brewer
K. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NIS (3)
R. V. Graham - File

September 22, 1953
New York Ship - Genoa, Italy

FIELD EXPERIENCE REPORT

TO [redacted]

FROM [redacted] DATE [redacted]

RE [redacted]

SUBJECT [redacted]

[redacted]

EXHIBIT #26

FIRST PROCEDURE WRITTEN BY THE DU PONT INSPECTION DEPARTMENT AND USED BY LOWELL FOR INTERNALLY CLEANING THE "L" TOP TUBE SHEET

(COPY)

Serial Number 208

CC: H. W. Gosney
W. Courtland - Dowell
S. R. Cochran
J. B. Johnson - File

March 5, 1953
New York Ship - Camden, N. J.

MEMORANDUM

TO: R. H. BARTO - J. W. REID
NEW YORK SHIPBUILDING CORP.
FROM: J. B. JOHNSON

CLEANING PROCEDURE FOR
TOP TUBE SHEET ASSEMBLY
WRAPPER PLATES INSTALLED

Cleaning Solution will be by weight:

0.1% Deterger
1.0% Caustic
1.0% Trisodium Phosphate
Remainder - De-ionized or distilled water
Temperature - 150-190°F

I Cleaning of Gussets and wrapper plates.

A. Tube sheet horizontal and upside down.

B. No pot chuck or rolling jig installed.

C. All openings in wrapper plates uncovered (34 approx.)

D. Jet straight in at maximum pressure for 5 minutes thru every opening using stainless steel nozzle.

E. Reverse jet same as above.

F. Drain through 18 outlet tubes (perforated)and 2" openings. Approx. 6 hours.

II Cleaning between baffle plate and tube sheet.

A. In same position as above.

B. All openings closed in wrapper.

C. Valve on each inlet and outlet tube closed.

D. Fill unit completely.

E. Feed thru one outlet tube at a time 10 min.

F. Drain thru mating inlet tube.

G. Repeat 18 times. Approx. 3 hours.

Fill and drain. Open all outlets.

III Internal cleaning with solution and air agitation.

A. Tube sheet in vertical position with X_1 axis at top and filling cradle installed.

B. All 2" ports closed except the third "B" filling port above the horizontal center line on both sides of the unit.

C. Fill the unit with cleaning solution thru the 9 upper half outlet tubes (perforated) until solution overflows the two open filling ports.

D. Close the two filling ports and rotate the unit approx. 45° and open two or three filling ports on the top for vents.

E. Fill with cleaning solution thru the 9 upper half outlet tubes and drain thru sufficient 2" filling ports in the lower half to maintain water level. Agitate simultaneously with air thru the 9 lower half outlet tubes for a period of 30 minutes.

F. Close vents and rotate the bundle 90°, (45° on the opposite side of vertical) Again open 2 or three filling ports on top for a vent and repeat filling, draining and agitation.

G. Gradually shut off feed, keep air on and drain completely thru 2" filling ports in the lower half.

IV Rinsing - use hot distilled or de-ionized water.

A. Stay in vertical position.

B. Close all openings except those at very top in wrapper plates.

C. Fill unit completely thru 9 upper half outlet tubes (perforated).

D. Drain thru all lower half 2" ports and keep flow on for 30 min.

E. Diminish feed gradually and drain completely. Time: 2 hours.

EXHIBIT # 27

FINAL CLEANING PROCEDURE WRITTEN BY THE DU PONT INSPECTION DEPARTMENT AND USED BY DOWELL FOR INTERNALLY CLEANING THE "L" TOP TUBE SHEET

DRAFT DRAFT

Serial Number 221-L

CC: H. W. Gosney
S. R. Cochran (2)
Dowell Corp. (2)
J. B. Johnson - File
R. V. Graham

July 20, 1953
New York Ship - Camden, N. J.

MEMORANDUM

TO: R. H. BARTO - J. W. REID
NEW YORK SHIPBUILDING CORP.

FROM: J. B. JOHNSON - R. V. GRAHAM

PROJECT 8980 - SAVANNAH RIVER PLANT - "L" UNIT
FINAL CLEANING OF TOP TUBE SHELT WITH WRAPPER PLATES INSTALLED

Cleaning solution (by weight)

0.1% Deterger
1.0% Caustic
1.0% Trisodium Phosphate

Remainder - Deionized water or distilled water (150-190°F)

Rinse Water - Hot deionized water (150-190°F)

I. Vacuum Cleaning

1. Place unit in a horizontal position with no jig installed and all 34 filling ports open.

2. Drop hammer on a line between each row of holes at 3 inch intervals.

3. With the use of mirrors and a vacuum cleaner, remove all foreign material possible.

II. Cleaning of gussets and wrapper plates (same as Part I of final cleaning procedure number 208).

1. Tube sheet horizontal and up side down with no pot chuck or rolling jig installed.

2. All filling ports in the wrapper plate open (approx. 34) and flange fitted with valves installed on the 36 inlet and outlet tubes. (All valves are to be open for draining during this part of the cleaning procedure.

3. Jet straight in at maximum pressure for 5 minutes with cleaning solution thru every opening in the wrapper using a S/S jet.

4. Reverse jet same as above.

5. Drain through 18 outlet tubes and 2" openings.

III. Cleaning between baffle plate and tube sheet. (Same as Part II of final cleaning procedure number 208).

1. Unit in same position as above.

2. All openings in the wrapper closed.

3. Valves on all inlet and outlet tubes closed except for filling.

4. Fill the unit completely with cleaning solution.

5. Feed(maximum flow) cleaning solution thru one outlet tube at a time for 10 minutes each and drain through mating inlet tube.

6. Repeat 18 times and drain unit completely.

7. Fill unit with rinsewater and drain completely by opening all valves and 2" ports.

IV Vertical cleaning of gussets and wrapper plates.

1. Install the filling cradle such that all 2" filling ports except one are free of steel cross beams on the cradle and place the unit in a vertical position over a washing pit.

2. All 34 - 2" screwed plugs and 2 - 4" screwed caps removed.

3. High pressure jet straight in with cleaning solution and S/S nozzle thru each opening for 5 minutes each starting at the top and working toward the bottom on each side.

4. Repeat step 3 using a reverse jet nozzle.

V. Internal Washing

1. Rotate the unit 45° toward Y1 axis and install connections and valves in all filling ports from No. 6 to No. 27 inclusive. Filling ports that cannot be fitted with valves are to be closed with sheet rubber and wooden wedges such that they can be opened quickly for draining.

2. Open valves on ports No. 25, 26, and 27 for venting and close all valves from No. 24 to No. 6 inclusive. Install screwed plugs on ports No. 3, 4 and 5.

3. Fill the unit with cleaning solution thru the 18 upper half inlet and outlet tubes to overflow ports No. 2 and 25 on opposite sides and then stop filling.

   Agitate with air thru the 18 lower half inlet and outlet tubes for 30 minutes.

4. Close valves on ports No. 25, 26, and 27 and install screwed plugs or wedges in ports No. 28, 29 and 30 and 31.

5. Rotate the unit 90° toward Y2. Remove screwed plugs from ports No. 3, 4, and 5 and open valves on ports No. 6, 7, 8, 9 and 10.

6. Make up solution lost in agitation by filling with cleaning solution thru the 18 upper half inlet and outlet tubes to overflow at ports No. 1 and 10, and then stop filling. Agitate with air thru the 18 lower half inlet and outlet tubes for a period of 30 minutes.

7. Close valves on ports No. 6, 7, 8, 9, and 10 and rotate the unit 45° back to normal position.

8. Start maximum flow of rinse water thru the 18 upper half inlet and outlet tubes, continue air agitation and open all 2" filling ports starting at the bottom and working toward the top with one man on each side. The two 4" ports are to be opened last with an extension wrench.

9. Continue to rinse for 10 minutes after cleaning solution has drained out.

VI. Internal Rinsing.

1. Remove the 2" screwed plug from port No. 31 and install a 2" screwed plug in port No. 5.

2. With the unit in the normal position continue flow of rinse water thru the 18 upper half inlet and outlet tubes, close all ports from No. 6 to 27 inclusive starting at the bottom and working upward with one man on each side.

3. When the unit is full to overflowing, agitate with air thru the 18 lower half inlet and outlet tubes for 30 minutes.

4. Continue filling with rinse water agitate with air and open every port and drain as in Part V paragraph 8 of this procedure.

5. Allow rinse water to flow for 10 minutes and check drain water by feel for evidence of caustic. If caustic is present, repeat the rinsing operation described above.

EXHIBIT #26

FINAL INTERNAL CLEANING OF THE "L" TCP TUBE SHEET

AND RESULTS

E. I. DU PONT DE NEMOURS & CO., INC.

Report Number 578-L

Construction Division

CC: J. B. Johnson
R. K. Mason-D.A.Haucer-SEF
R. K. Mason-W.P.Duncan-SEF
H. L. Bunker-J.C.Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Bartc - NYS (3)
R. V. Graham - File

August 28, 1953
New York Ship - Camden, N. J.

FIELD INSPECTION REPORT

TO C. J. WEIN - N.S.B.B.&D.D.

FROM C. Sadowski DATE July 29, 1953

PROJECT NO. 8560 [illegible] ORDER NO. AMS-1677

EQUIPMENT Top Soil [illegible] P.O. NO. 15h-L

DRAWING NO. [illegible] J.O. RATING

VENDOR [illegible]

[illegible] clearing of the [illegible] was contracted by Bovell C[illegible] representative. The [illegible] consisted of all grass, rush, remains of clearing activities [illegible]. To accomplish this it was necessary [illegible]

The three [illegible] of the riparian plants, sensible remains, and [illegible] to level as the original base [illegible]. [illegible] shall humidify and [illegible] gathered [illegible]. These particles were carefully [illegible] of the riparian plants so the [illegible] at [illegible] and [illegible] This [illegible] surface. [illegible] solution. The remainder of the [illegible] the elevation [illegible] steps as follows.

1. [illegible] to dislodge any particles, which after [illegible] were removed by a vacuum cleaner with attachments.

FROM: C. Sadowski

II. Cleaning of gussets and trays.

The tube sheet had [illegible] up, and all pores opened. [illegible] a high speed jet (1500 psi, [illegible] reverse jet. The cleaning solution employed of 0.1% Dowfax detergent, 1.0% caustic, 1.0% [illegible] phosphate by weight, and remainder de-ionized water at [illegible] of 150°-190°F.

III. Cleaning between baffle plates [illegible]

The unit remained in [illegible] position, and all valves were closed. Through the inlet and [illegible], the pump [illegible] constant flow of cleaning [illegible] The unit was drained and [illegible] de-ionized water which was also 150°-190°F.

IV. Vertical cleaning of [illegible]

The nozzle [illegible] the unit and the tube sheet [illegible] using cleaning solution [illegible] with [illegible]

V. Internal [illegible]

[illegible]

[illegible]

EXHIBIT #29

PROFILE OF TUBE ENDS ON TOP SIDE OF THE "L"

TOP TUBE SHEET AFTER LOADING WITH RASCHIG

RINGS

[redacted]

Report Number 602-1

cc: J. T. Johnson
F. V. Mason-D.A.Mauser-SRP (2)
R. E. Mason-W.P.Duncan-SRP
H. L. Bunker-J.G.Brewer (6)
J. C. Brewer
M. B. Gage
J. C. Brenninger
S. D. Cochran (2)
R. H. Barto - NYS (3)
R. V. Graham - File

September 28, 1953
New York Ship - Camden, N. J.

FIELD INVESTIGATION REPORT

TO [redacted]

[redacted] DATE August 11, 1953

[redacted] ORDER NO. AXC-167}

[redacted] P.O.NO. 151-1

[redacted] JOB RATING [redacted]

[redacted] LOCATION Camden, N. J.

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted] REPORT
[redacted]/Louder

Reading on Y Axis

Tube # X	Tube # Y	Y1 Side of tube	Y2 Side of tube	Tube # X	Tube # Y	Y1 Side of tube	Y2 Side of tube
0	28	.000"	.002"	54	28	.000"	.000"
12	"	.002"	.002"	60	"	.0015"	.002"
18	"	.003"	.003"	66	"	.003"	.003"
24	"	.003"	.003"	72	"	.003"	.004"
30	"	.003"	.003"	78	"	.003"	.003"
36	"	.002"	.002"	84	"	.002"	.003"
42	"	.000"	.000"	90	"	.003"	.003"
48	"	.000"	.000"				

Note: Profile was taken after completion of all welding, annealing, and filling nuts with retaining rings. Unit was supported on outside - 6 positions only and no support in center.

lmw

[redacted]

EXHIBIT #30

RESULTS AND INSPECTIONS PERFORMED ON THE 9 MODIFIED ROD TUBES IN THE "L" TOP TUBE SHEET ASSEMBLY

E. I. DU PONT DE NEMOURS & CO., INC.

Report Number 660-L

Construction Division

cc: J. D. Johnson
J. T. Mason-D.A.Hauser-SRP (3)
J. T. Mason-W.P.Duncan-SRP
E. L. Bunker-J.G.Brewer
J. G. Brewer
J. B. Cage
F. C. Breuninger
S. R. Cochran (2).
R. H. Barto - NYS (3)
R. V. Graham - File

October 7, 1953
New York Ship-Camden, N.J.

FIELD INSPECTION'S REPORT

TO C. J. VEITH - [illegible] E NYS

FROM I. R. Louder DATE August 27, 1953

PROJECT NO. 4960 PLANT [illegible] PRINT NO. AMC-1678

EQUIPMENT Top Tube Seat [illegible] P.O. NO. 154-L

DRAWING NOS. [illegible]

VENDOR New York Ship[illegible] Corp. [illegible] Camden, N. J.

Final Surge [illegible]

Scope: [illegible] Lined and Clad

Procedure: To [illegible] and for a distance [illegible] dial indicator at [illegible]

[illegible]

Tube	Data	Remarks
[illegible]	[illegible]	[illegible]
150-L-17	[illegible]	[illegible]

[illegible]

Three instrument lead tubes - dwg. W-133141 Det."B"

Tube	Bore	Remarks
X36-Y44	1.317"	Bottom of tube parallel with bottom of bearing plate and at 1/8"* accepted by Design.
X53-Y 1	1.314"	Bottom of tube parallel with bottom of bearing plate and at 1/8"* accepted by Design.
X 5-Y39	X-1.324" Y-1.318"	Bottom of tube parallel with bottom of bearing plate and at 1/8"* accepted by Design.

* B/P specifies 1/4".

Nine modified rod tube inspection

2 instrument lead tubes - dwg. W-133143 Det. "A"
1 liquid level tube - dwg. W-133143 Det. "A".

Tube	Bore	Remarks
X_1 ℄	1.317"	Bottom of tube parallel with bottom of plate and at 1/8". Chamfer dia. 1.402".
X_1 ℄ towards Y_2 direction	1.314"	Bottom of tube parallel with bottom of plate and at 1/8". Chamfer dia. 1.402". One spot 3" from bottom and bore X direction 1.324".
X_1 ℄	1.316"	Bottom of tube parallel with bottom of plate and at 1/8". Chamfer dia. 1.437". One spot on bottom surface and chamfer on X_1 side of tube did not clean up.

lrw

[redacted]

EXHIBIT #31

RESULTS OF DIMENSIONAL LOCATION OF THREE INDEXING DEVICES, TWELVE BEARING PADS AND CIRCUMFERENTIAL TAKEN ON THE "L" TCP TUBE SHEET

E. I. DU PONT DE NEMOURS & CO., INC.

Report Number 559-L

Construction Division

[redacted]

CC: J. E. Johnson
A. K. Mason-D.A.Hauser-SRP (3)
R. K. Mason-W.P.Duncan-SRP
H. L. Bunker-J.G.Brewer
J. G. Brewer
H. B. Gage
F. C. Breuninger
S. R. Cochran (2)
R. H. Barto - NYS (3)
R. V. Graham - File

August 6, 1953
New York Ship - Camden, N. J.

FIELD INSPECTOR'S REPORT

TO C. J. VEITH - [illegible]

FROM R.E.Cheney - J. E. [illegible] DATE August 5, 1953

PROJECT NO. 696 [illegible] ORDER NO. [illegible]

EQUIPMENT [illegible] I.C.P.C.NO. [illegible]

DRAWING NOS. [illegible] SUB EARTH [illegible]

VENDOR [illegible]

Scope: [illegible]

Procedure: [illegible]

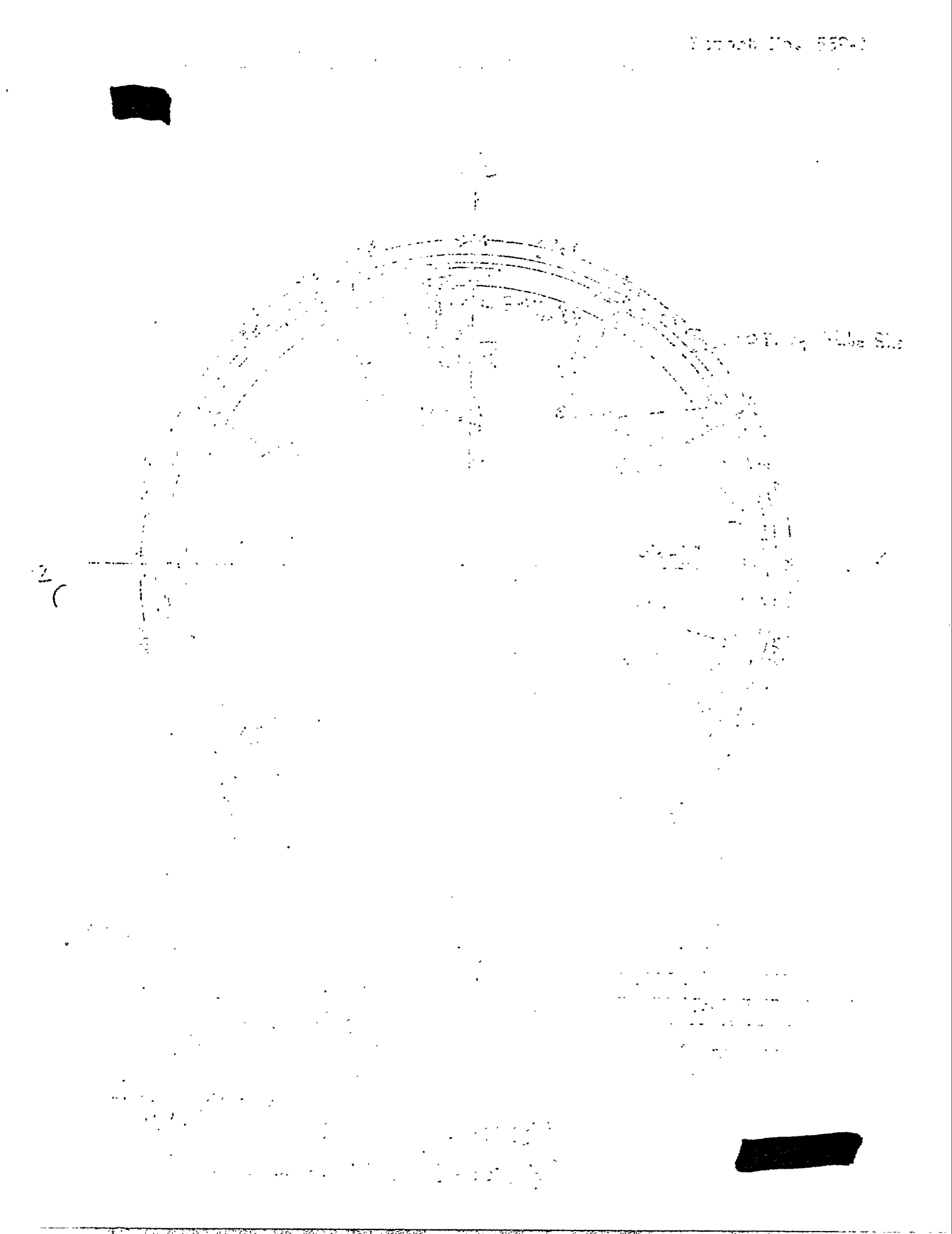
Results: [illegible]

Disposition: [illegible]

Notes: [illegible]

[redacted]

Rev
attach.



rod tube ligament measurements taken on the top side of the unit were accepted by the Design Division as being within tolerance.

(41) Inspection of Slots for Thermocouple Clips

Twelve slots located on the bottom tube plate of the "L" top tube sheet were inspected for location, depth, length and width. See du Pont drawing W-133145-R5 for specifications. The slots were all visually checked for location using a 6 in. scale graduated in 1/64 in. All slots were within drawing tolerance and accepted.

(42) Functional Gaging of Plenum Chamber and Top Tube Sheet After Filling Top Tube Sheet with Raschig Rings and Tube Repair

The inspections performed and problems encountered during final functional gaging of the plenum chamber and top tube sheet are covered in Part VII, Section I, item 16C-(22).

(43) Final Inspection of Unit and Shipping Gear Installation

The top and bottom sides of the "L" top tube sheet were jetted with air to remove all loose material present. All dirty spots on the unit were acid washed and then rinsed with city water and allowed to dry. Ferroxyl tests were performed at random to determine if any "free iron" was present on the surfaces of the unit.

Next, all tube bores were swabbed out using F.O. 128 (Fine Organics Safe-Tee Solvent) and then followed up with a dry clean cloth to remove the excess F.O. 128 and any grime left in the tube bores.

After all cleaning was completed, a visual inspection revealed a satisfactory condition of cleanliness and the unit was accepted.

However, during the process of assembling the handling jig (and aluminum disc for tube end protection) to the bottom side of the unit, interference between the jig and the 94 thermocouple studs welded to the bottom tube plate resulted. The handling jig and aluminum disc was removed. It was discovered that the thermocouple studs were protruding beyond the $\frac{1}{2}$" tube ends (referenced from bottom tube plate) which was preventing the handling jig and aluminum disc from mating flush with the bottom tube ends. (For location of thermocouple studs, see du Pont drawing D-114773.)

To correct this discrepancy, all 94 studs were ground off to $\frac{1}{2}$". After the grinding operation, the height of all thermocouple studs were checked using a 6" scale and found satisfactory. In addition, the condition of the threads were visually inspected and found free from burrs and other mechanical defects and accepted.

New York Ship re-assembled all handling equipment, "pillow cased" the unit with canvas and laced it on the outer periphery and made ready for shipping.

The "L" top tube sheet was shipped by tug boat and barge from New York Ship on October 2, 1952 to the Savannah River Plant located in the state of South Carolina.