UNCLASSIFIED

MANHATTAN DISTRICT HISTORY

BOOK IV - PILE PROJECT

X-10 ~~SECRET~~

VOLUME 3 - DESIGN

APPENDIX - A, B, C, D, [redacted] 4A

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THIS DOCUMENT CONSISTS OF 99 PAGES

NO. 4 OF 4 COPIES, SERIES A

UNCLASSIFIED

CLASSIFICATION CANCELLED
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JOHN E. HAMLOCK
REVIEWED BY
DATE 9/5/79
Erin Hulzer, D.D., 50-10.23, 10/24/05

APPENDIX A

MAPS AND DIAGRAMS

RESTRICTED DATA
This document contains restricted data as defined in the Atomic Energy Act of 1946.

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[redacted]

MANHATTAN DISTRICT HISTORY

BOOK IV - PILE PROJECT

VOLUME 3 - DESIGN

APPENDIX A

MAPS AND DIAGRAMS

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[redacted]

No.	Description
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No.	Description
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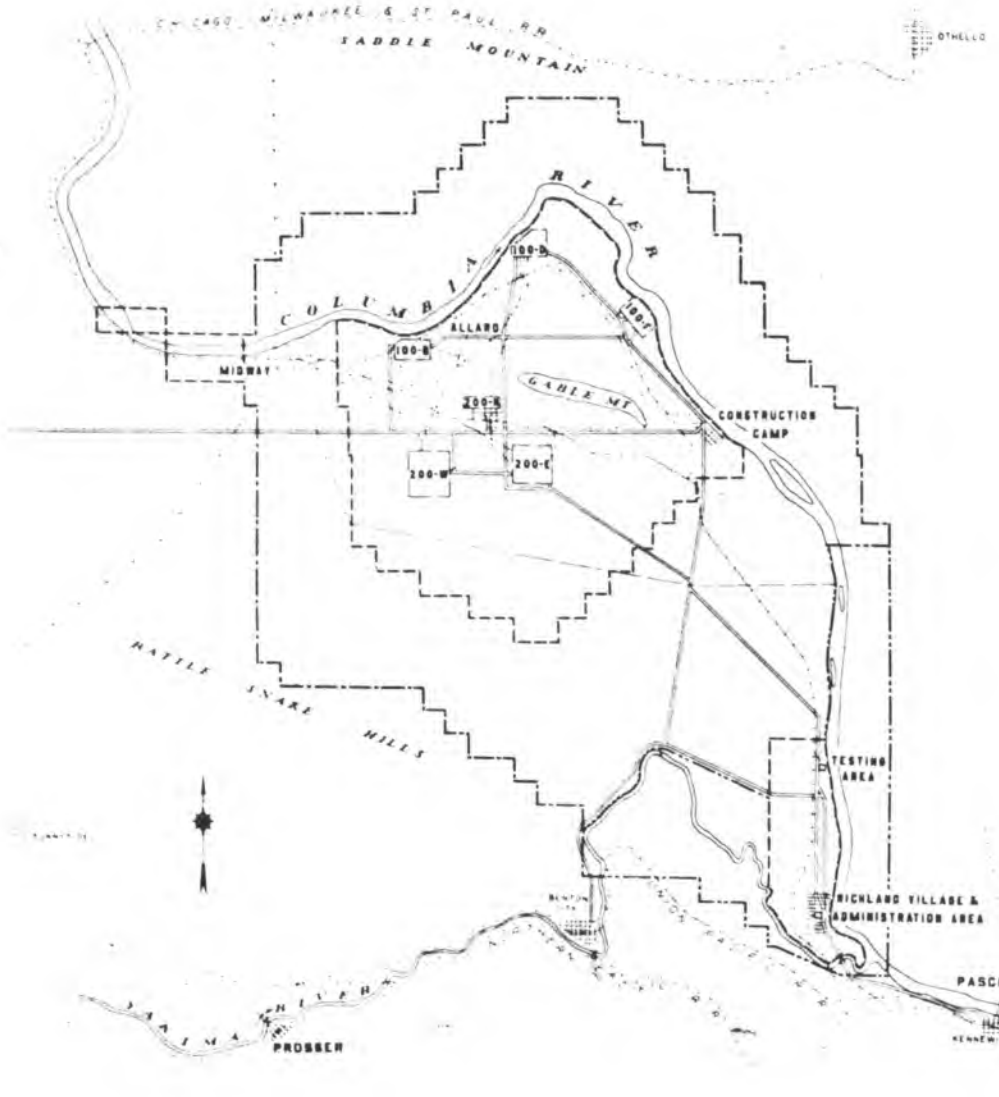
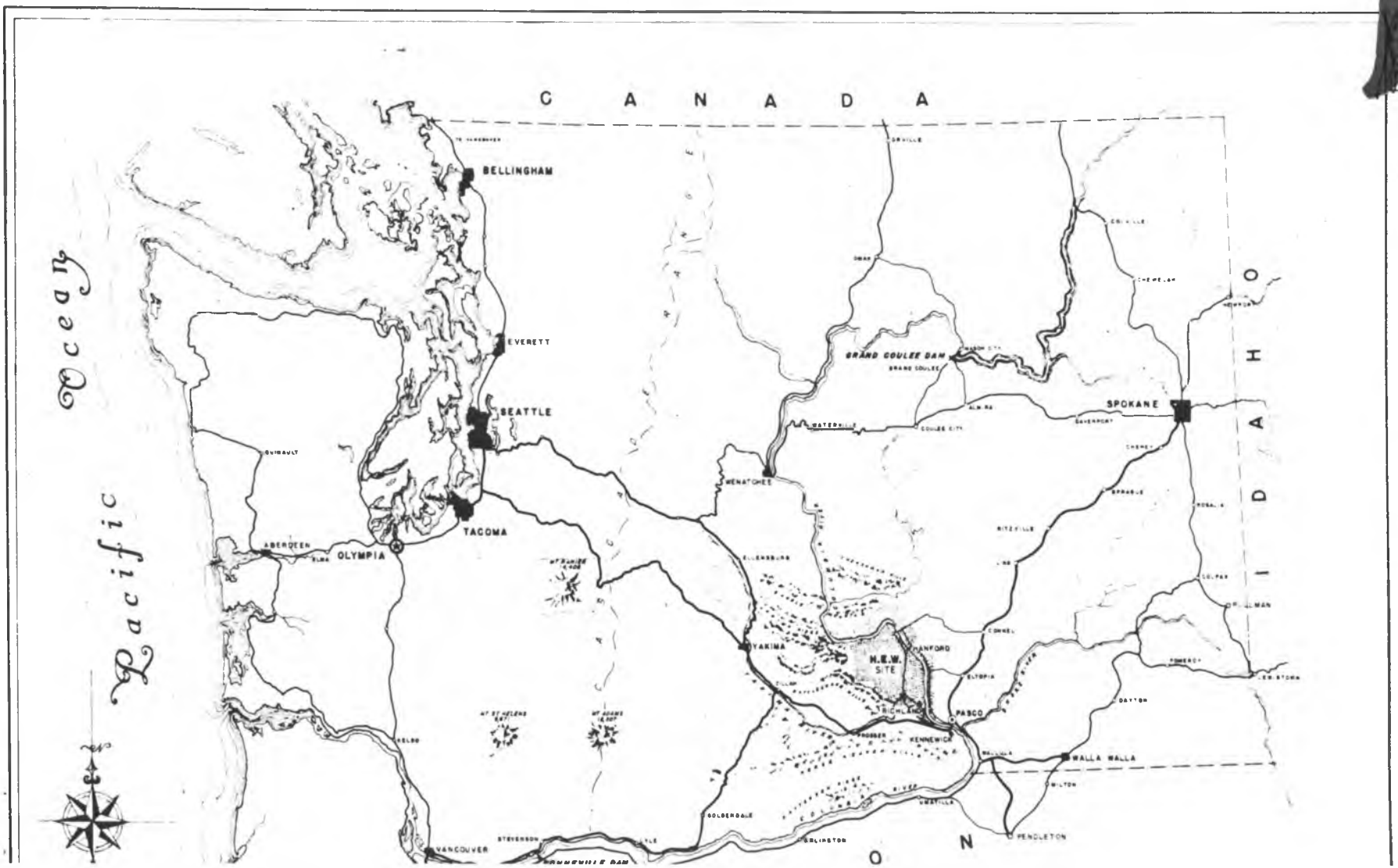


LEGEND

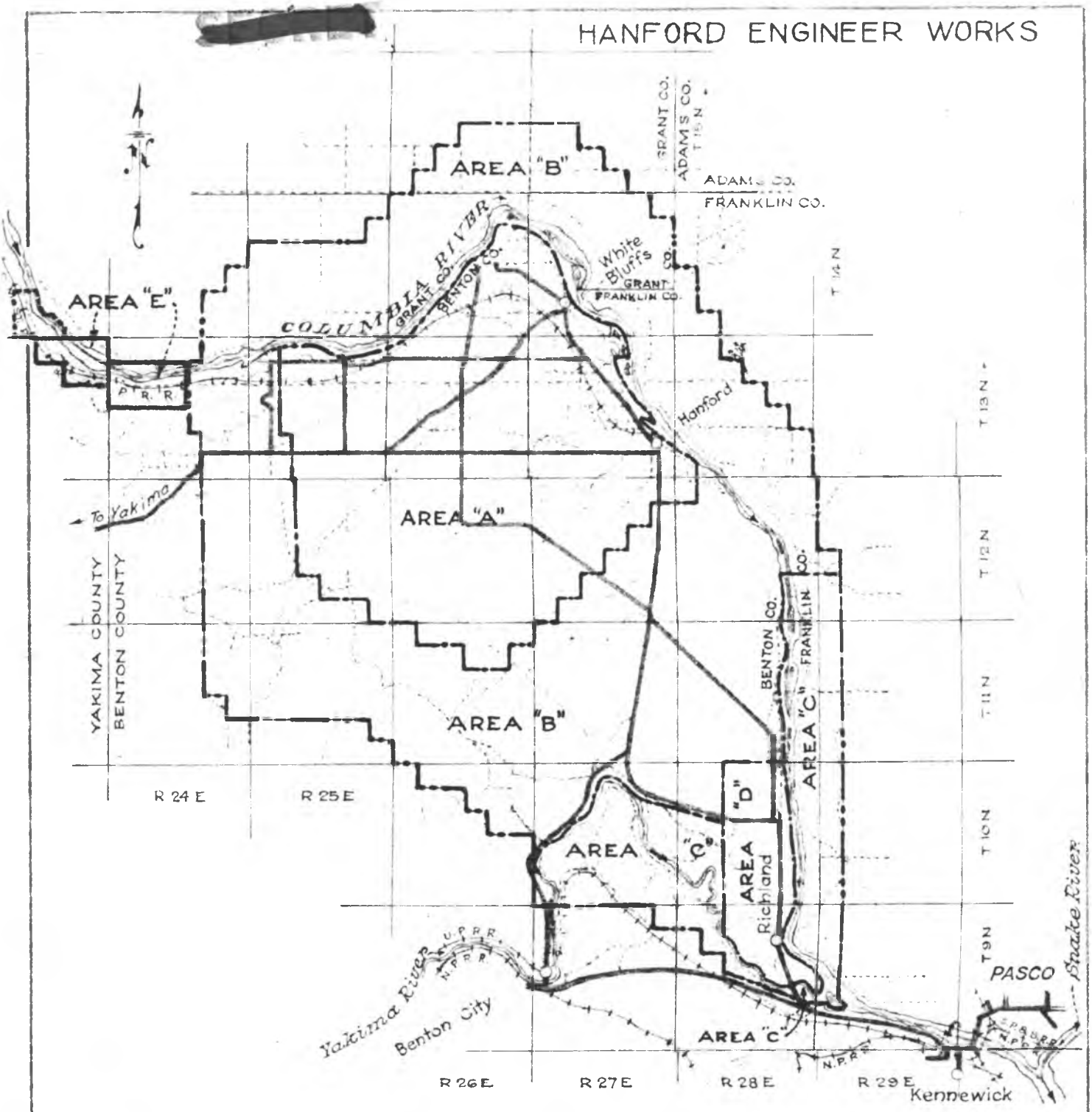
100-B	PILE AREA
100-D	" "
100-F	" "
200-N	PROCESS METAL STORAGE AREA
200-E	SEPARATION AREA
200-W	" "

- AREA ACQUIRED IN FEE
- AREA LEASED-OCCUPANTS REMOVED
- AREA LEASED-OCCUPANTS REMAIN
- ROADS
- RAILROADS
- FENCE
- POWER LINES
- WATER LINES

HANFORD ENGINEER WORKS


C A N A D A
Pacific Ocean
BELLINGHAM
EVERETT
SEATTLE
TACOMA
OLYMPIA
ABERDEEN
GRAND COULEE DAM
SPOKANE
WENATCHEE
YAKIMA
H.E.W. SITE
HANFORD
PASCO
KENNEWICK
WALLA WALLA
PENDLETON
VANCOUVER
I D A H O
O N

HANFORD ENGINEER WORKS



AREA "A" & "D"	– Acquired in fee	– * 140,081	Acres
AREA "B"	– Acquired by lease	– ** 239,014	Acres
AREA "C"	– Restrictive Agreement	– 43,227	Acres
AREA "E"	– Acquired by lease	– 6,649	Acres

* Includes 23,800 Acres of Public Domain

** Includes 45,353 " " " "

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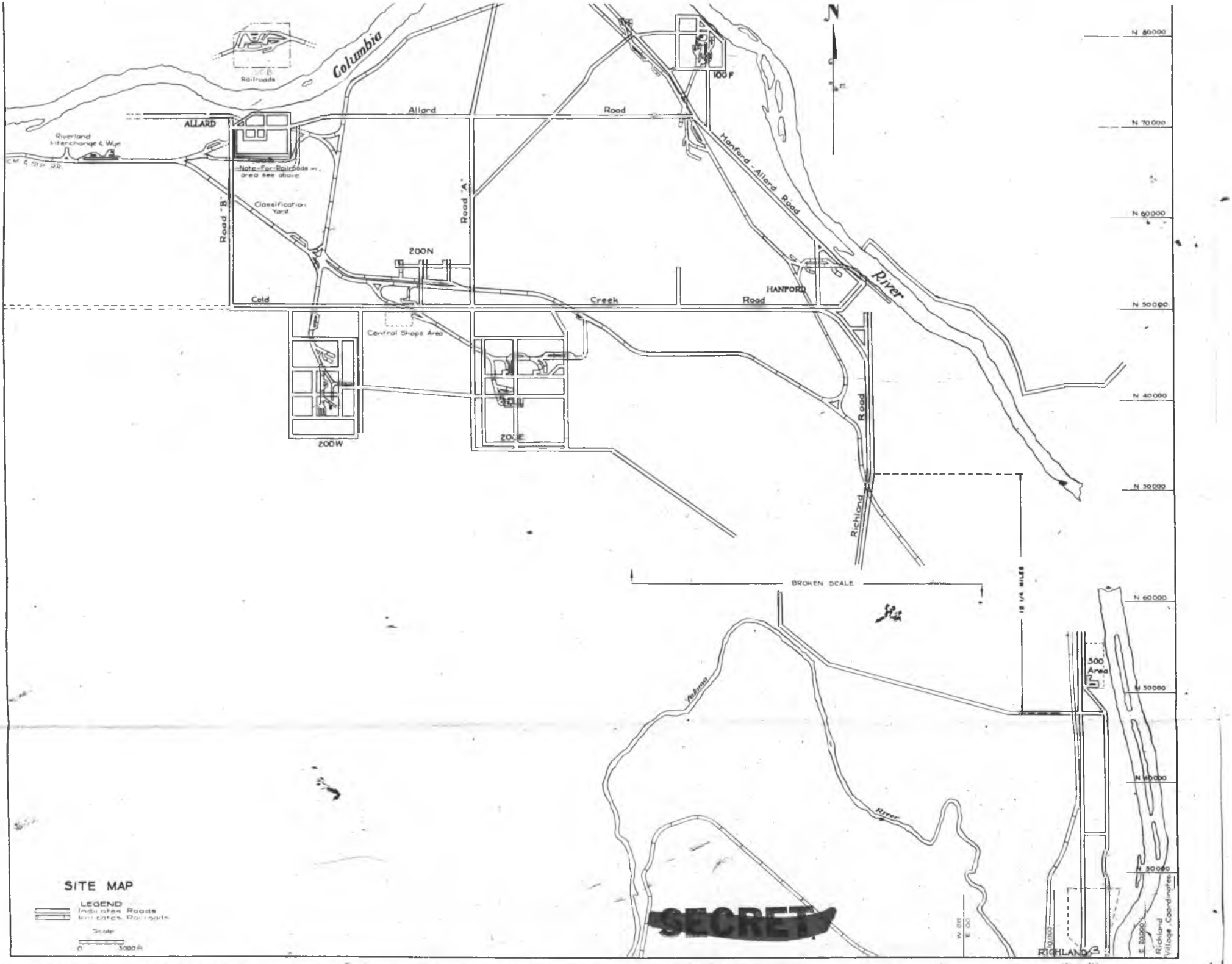
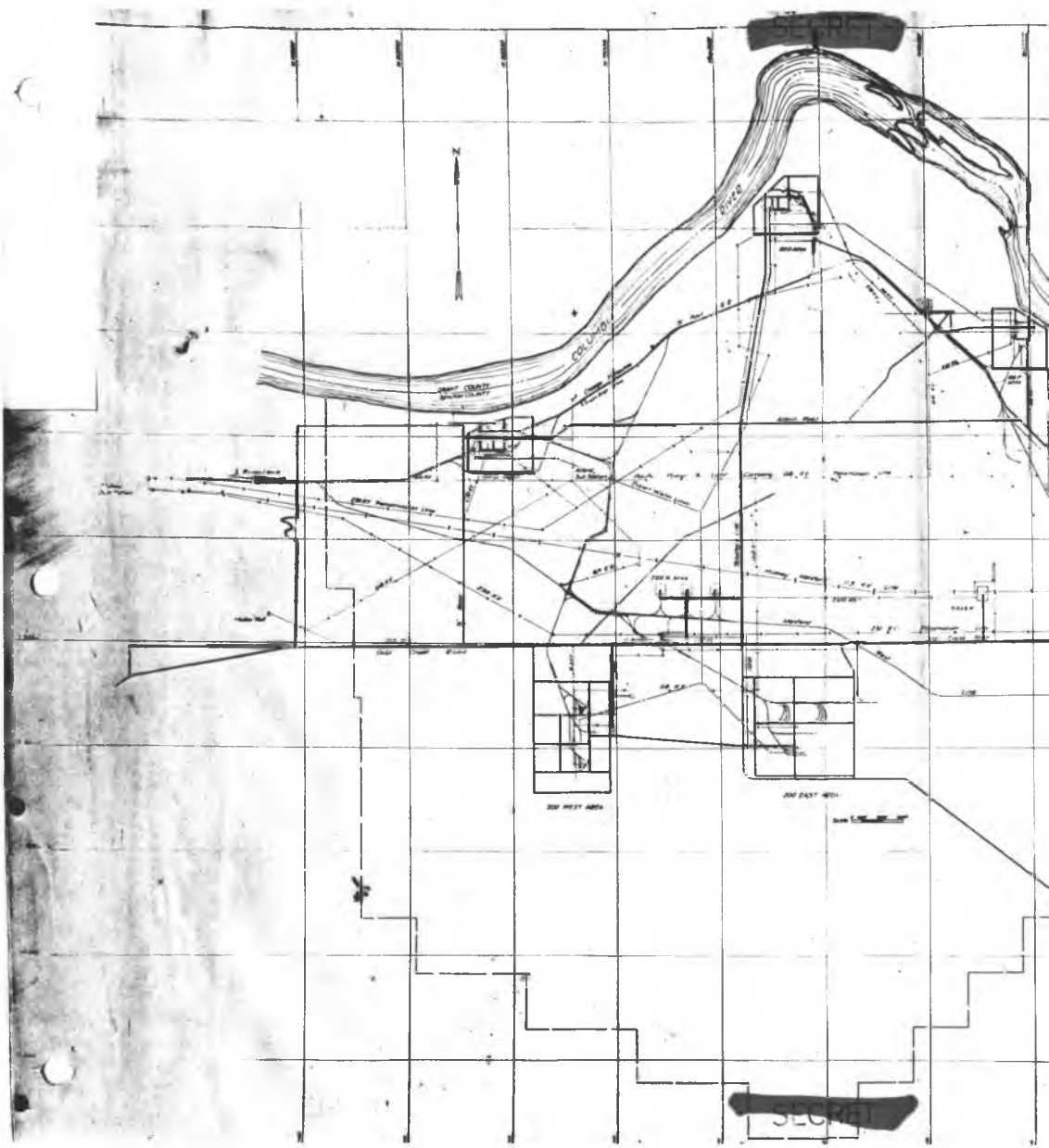
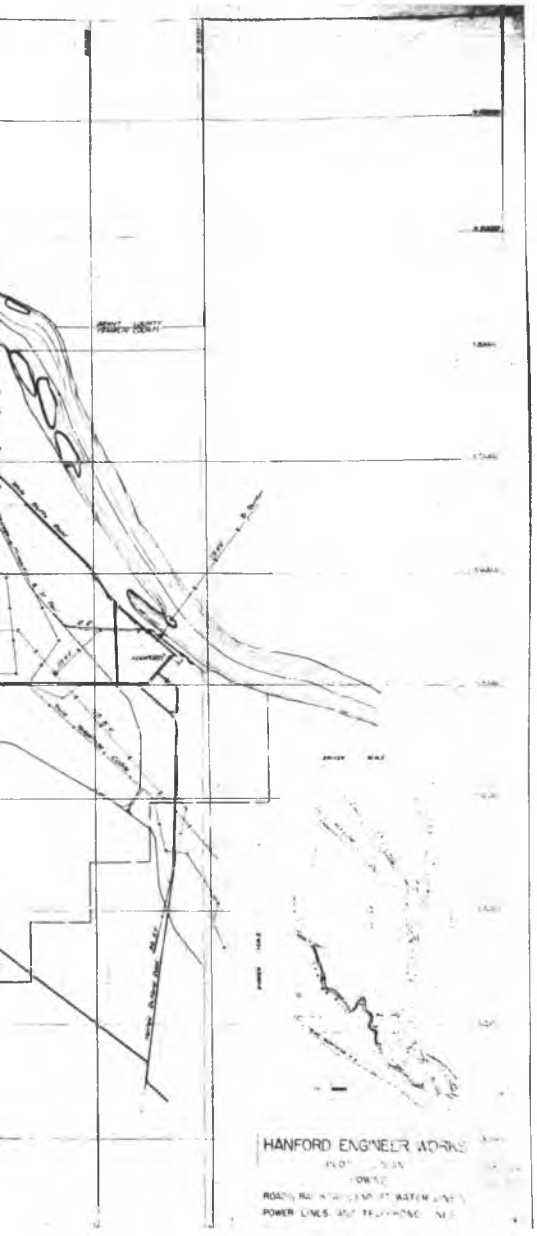
BY [illegible] DATE 2-13-29


Columbia
Railroads
ALLARD
Riverland Interchange & Wye
Note-For Railroads in area see above
Allard Road
Hanford-Allard Road
100 F
Road "A"
Road "B"
Classification Yard
200N
Cold Creek
HANFORD Road
Central Shops Area
200W
200E
Richland Road
Columbia River
N 80000
N 70000
N 60000
N 50000
N 40000
N 30000
BROKEN SCALE
15 1/4 MILES
300 Area
Yakima River
RICHLAND
SECRET
SITE MAP
LEGEND
Indicates Roads
Indicates Railroads
Scale
0 5000 ft


SECRET
N
RIVER
SECRET


HANFORD ENGINEER WORKS

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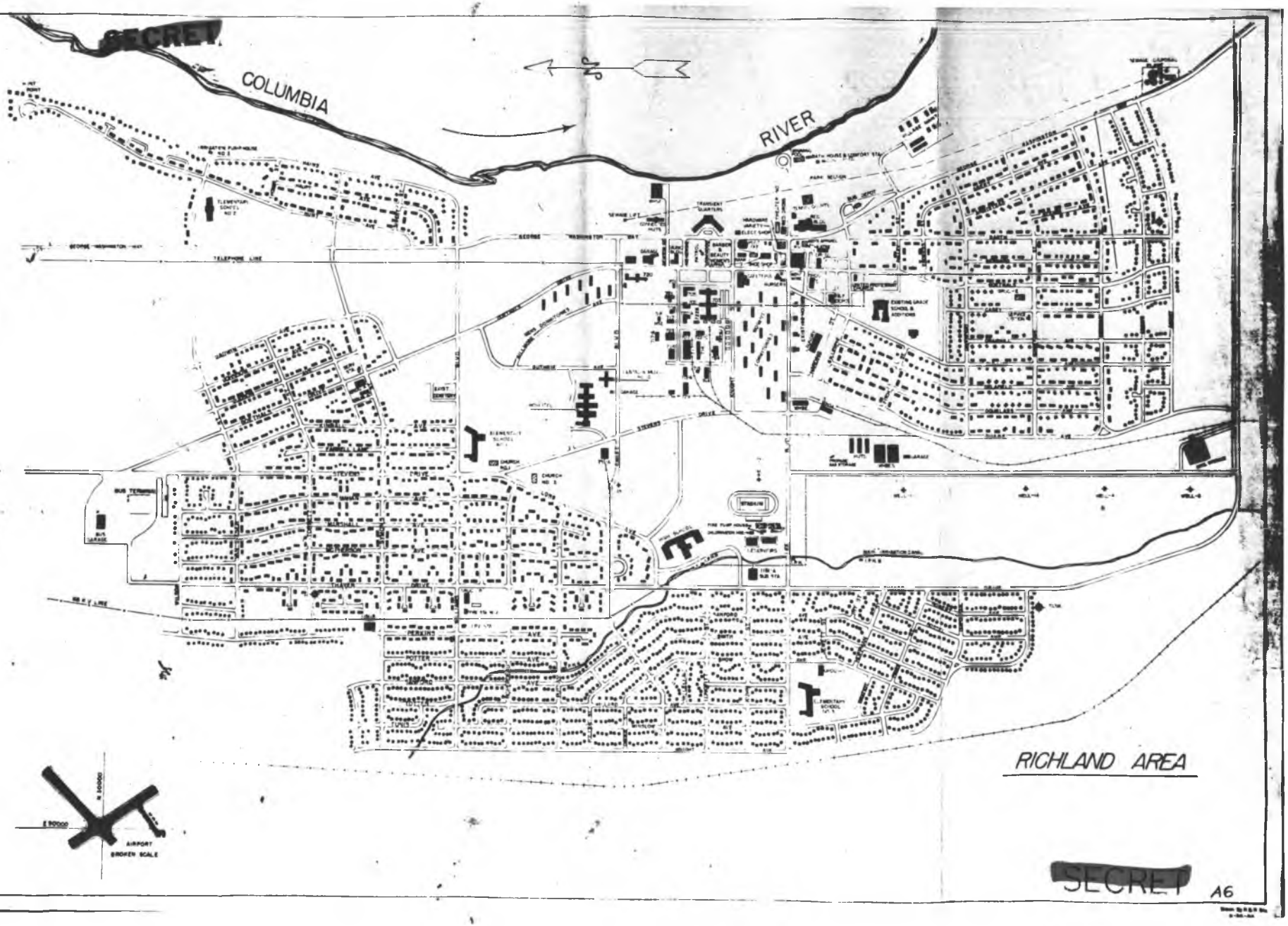

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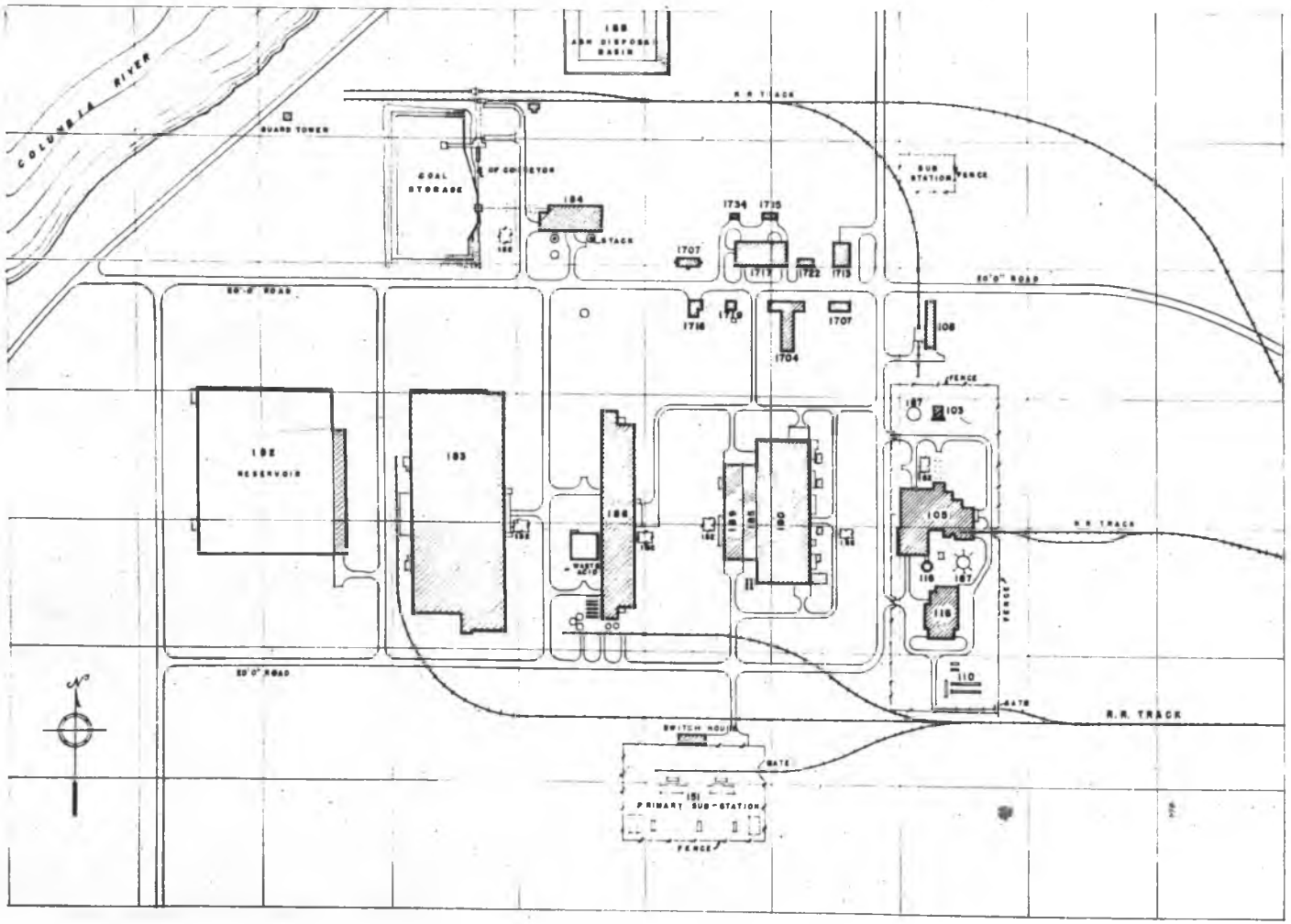
· LEGEND ·

103	METAL STORAGE
105	PILE BUILDING
107	RETENTION BASIN
108	CHEMICAL BUILDING
110	HELIUM STORAGE
115	HELIUM CIRCULATION & PURIFICATION
116	STACK
151	PRIMARY SUB-STATION
152	SECONDARY SUB-STATION
181	RIVER PUMP HOUSE
182	RESERVOIR & PUMP HOUSE
183	FILTER PLANT & PUMPS
184	POWER HOUSE
185	DEAERATING PLANT
186	DEMINERALIZATION PLANT
187	ELEVATED TANKS
188	ASH DISPOSAL BASIN
189	REFRIGERATION BLDG.
190	MAIN PUMP HOUSE
1701	GATE HOUSE & CLOCK ALLEY
1704	SUPERVISOR'S OFFICE & LAB.
1707	CHARGE HOUSE
1708	FIRE HEADQUARTERS
1715	STOREROOM
1716	OIL & PAINT STORAGE
1717	AUTOMOTIVE REPAIR SHOP
1718	COMBINED SHOPS
1719	FIRST AID
1720	PATROL HEADQUARTERS
1722	AREA SHOP
1734	CYLINDER STORAGE



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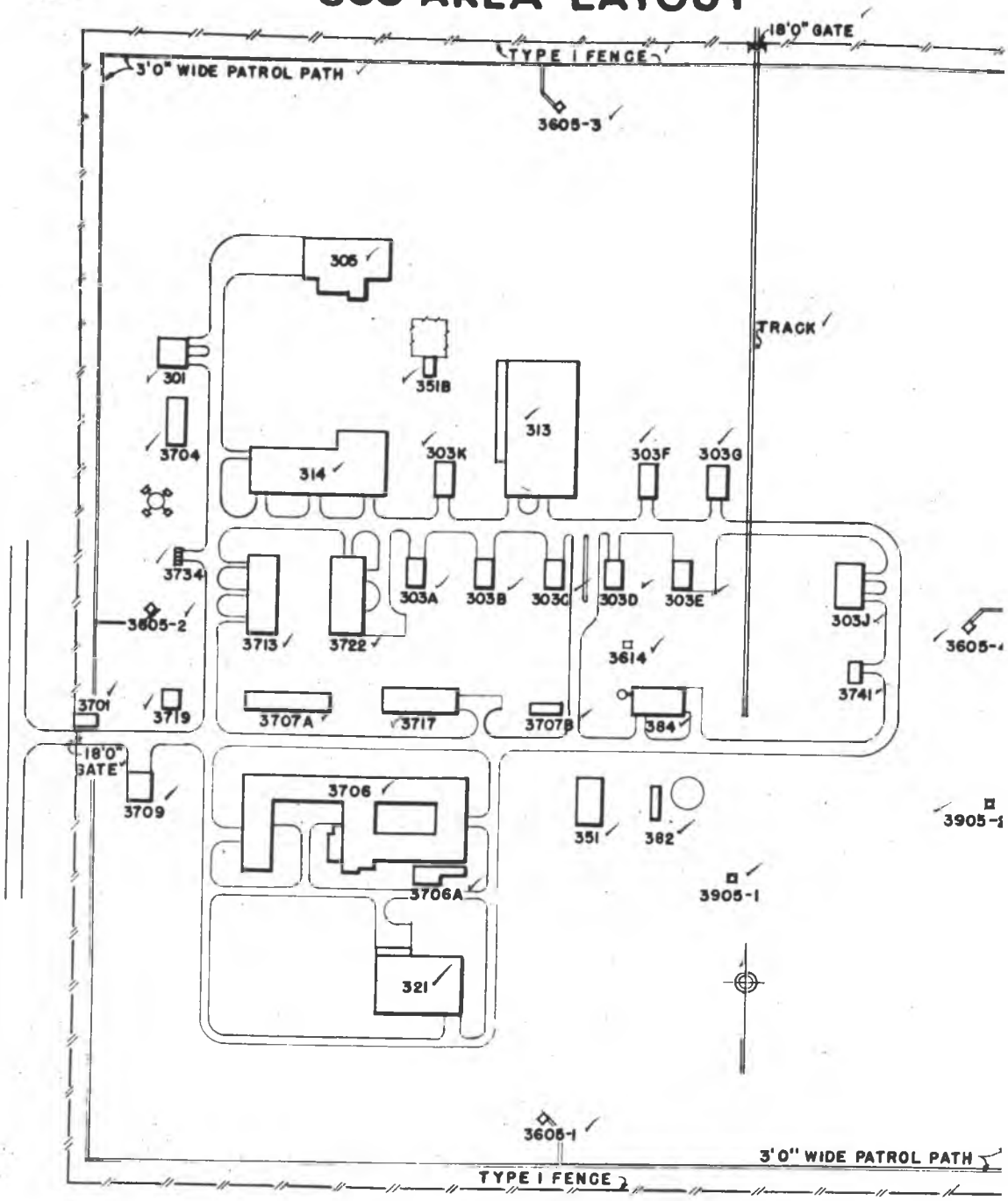
METAL FABRICATION AND TESTING

300 AREA LAYOUT



· LIST OF BUILDINGS ·

- 301 STORAGE - GRAPHITE
- 303 - A, B, C, D, E, F, G, J, K. METAL STORAGE BLDGS.
- 305 TEST PILE
- 313 SLUG MACHINING AND CANNING
- 314 ROD EXTRUSION
- 321 SEPARATION LABORATORY
- 351 - 351-B SUB STATION
- 382 PUMP HOUSE
- 384 BOILER HOUSE
- 3605 - 1, 2, 3 & 4 GUARD TOWERS
- 3614 MONITOR STATION
- 3701 GATE HOUSE
- 3704 SUPERVISOR'S OFFICE
- 3706 LABORATORY
- 3706 - A AIR CONDITIONING
- 3707 - A CHANGE HOUSE
- 3707 - B CHANGE HOUSE
- 3709 FIRE HEADQUARTERS
- 3713 STORE ROOM - SUPPLIES
- 3717 INSTRUMENT SHOP
- 3719 FIRST AID
- 3722 AREA MAINTENANCE SHOP
- 3734 CYLINDER STORAGE
- 3741 BOX STORAGE
- 3905 - 1, 2 WELLS

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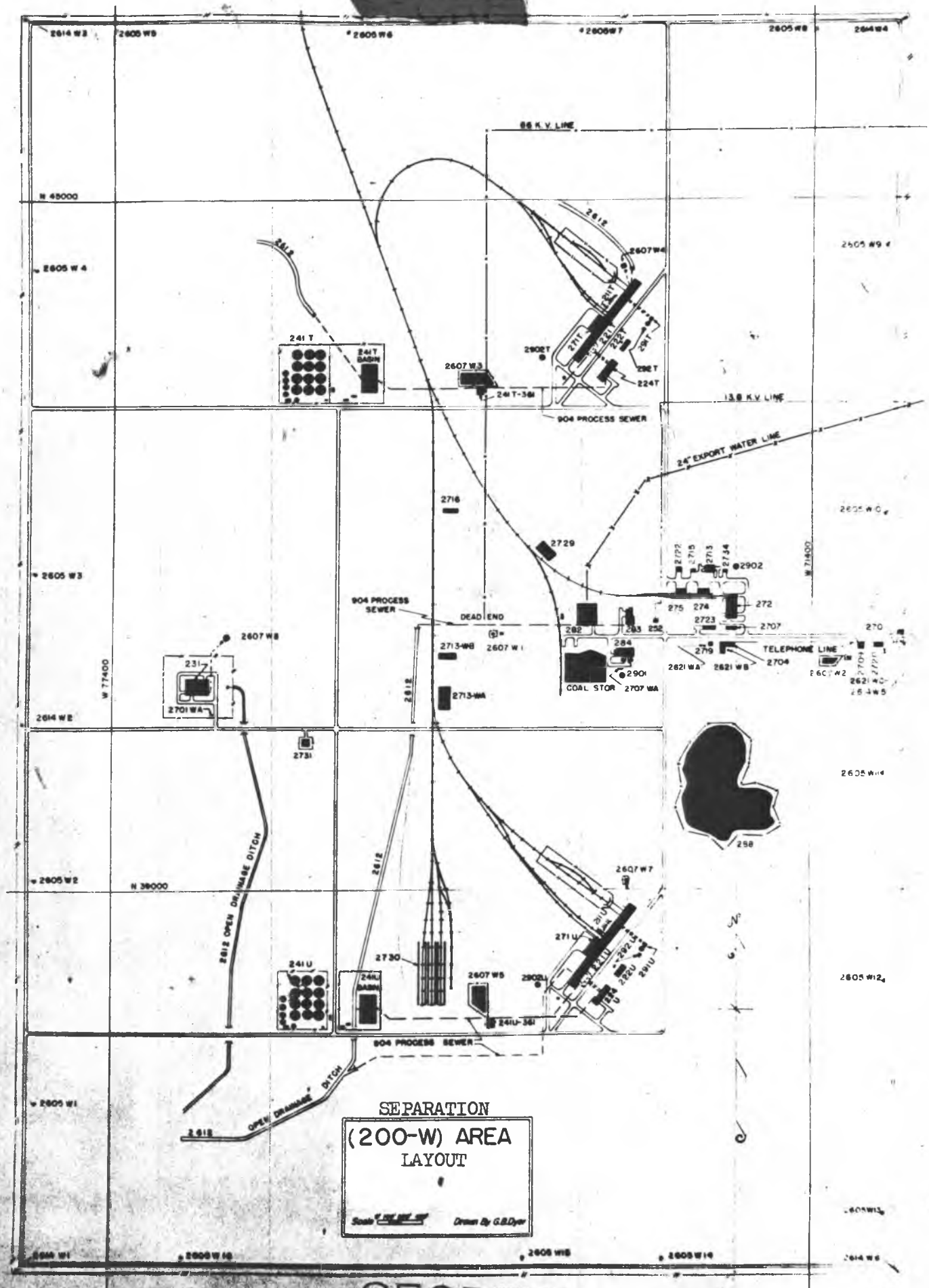
APPENDIX A 9

SEPARATION AREA LAYOUT

Legend

211 - Tank Farm
221 - Separation Building
222 - Sample Preparation Building
224 - Concentration Building
231 - Isolation Building
241 - Waste Disposal
252 - Secondary Substation
271 - Service Building
272 - Shops
274 - Machinery Store-House
275 - Chemical Store-House
282 - Reservoirs and Pump House
285 - Filter Plant
284 - Power House
291 - Ventilation Building
2901 - Water Storage
2902 - Water Storage
2704 - Supervisors' Office
2707 - Change House
2715 - Store Rooms
2718 - Oil and Paint Storage
2719 - First Aid
2722 - Paint and Riggers Shop
2725 - Laundry
2734 - Cylinder Storage


66 K.V. LINE
N 45000
2605 W 4
241 T
241 T BASIN
2607 W3
241 T-361
2902T
2907T
2911T
2921T
2931T
2941T
2607 W4
2612
904 PROCESS SEWER
138 K.V. LINE
24" EXPORT WATER LINE
2716
2729
2605 W 3
2722
2715
2713
2734
2902
W 71400
275
274
272
2723
2707
270
282
283
252
284
2713-WB
2607 W 1
2713-WA
DEAD END
904 PROCESS SEWER
2621 WA
2621 WB
2704
TELEPHONE LINE
2901
COAL STOR
2707 WA
2607 W8
231
2701 WA
W 77400
2614 W2
2731
2612 OPEN DRAINAGE DITCH
2605 W2
N 39000
2730
241 U
241 U BASIN
2607 W5
2902U
241 U-361
2607 W7
271 U
2912U
2922U
2932U
2942U
2911U
904 PROCESS SEWER
OPEN DRAINAGE DITCH
2605 W1
2612
258
2605 W14
2605 W12
2605 W13
2614 W1
2605 W10
2605 W15
2605 W16
2614 W6
SEPARATION
(200-W) AREA
LAYOUT
Scale
Drawn By G.B.Dyer

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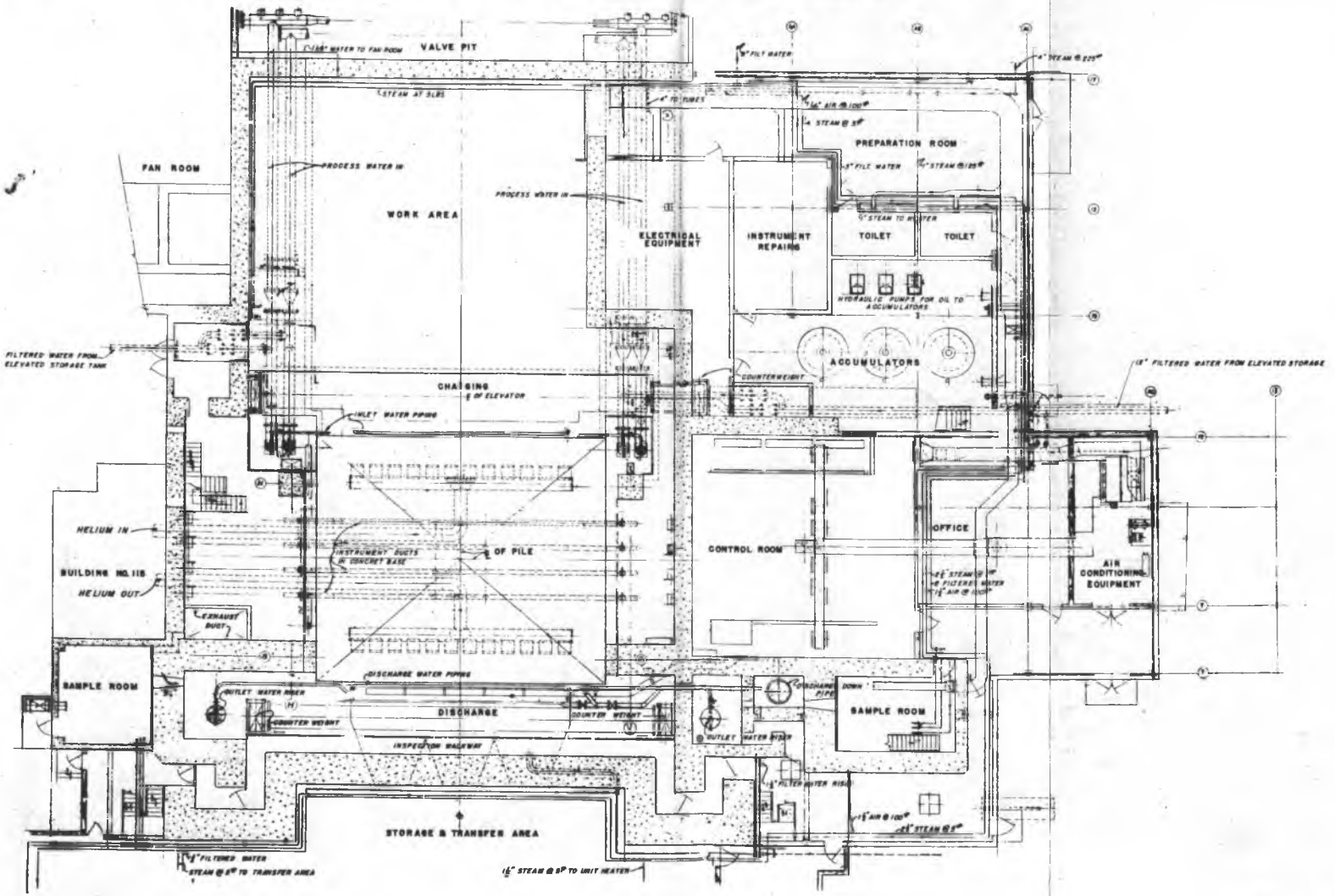
GROUND FLOOR PLAN OF BUILDING NO. 105



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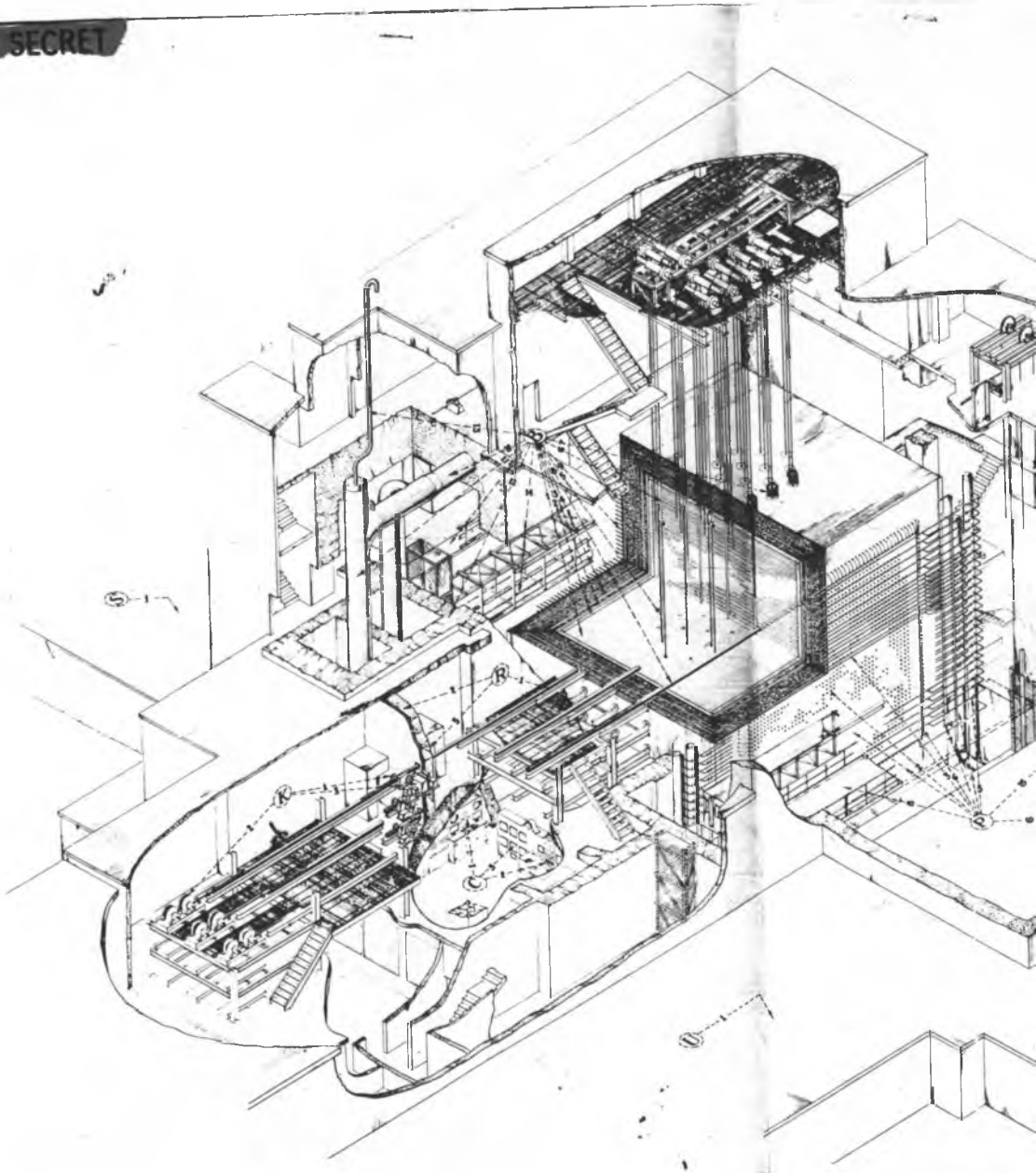

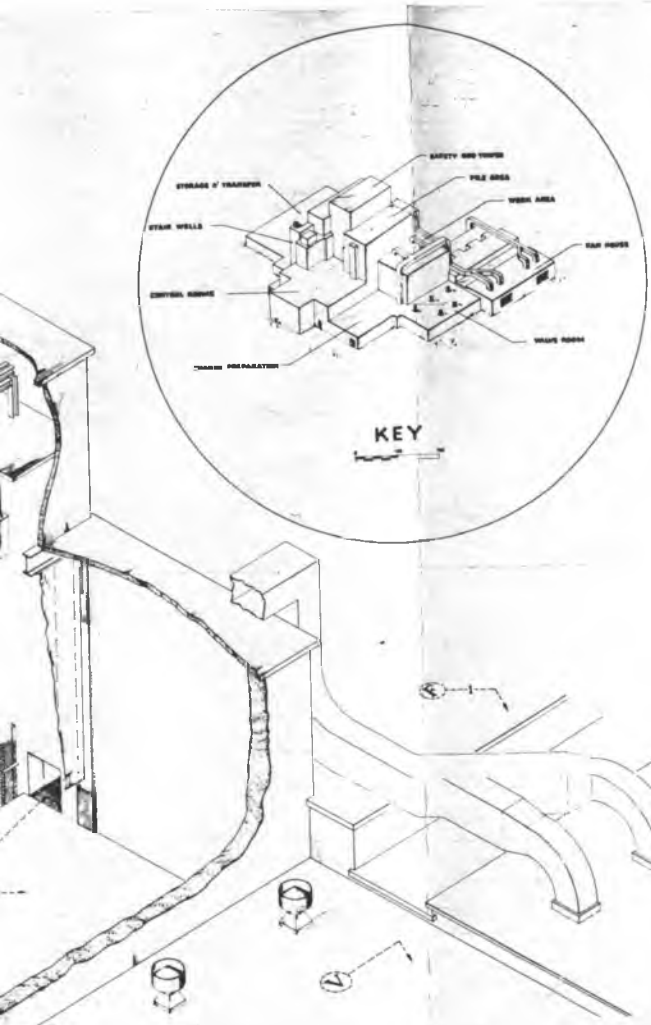

HANFORD ENGINEER WORKS

PILE BUILDING

CHARGING FACE

J.A.W., H.L.C., 1944-4-10


NEER WORKS
ILDING
G FACE
CHARGE PREPARATION
C-1 HANDLING OF URANIUM SLUGS PREPARATORY TO LOADING THEM IN PILE.
FACE OF PILE
F-1 SHIELD COMPOSED OF LAMINATIONS OF STEEL AND MAGNETITE.
F-2 RUN TUBES PROJECT THROUGH SHIELD AND PILE.
F-3 HEADERS CARRY WATER TO TUBES. FLOW CONTROLLED BY ADJUSTABLE ORIFICE IN EACH TUBE.
F-4 RUBBER FEED HEADERS. THIS RUBBER MAKE IT POSSIBLE TO FEED MOST ACTIVE TUBES WITH REFRIGERATED WATER, LESS ACTIVE TUBES WITH WATER AT NORMAL RIVER TEMPERATURE. GIVEN MAXIMUM POWER.
F-5 VALVE ON EACH HEADER.
F-6 TUBES FOR COOLING OF SHIELD OF PILE.
F-7 AUXILIARY PIPING SYSTEM MAKES POSSIBLE DRAINING OF ANY SELECTED HEADER AT TIME OF LOADING PILE.
F-8 ELEVATOR PLATFORM FOR USE IN LOADING TUBES AND FOR ANY WORK ON PILE FACE. CAN BE WITHDRAWN INTO ELEVATOR PIT BELOW.
F-9 MAIN AREA. LENGTH DETERMINED BY POSSIBILITY OF HANDLING TO REMOVE ALUMINUM TUBE FROM PILE. DUCT LEADS IN AIR FOR VENTILATION AND REMOVAL OF RADIOACTIVE EMANATIONS.
F-10 CANVAS CURTAIN FORCES VENTILATION TO SWEEP OVER WHOLE FACE OF PILE.
FAN HOUSE
F-1 EQUIPMENT FOR CIRCULATING AIR THROUGH PILE BUILDING TO REMOVE RADIOACTIVE GASES.
VALVE ROOM
V-1 VALVES FOR CONTROL OF FLOW OF WATER IN INLET PIPES
FROM BALCONY
B-1 GRAPHITE BLOCKS IN PILE LAID UP IN CRISS-CROSS ARRAY
B-2 THERMAL SHIELD CONSTRUCTED OF IRON TO REMOVE MAJOR PART OF HEAT OF EMERGENT NEUTRONS AND GAMMA RAYS.
B-3 GAP FOR ENTRANCE OF HELIUM INTO PILE; DISPLACES NITROGEN, NEUTRON ABSORBING CONSTITUENT OF AIR
B-4 LAMINATED SHIELD TO LOWER INTENSITY OF RADIATIONS TO LEVEL SAFE FOR PERSONNEL.
B-5 SAFETY RODS CONSTRUCTED OF NEUTRON ABSORBING MATERIAL DROPPED INTO PILE IN CASE OF EMERGENCY TO BRING NEUTRON CHAIN REACTION TO QUICK HALT
B-6 CABLES ATTACHED TO RODS LEAD TO HYDRAULIC WINCHES.
B-7 HYDRAULIC BUFFERS TO BREAK SHOCK OF FALL OF WHICH BRAKES FAIL.
B-8 RODS USED FOR CONTROL BY REACTION UNDER NORMAL OPERATING CONDITIONS.
B-9 ALUMINUM TUBES LEAD WARMED WATER FROM PILE TO HORIZONTAL HEADERS (NOT SHOWN).
B-10 HORIZONTAL CONNECTOR COMBINES WATER FROM SIX'S EXIT RISERS.
B-11 DOWNCOMER CARRIES RADIOACTIVE DISCHARGED WATER TO SHIELDED CANAL WHICH LEADS TO SETTLING BASIN AND RIVER.
B-12 CONCRETE WALLS SHIELD OPERATORS FROM PENETRATING RADIATIONS COMING FROM RADIOACTIVE WATER.
B-13 VENT PIPE PREVENTS FORMATION OF VACUUM. IT IS IMPORTANT THAT WATER SHALL NOT BE SIPHONED OUT OF PILE IN CASE THE INLET PUMPS FAIL.
B-14 ELEVATOR PLATFORM ALLOWS OPERATOR TO UNSCREW CAPS AT ENDS OF TUBES AT TIMES OF DISCHARGE OF IRRADIATED URANIUM
B-15 BALCONY FOR INSPECTION OF REAR FACE OF PILE AND WATER BASIN BELOW INTO WHICH SLUGS FALL.
ROD ROOM
R-1 FIVE RODS OF WHICH SEVEN MAY BE USED FOR COMPENSATION OF MAJOR PART OF UNUSED MARGIN OF MULTIPLICATION FACTOR AND TWO FOR THE MINUTE-TO-MINUTE CONTROL OF THE CONSTANCY OF THE POWER OUTPUT.
R-2 LEAD-CONCRETE WALL PROTECTS OPERATORS BUTTONS AGAINST ACTIVITY INDUCED IN CONTROL RODS WHILE THEY ARE IN PILE.
R-3 LABYRINTH PREVENTS ESCAPE OF RADIATION FROM RODS BUT MAKES POSSIBLE ENTRANCE TO ROD ROOM AFTER DECAY OF ACTIVITY.
BACK ROOM
R-1 RACK AND PINION DRIVE OF CONTROL RODS.
R-2 FLEXIBLE HOSES CONNECTING FROM STEELS CARRY COOLING WATER TO RODS AND LEAD HEATED WATER AWAY FROM RODS.
R-3 SELSYN MOTOR TRANSMITS TO CONTROL ROOM INDICATION OF POSITION OF CONTROL RODS.
CONTROL ROOM
C-1 LIGHTS ON CONTROL PANEL GIVE INDICATION IF TEMPERATURE OF EXIT WATER IN ANY TUBE EXCEEDS PERMISSIBLE VALUE. SIMILAR PANEL FACING THIS ON OPPOSITE SIDE OF ROOM GIVES INDICATION IF PRESSURE AT INLET OF ANY TUBE EXCEEDS OR FALLS BELOW PERMISSIBLE RANGE.
C-2 CONTROL PANEL PROVIDES INDICATION OF POSITION OF RODS AND OF OTHER OPERATING CONDITIONS. OPERATOR ADJUSTS POWER LEVEL BY ALTERING POSITION OF RODS BY REMOTE CONTROL.
C-3 POWER OUTPUT INDICATED ON PANEL. METER WORKS ON BASIS OF READINGS OF WATER FLOW AND INLET AND OUTLET TEMPERATURES.
STORAGE AND TRANSFER
S-1 BASIN FOR TEMPORARY UNDERWATER STORAGE OF IRRADIATED URANIUM SLUGS. EQUIPMENT FOR TRANSFER OF SLUGS TO CARS WHICH CARRY THEM TO STORAGE AREA.
FURTHER DETAILS SHOWN ON ISOMETRIC VIEW OF PILE BUILDING FROM DISCHARGE FACE.
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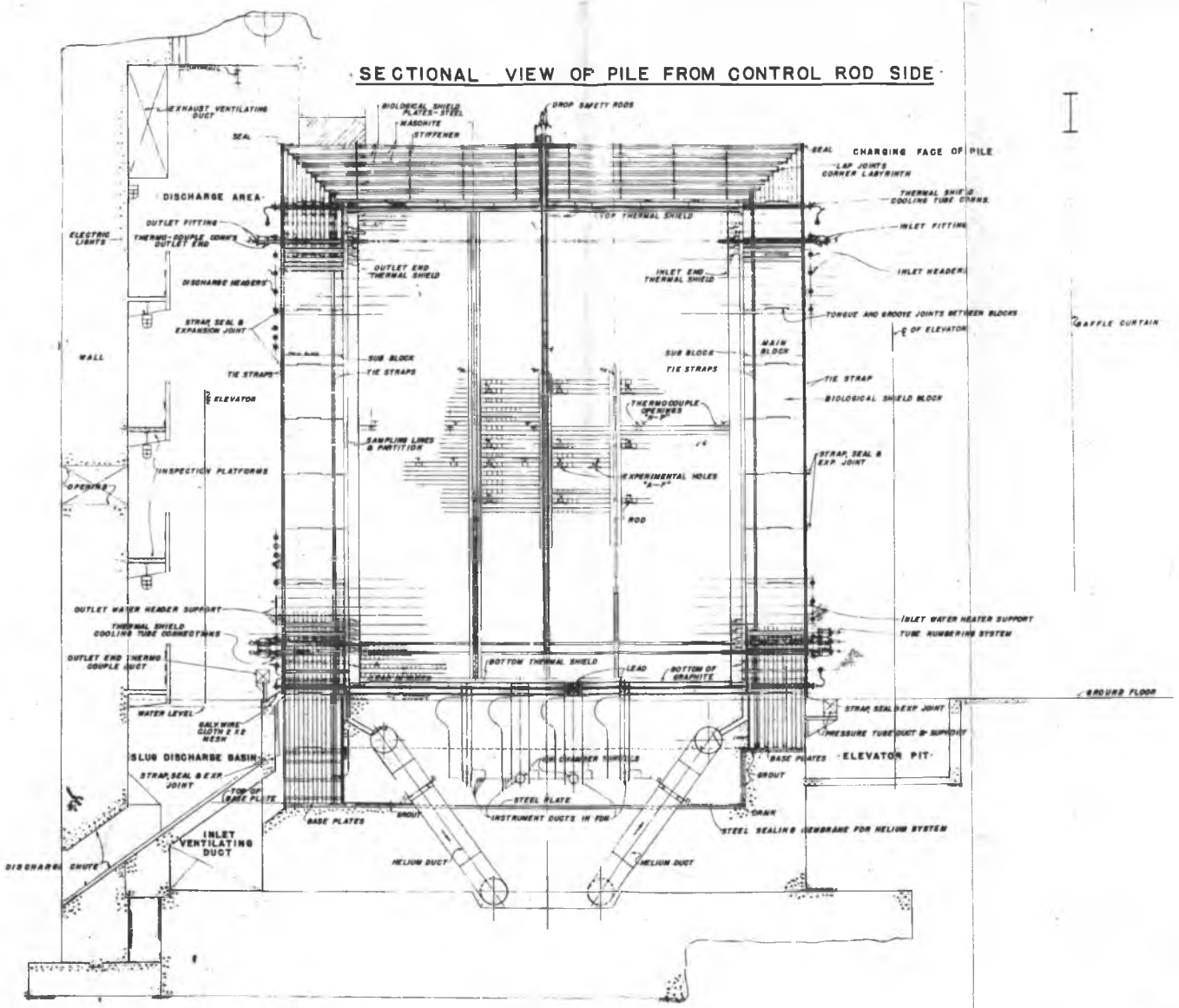
SECTIONAL VIEW OF PILE FROM CONTROL ROD SIDE



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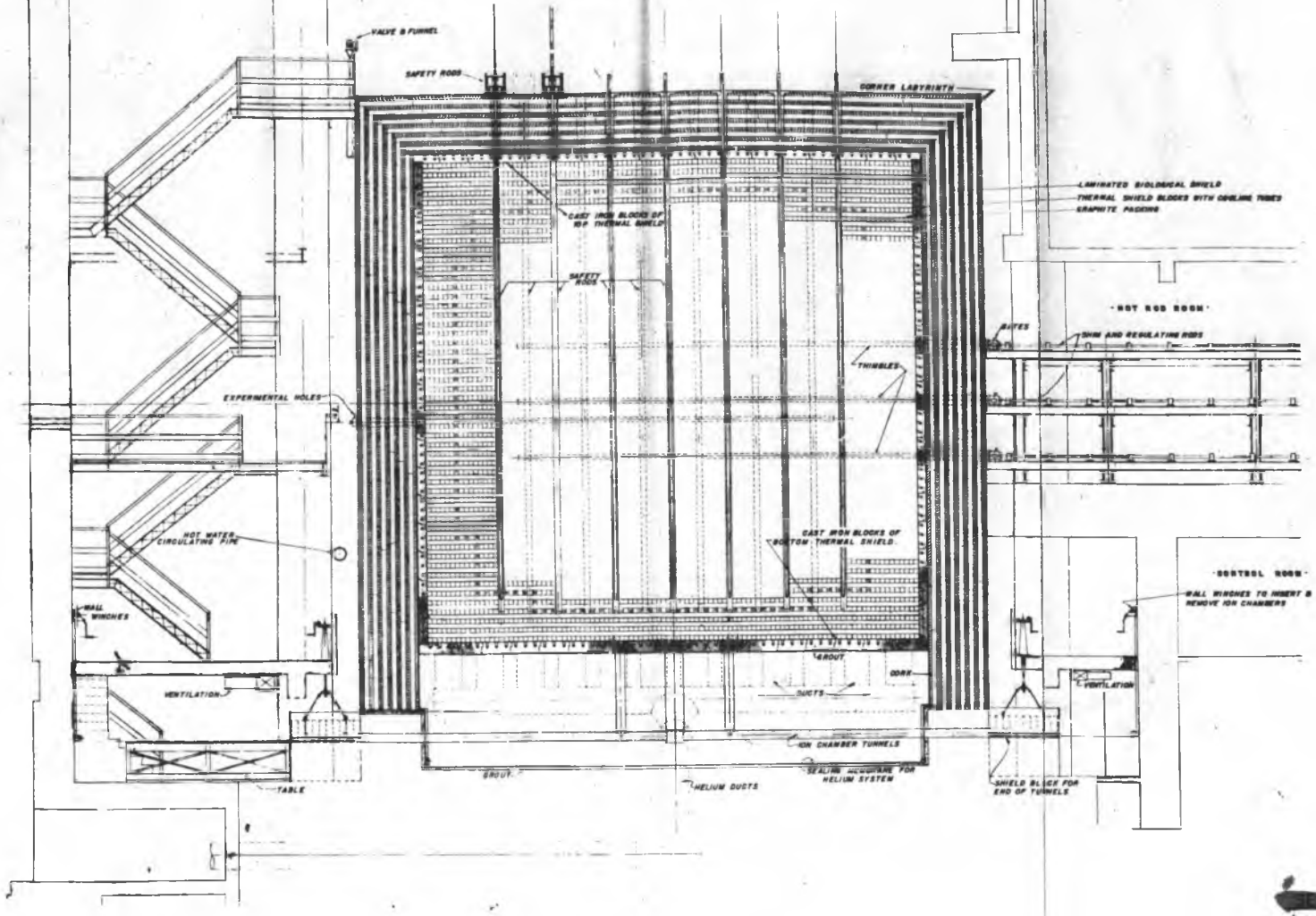
SECTIONAL VIEW OF PILE FROM DISCHARGE END



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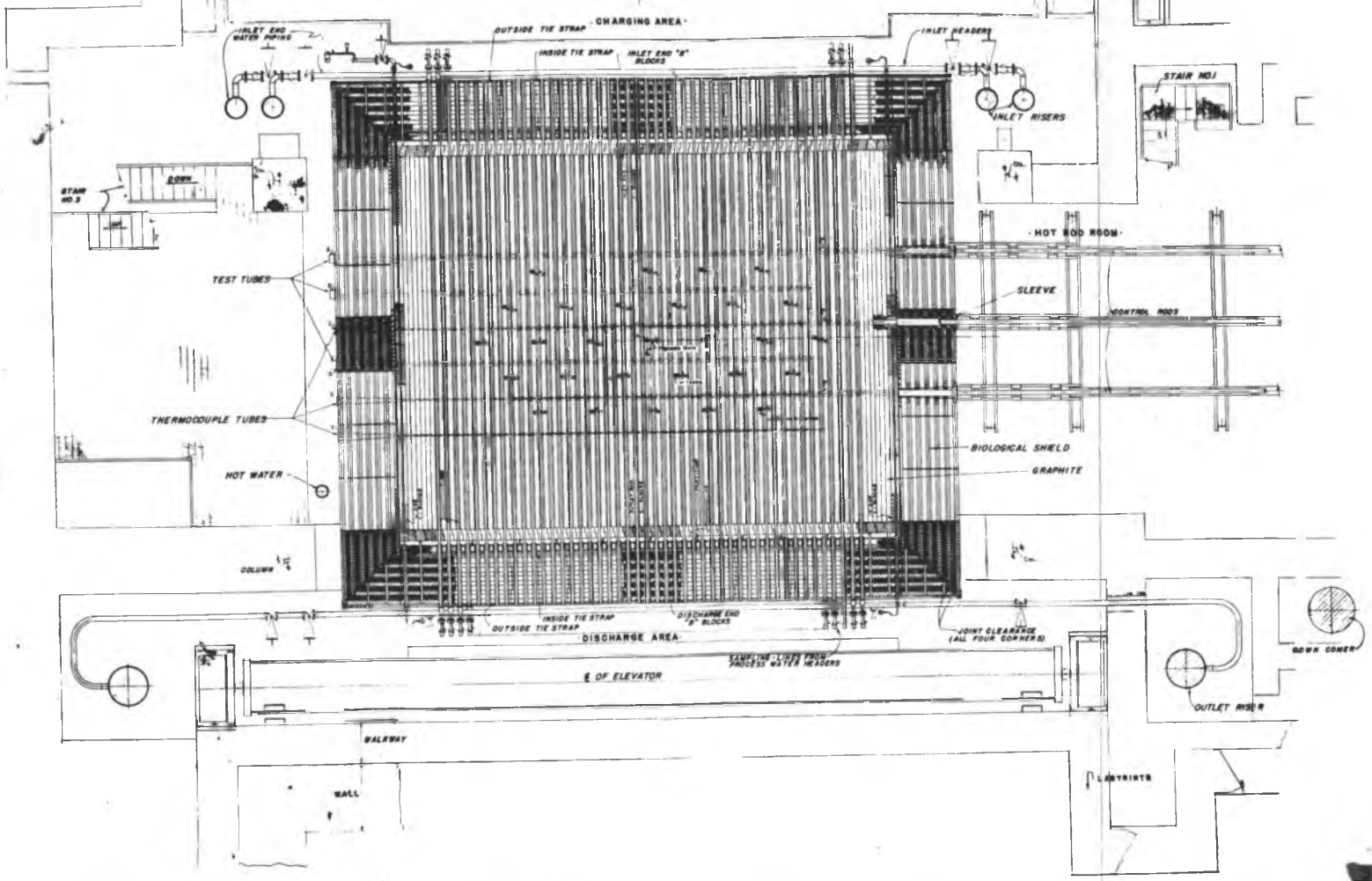
SECTIONAL VIEW OF PILE FROM TOP



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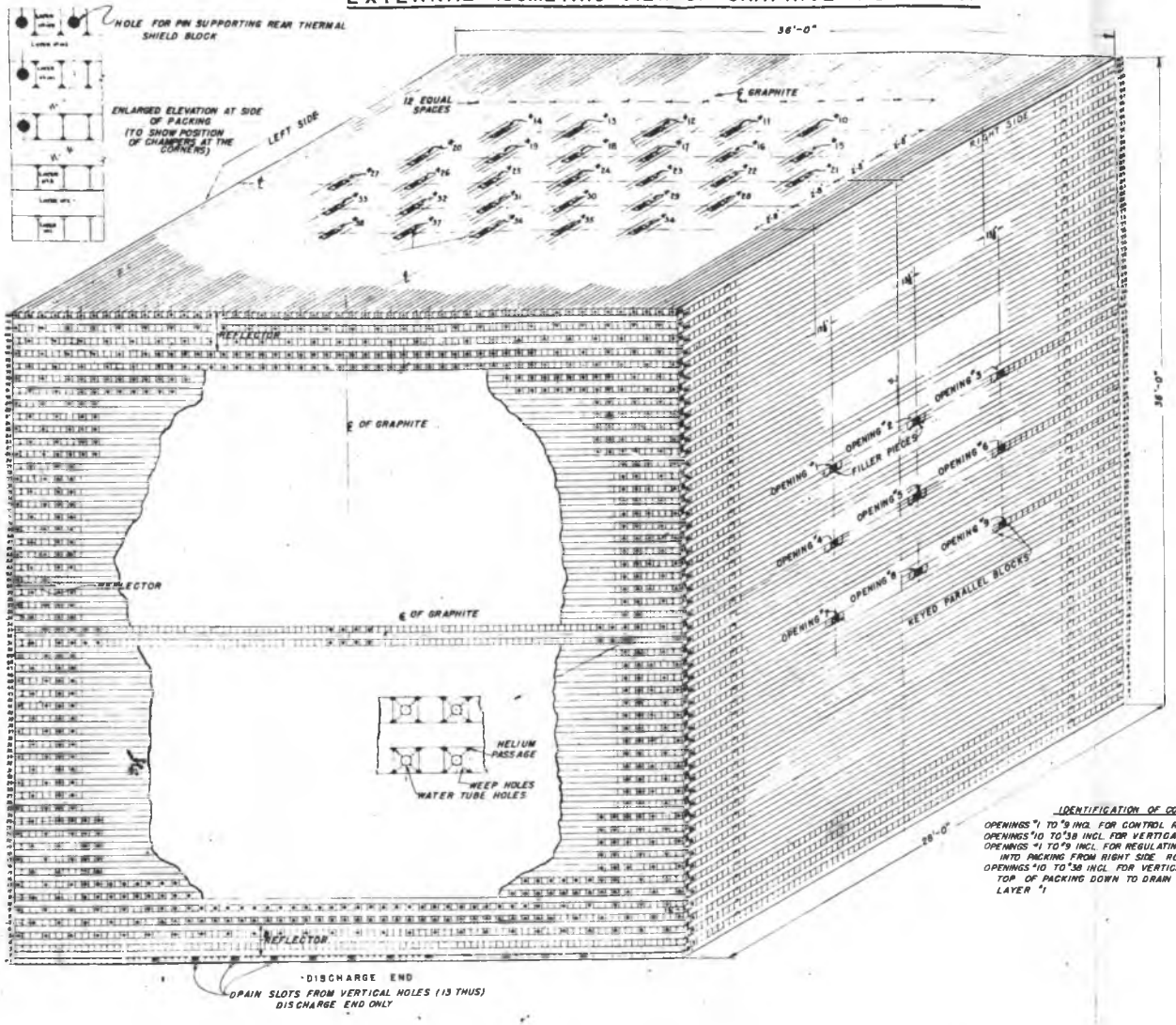
EXTERNAL ISOMETRIC VIEW OF GRAPHITE ASSEMBLY



IDENTIFICATION OF CONTROL OPENINGS

OPENINGS "1 TO "9 INCL. FOR CONTROL RODS (7 SHIM - 2 REG.)
OPENINGS "10 TO "38 INCL. FOR VERTICAL SAFETY RODS
OPENINGS "1 TO "9 INCL. FOR REGULATING AND SHIM RODS EXTEND 29'2" INTO PACKING FROM RIGHT SIDE RODS ENTER FROM RIGHT SIDE
OPENINGS "10 TO "38 INCL. FOR VERTICAL SAFETY RODS EXTEND FROM TOP OF PACKING DOWN TO DRAIN SLOTS AT TOP OF PACKING LAYER "1

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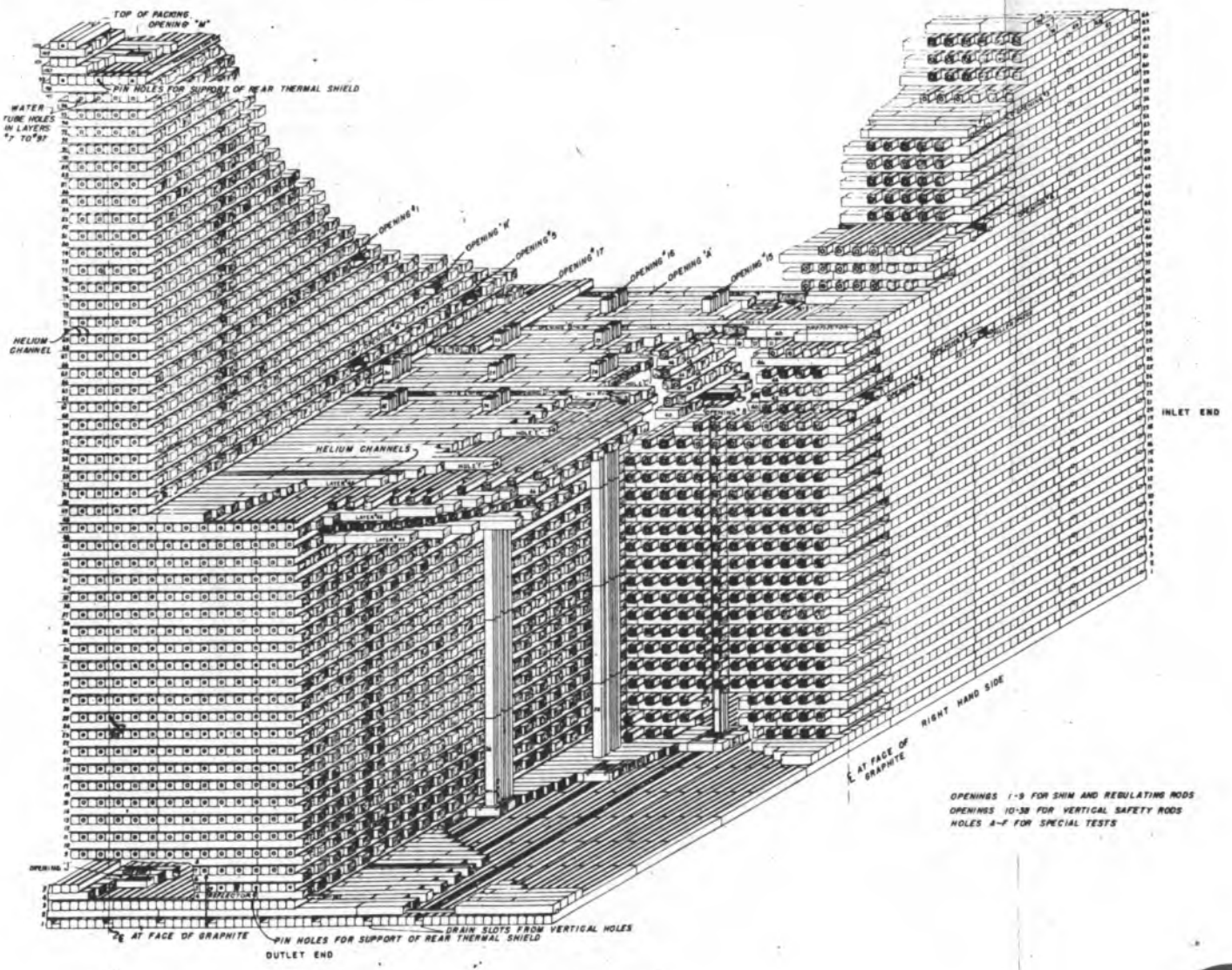
CUTAWAY ISOMETRIC VIEW OF GRAPHITE ASSEMBLY



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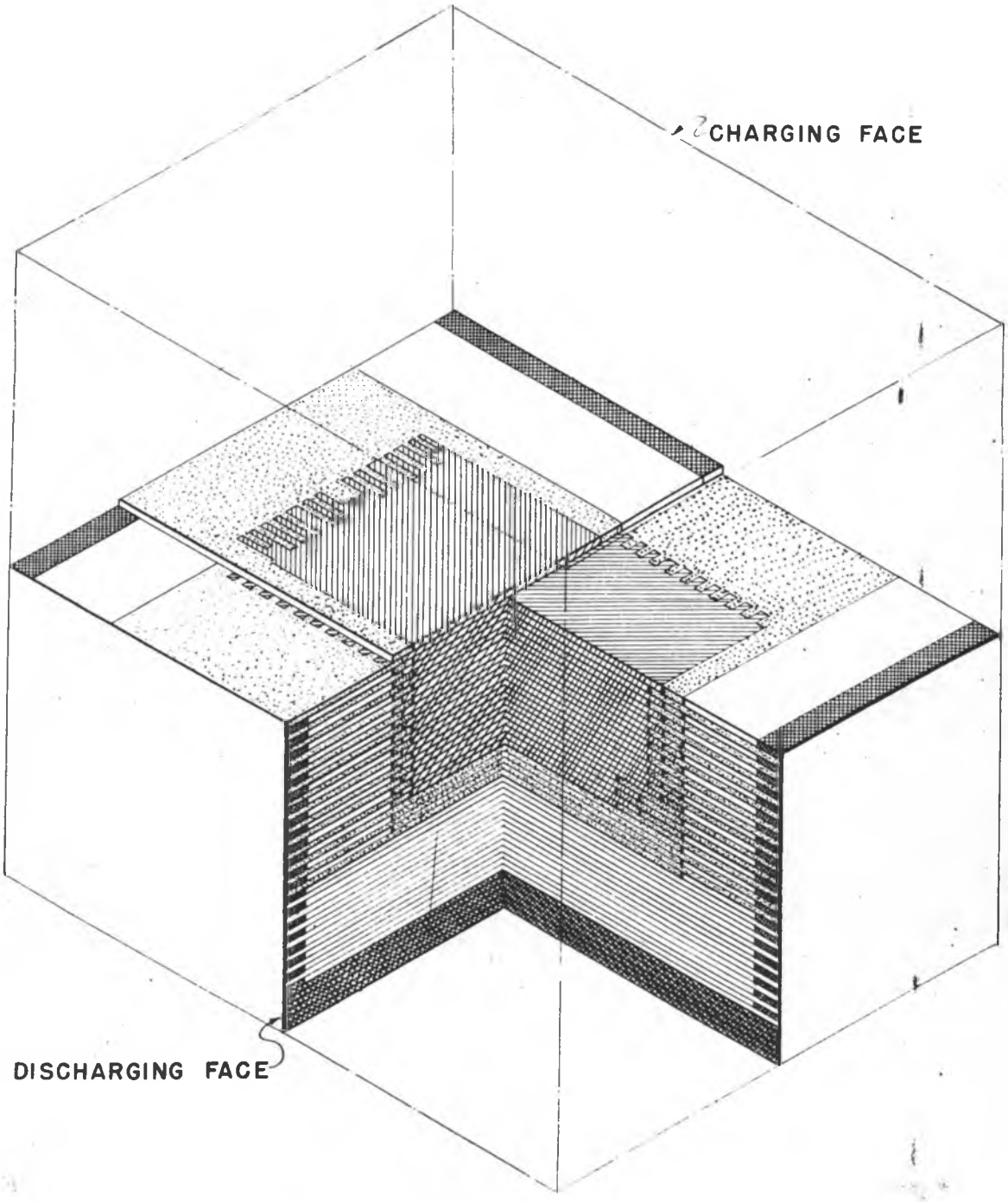
SCHEMATIC ARRANGEMENT OF DIFFERENT GRADES OF GRAPHITE IN THE PILE



LEGEND

- GREEN (KENDALL - CHICAGO)
- WHITE (KENDALL - STANDARD)
- BLUE (CLEVES - STANDARD)
- RED (MIXTURE OF POORER GRADES)

A17

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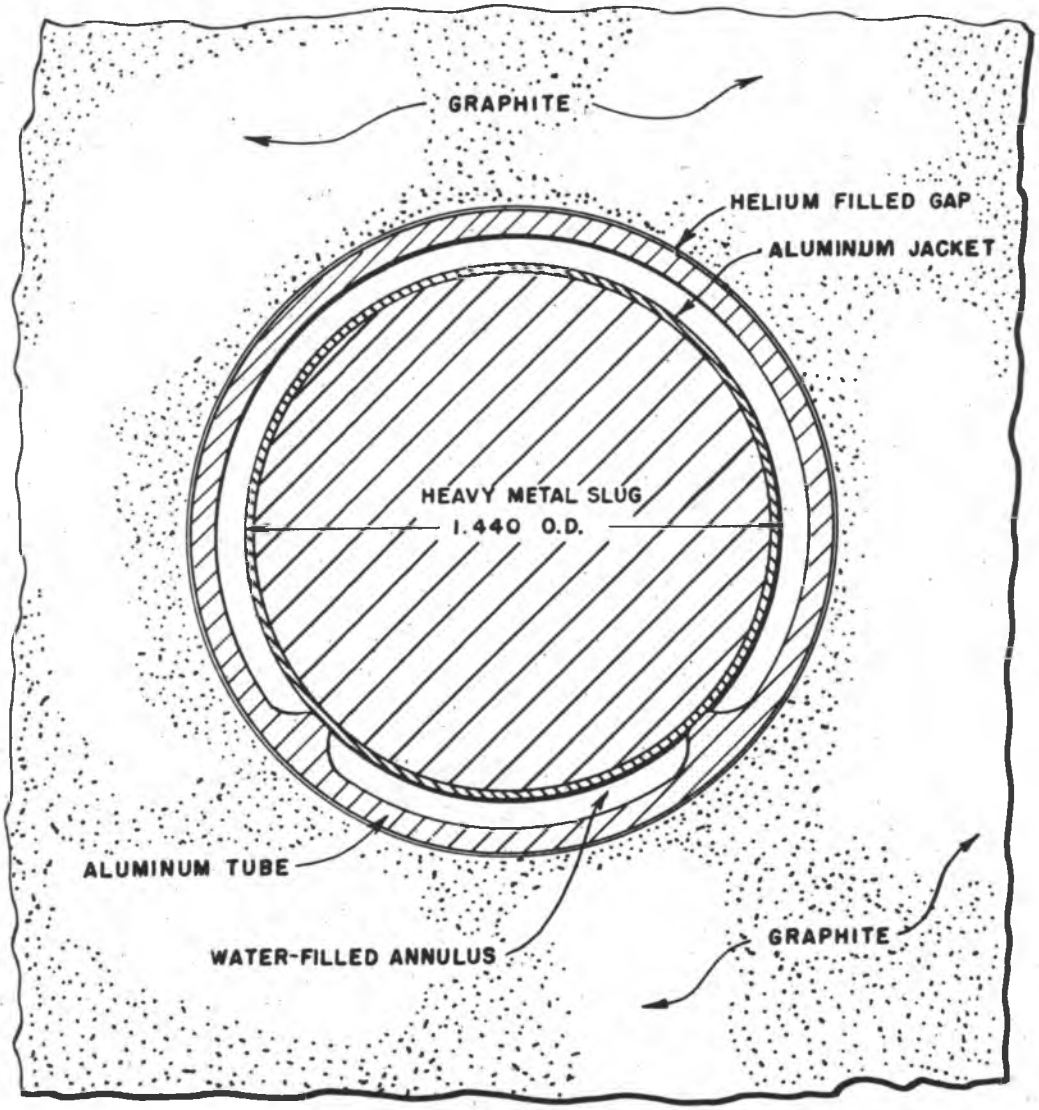
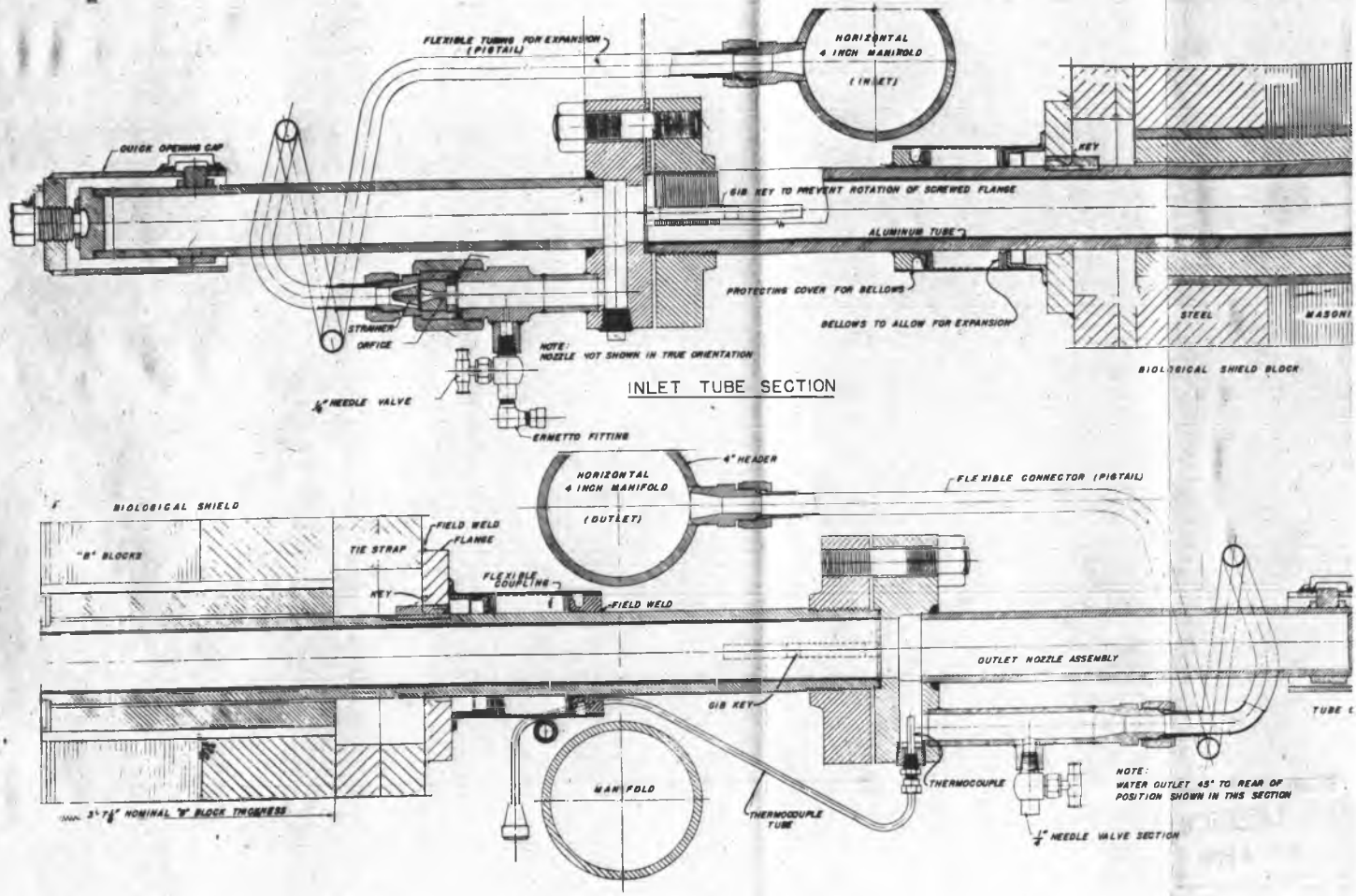
H-M-B-407-1

CROSS SECTION THROUGH A CHARGED TUBE IN THE PILE



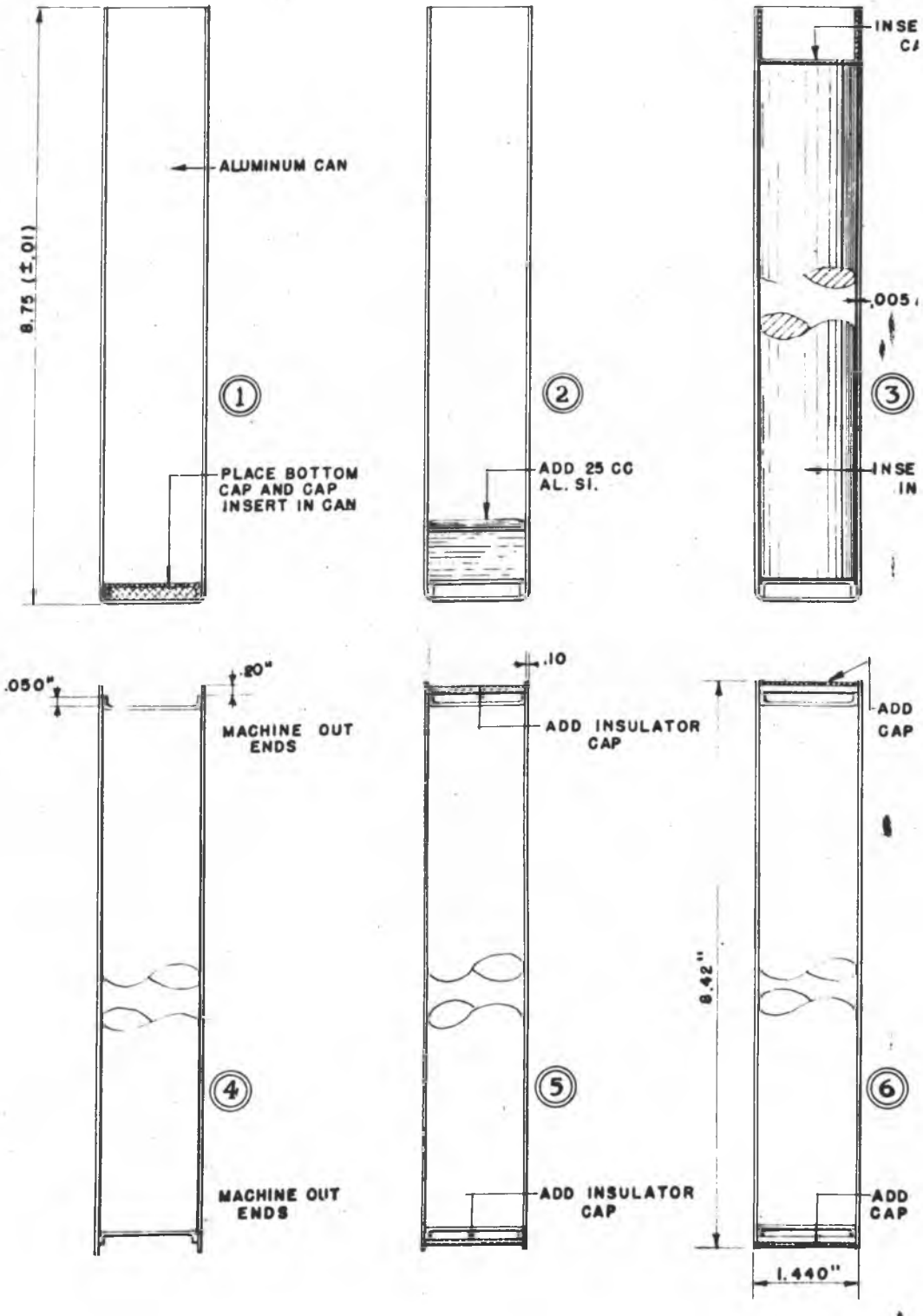
(APPROX: DOUBLE SIZE)

WATER CONNECTIONS AT FACES OF PILE



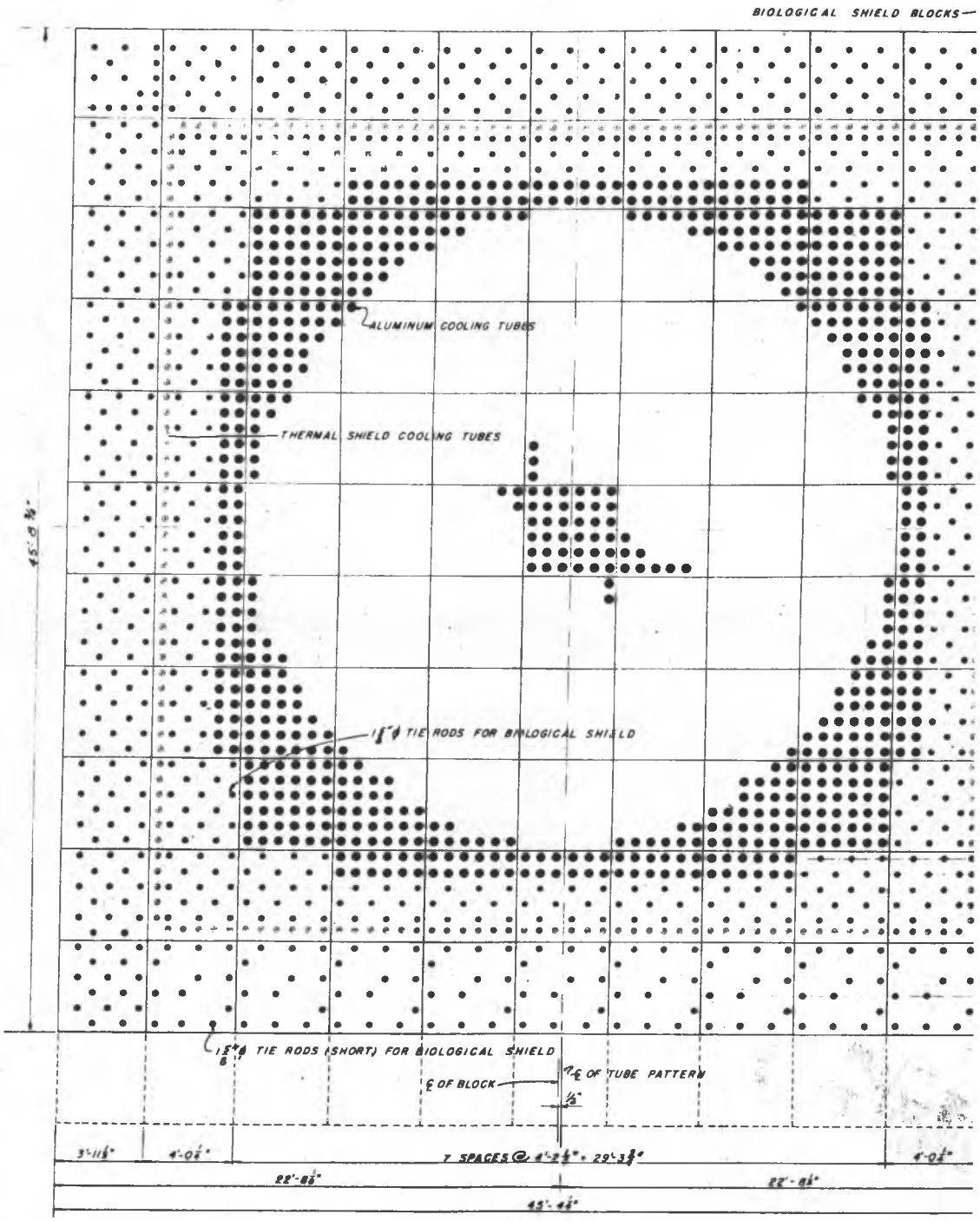
SECRET

CANNING PROCESS



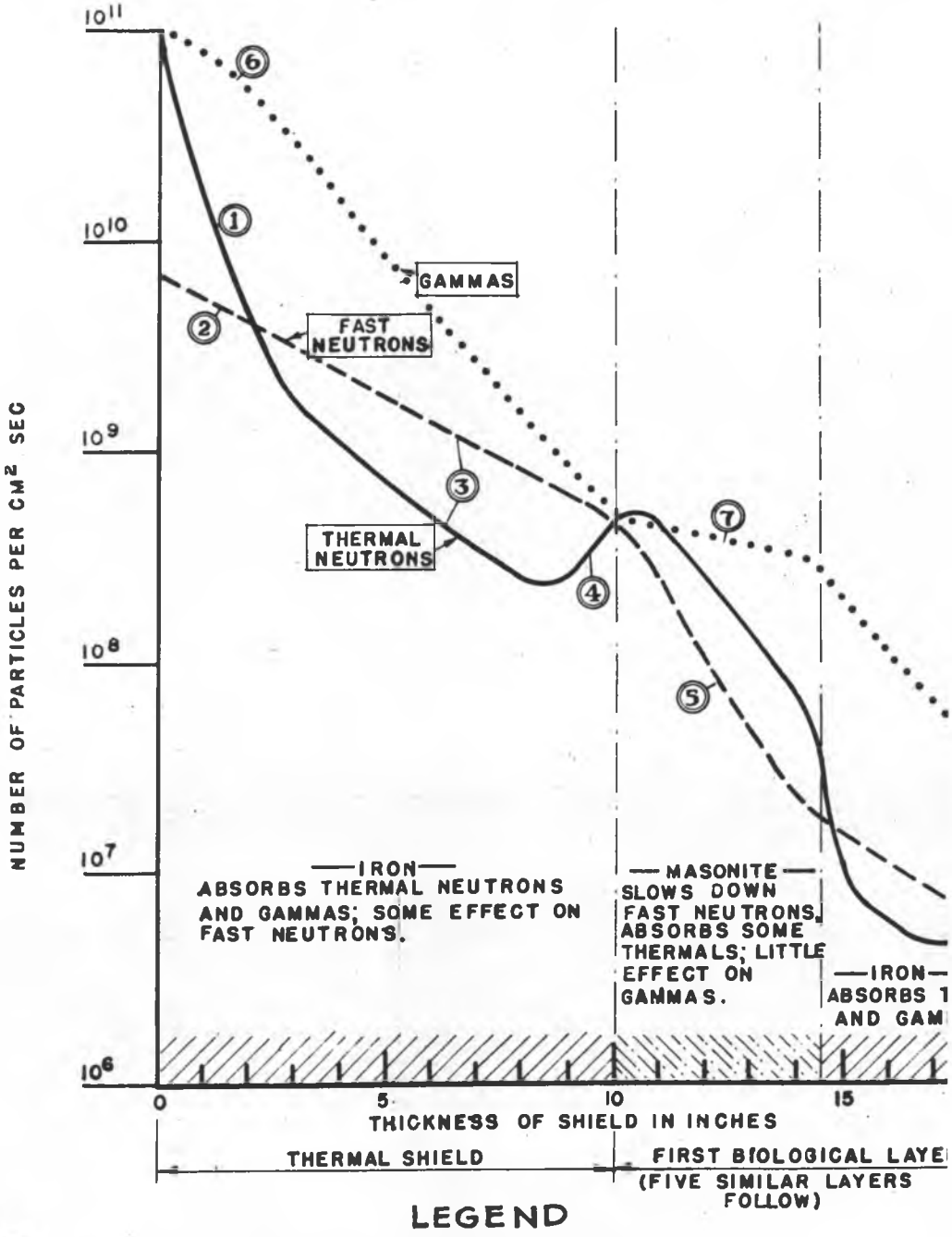
SECRET

ARRANGEMENT OF TUBES & BIOLOGICAL SHIELD BLOCKS AT CHARGING FACE



SECRET

ACTION OF COMPOSITE SHIEI

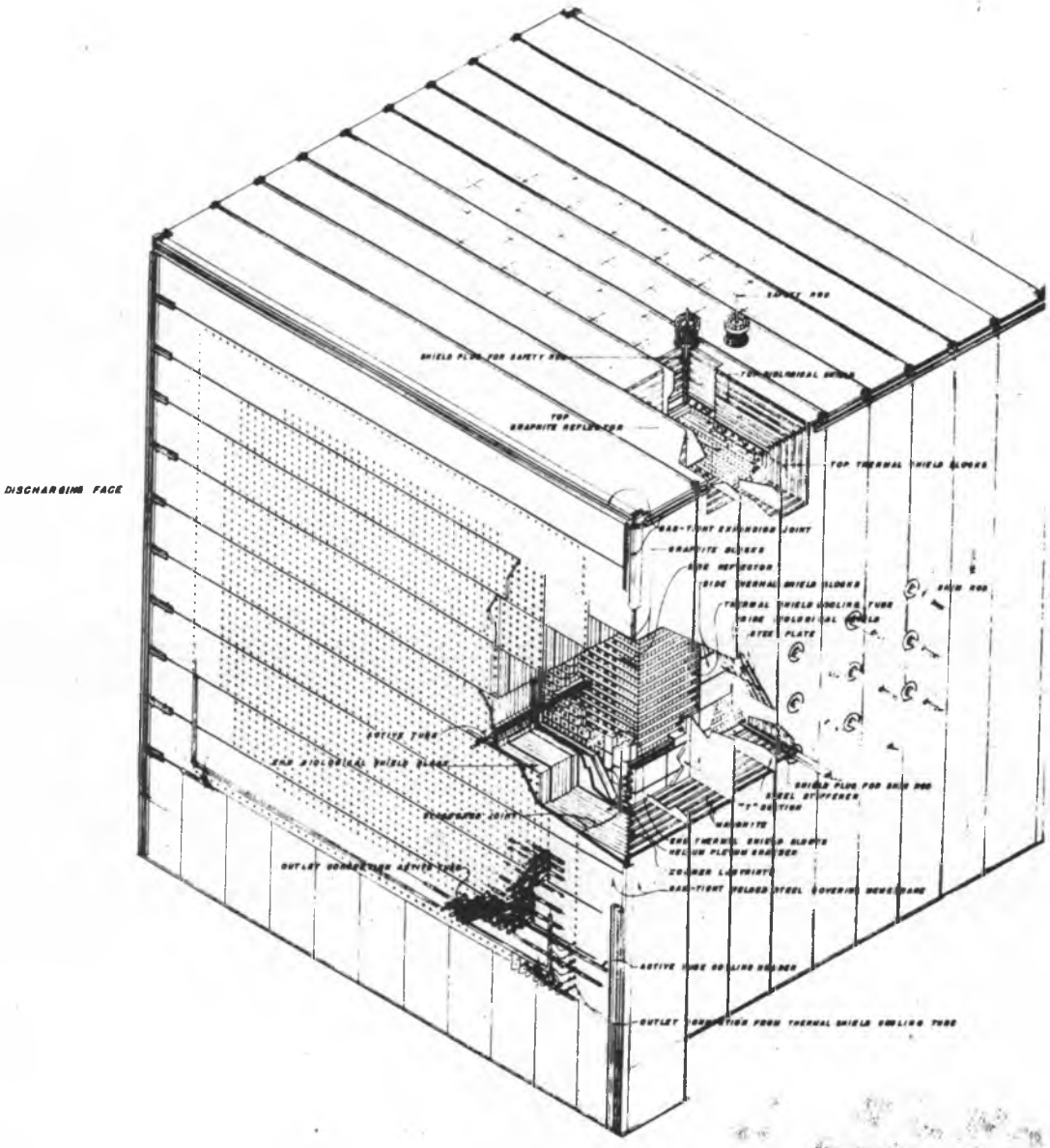


LEGEND

① THERMAL NEUTRONS RAPIDLY ABSORBED
② FAST NEUTRONS GRADUALLY SLOWED
③ MIXTURE OF FAST AND THERMAL NEUTRONS APPROACHES EQUILIBRIU
④ THERMAL NEUTRONS DIFFUSE BACK FROM MASONITE LAYER
⑤ FAST NEUTRONS RAPIDLY SLOWED DOWN IN MASONITE
⑥ GAMMA DECREASE AT LESS THAN EXPONENTIAL RATE BECAUSE OF GAI PRODUCTION BY THERMAL NEUTRONS CAPTURED IN THIS REGIO
⑦ GAMMAS GRADUALLY ABSORBED BY MASONITE

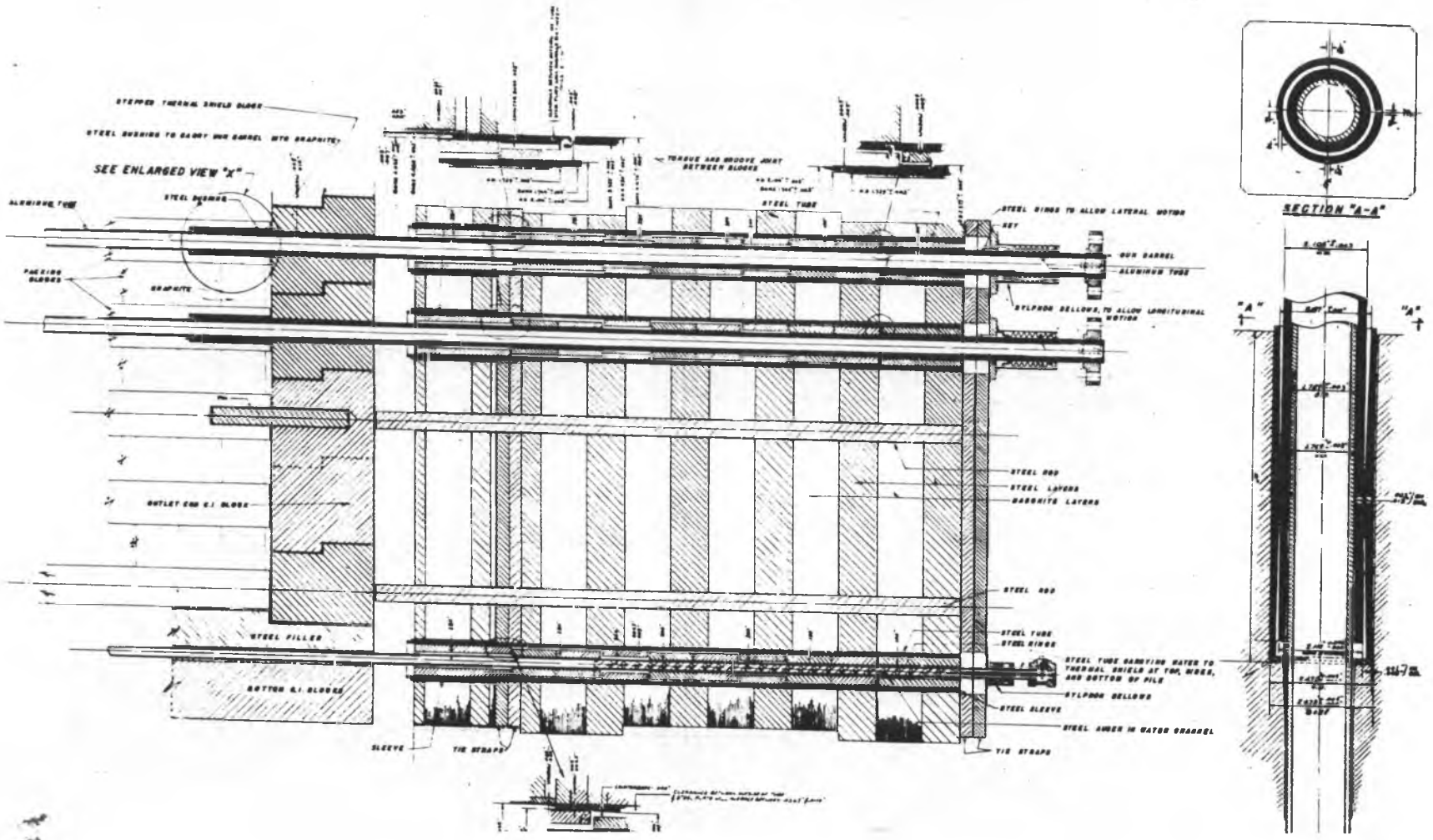
SECRET

PILE SHIELDING



H-1

SECTIONAL VIEW OF THERMAL AND BIOLOGICAL SHIELDS



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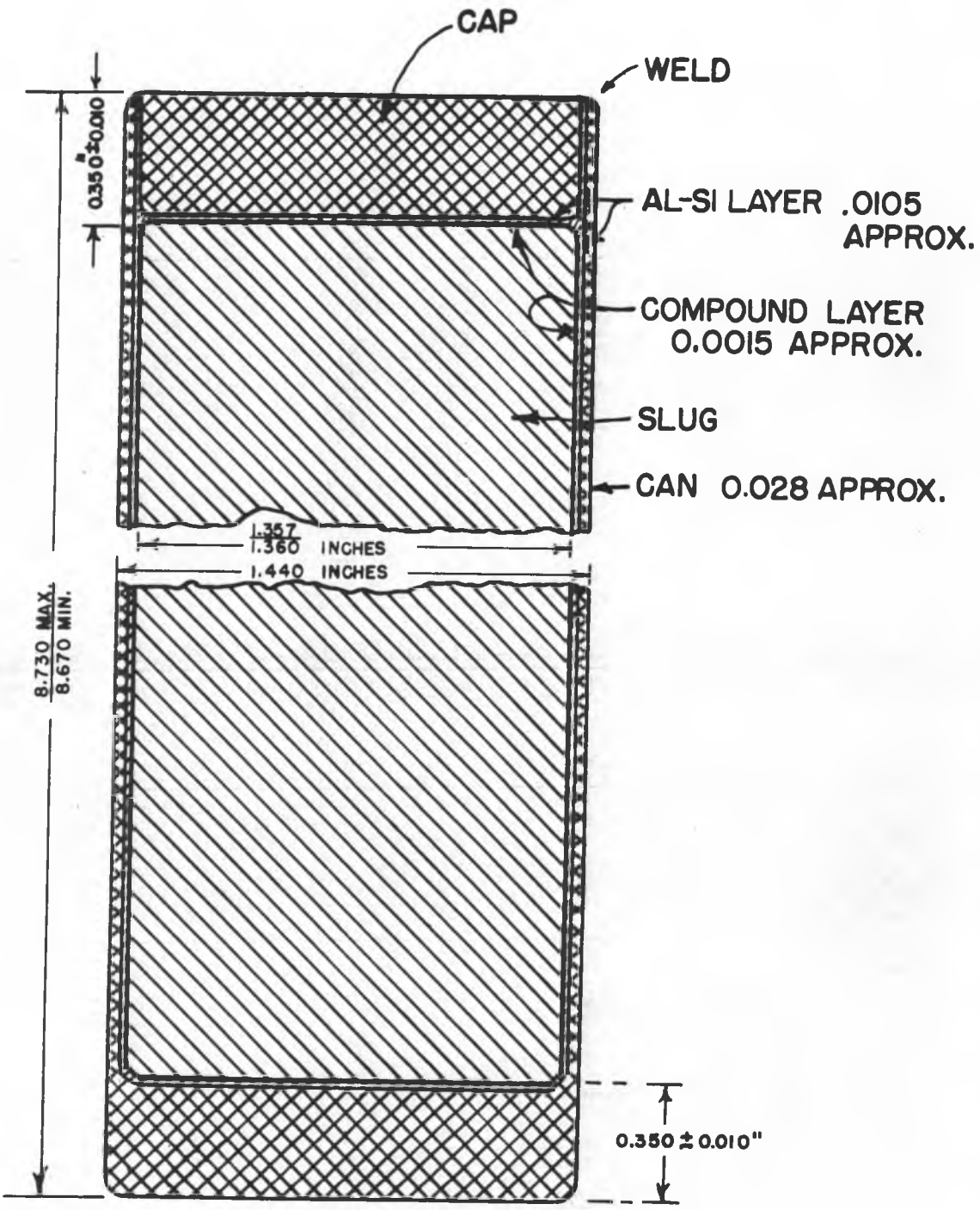
ASSEMBLED SLUG



ASSEMBLY MUST PASS THROUGH A FULL LENGTH TUBE GAUGE 1.455" DIAMETER

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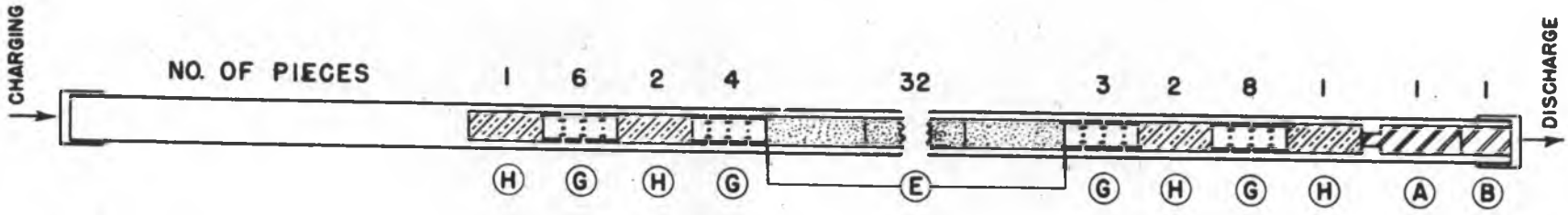
SECRET

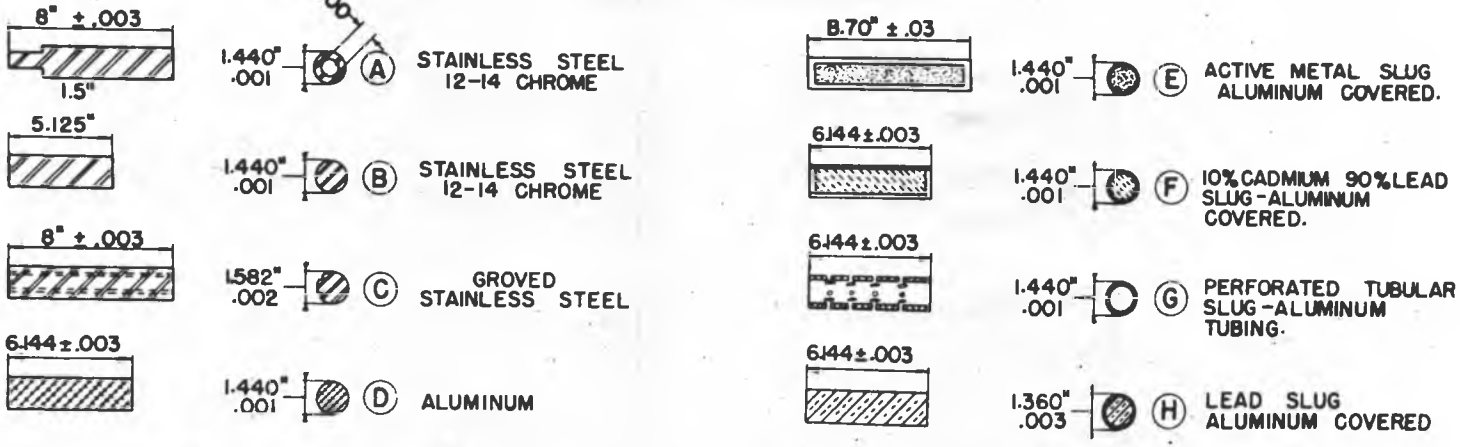
H-M-A-115-1 Rev.

SECRET

TYPICAL ARRANGEMENT OF SLUGS IN ACTIVE TUBES



TYPES OF SLUGS



NOTE: COMBINED LENGTH OF (A) AND (B) = 13-1/8"; LENGTHS OF INDIVIDUAL PIECES ARE SUBJECT TO VARIATION.

SECRET

H-M-B-511-4

A27

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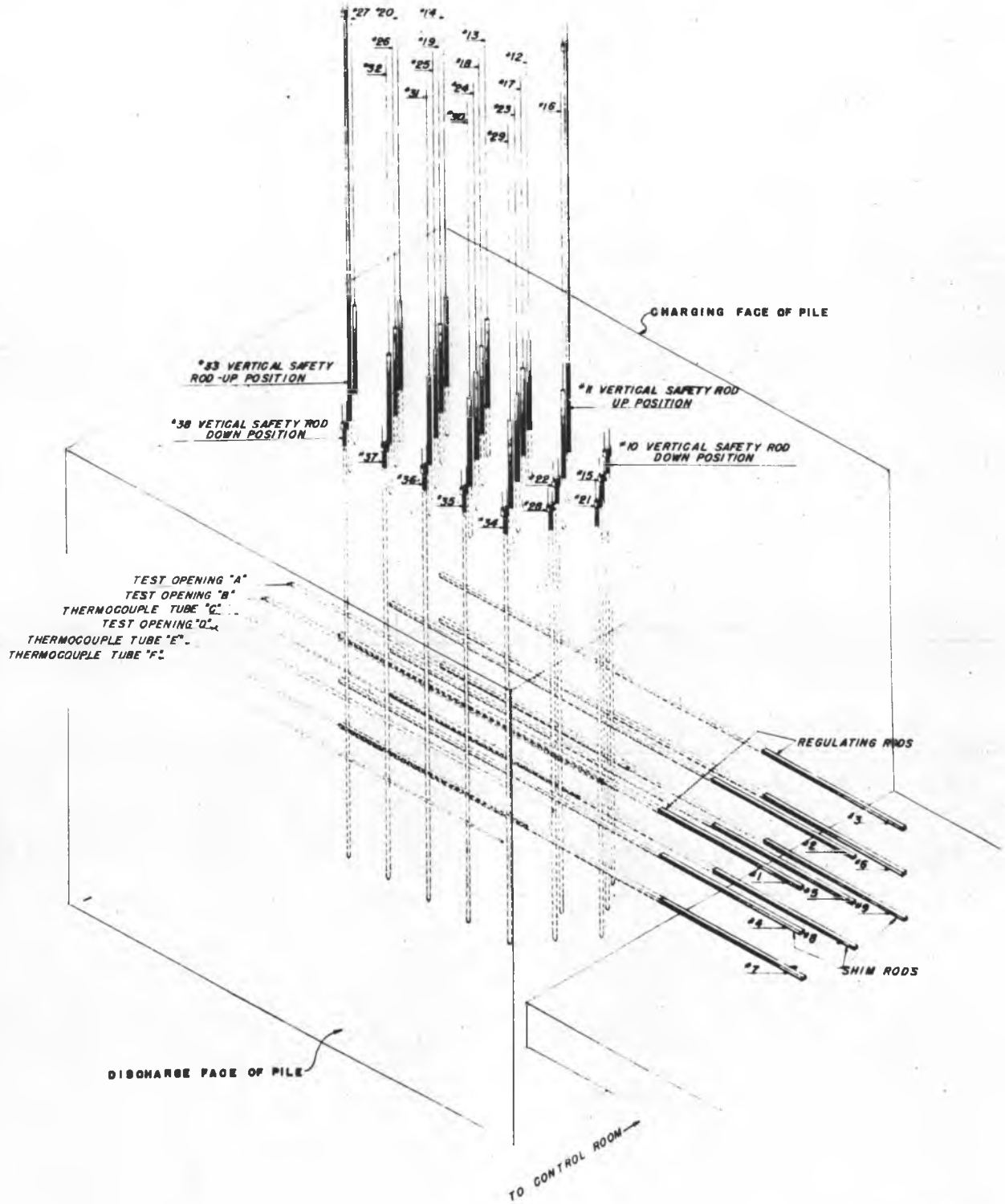
ISOMETRIC DIAGRAM SHOWING ROD PATTERN FOR VERTICAL DROP SAFETY RODS AND SHIM AND REGULATING RODS (HORIZONTAL)



A28

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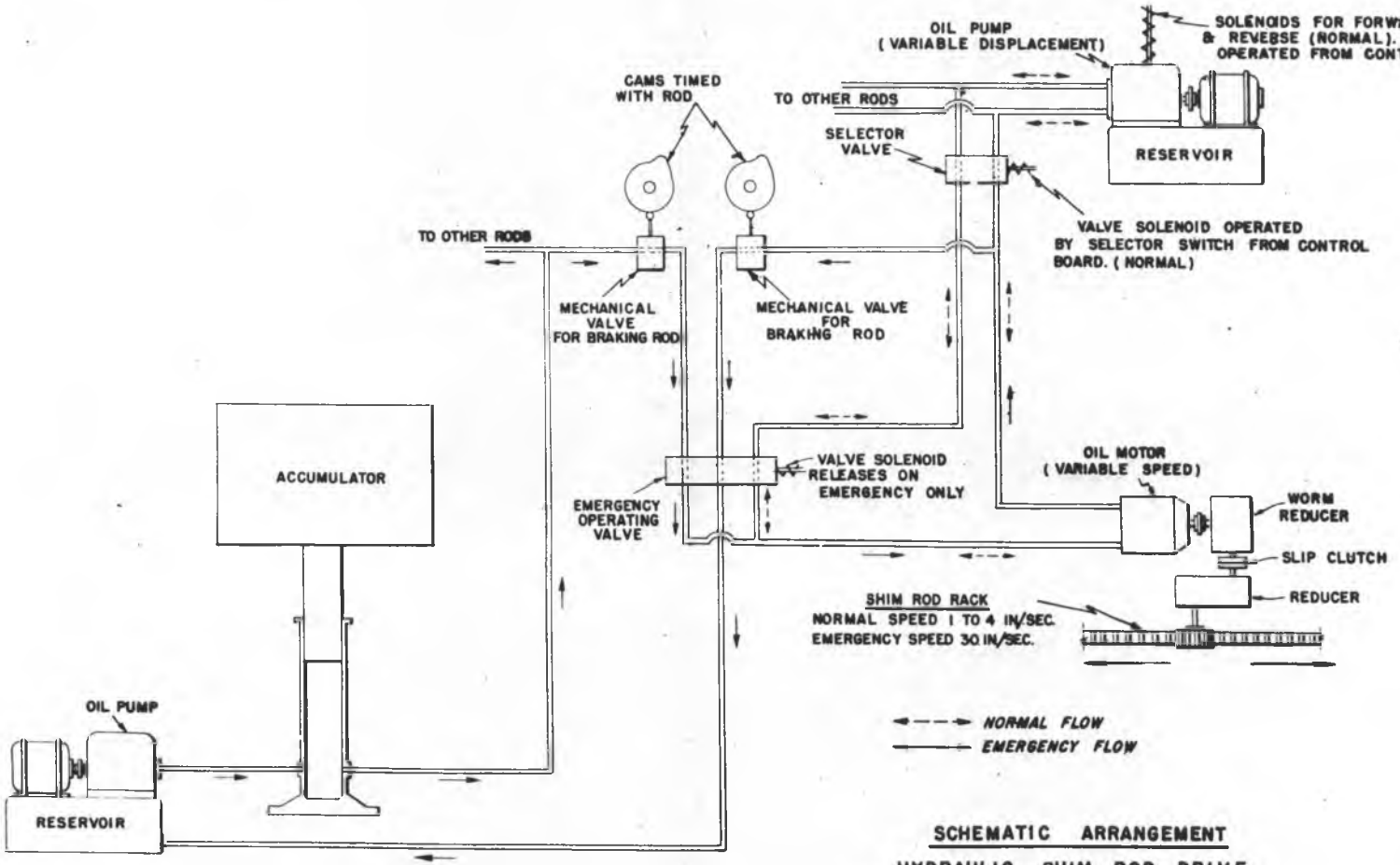
H-M-B-608-1



SCHEMATIC ARRANGEMENT

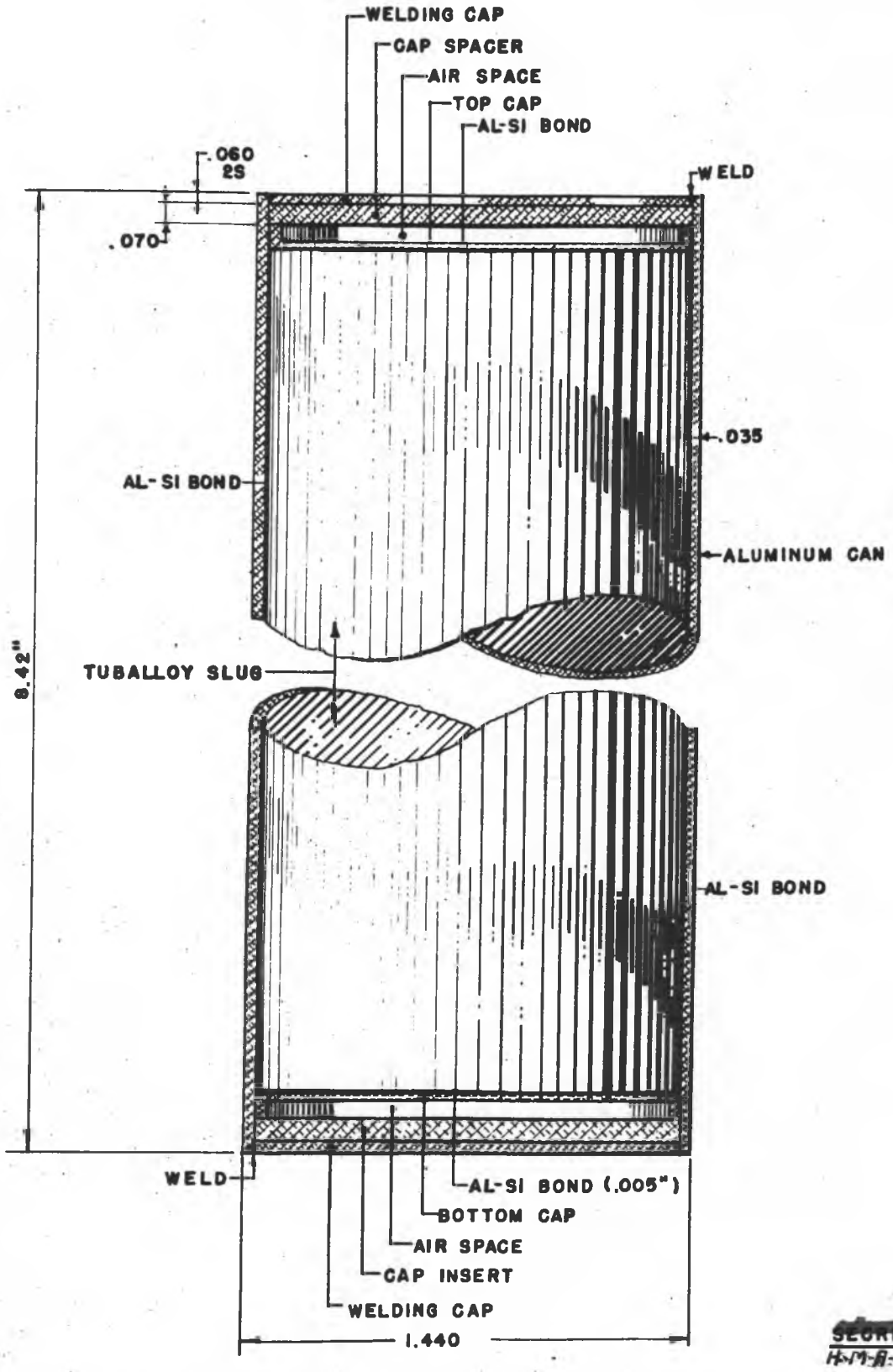
HYDRAULIC SHIM ROD DRIVE

H-N-B-615-4

A29

SECRET

ASSEMBLED SLUG



A25

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HW-A-12121

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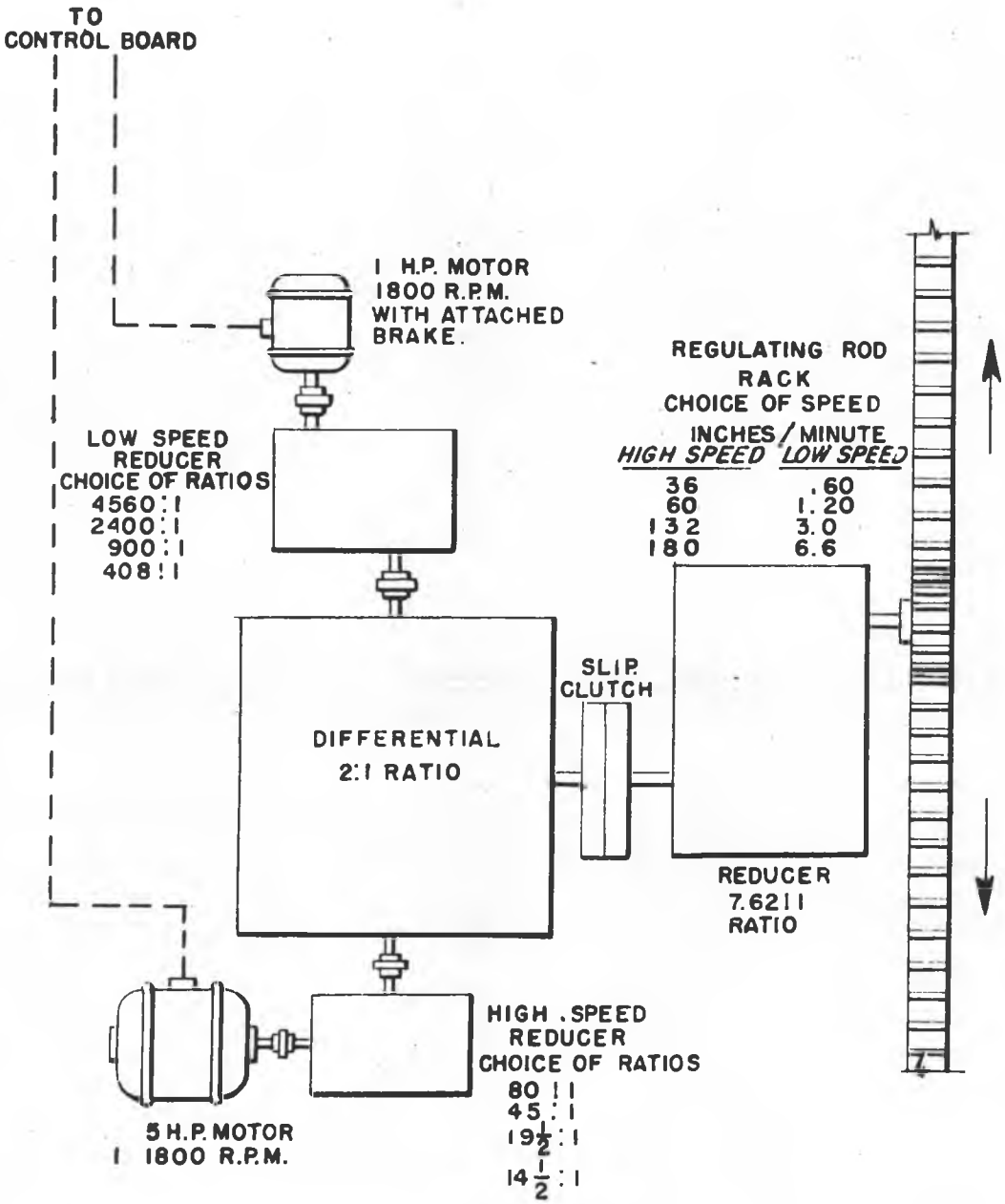
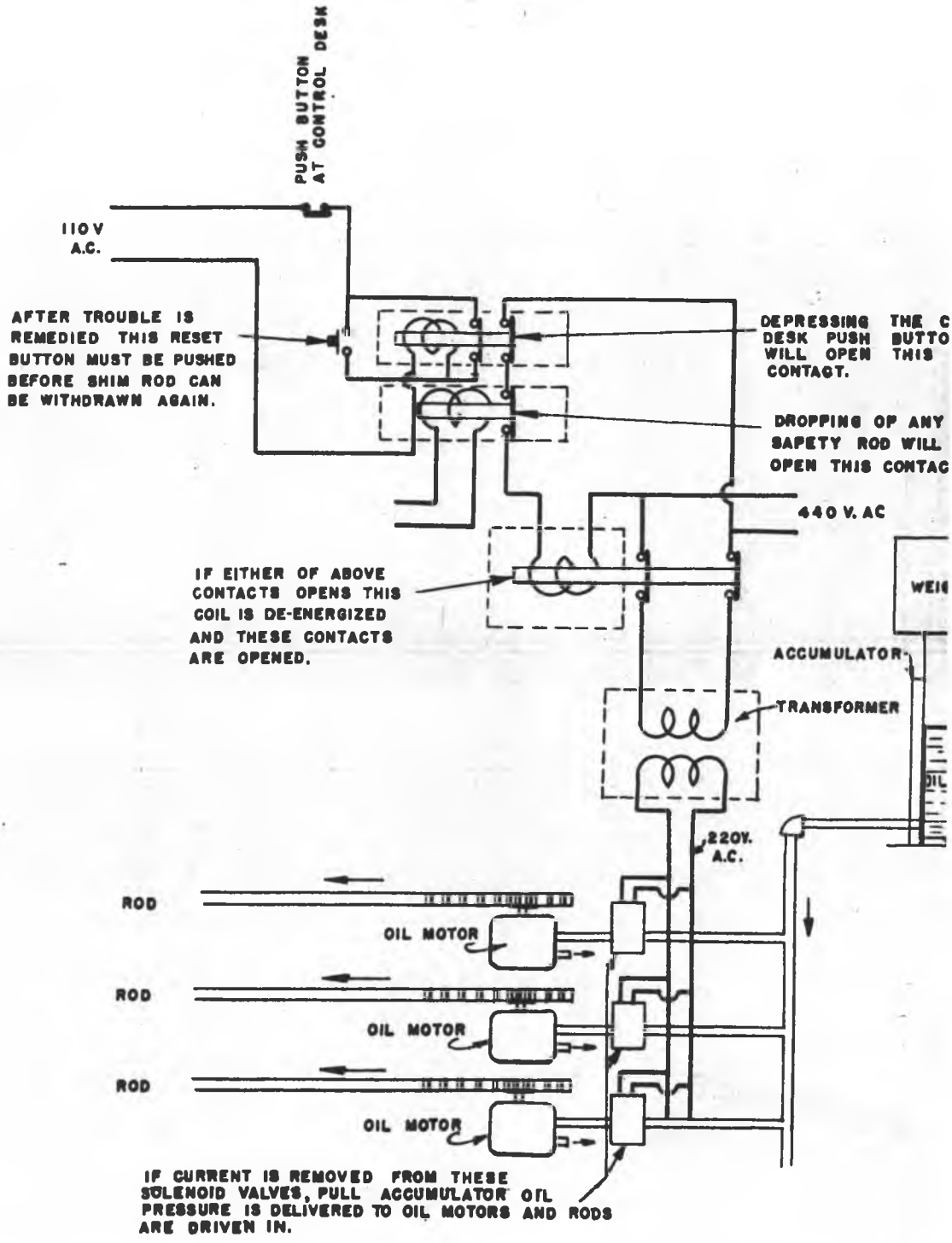


SCHEMATIC ARRANGEMENT
ELECTRIC REGULATING ROD DRIVE

SECRET

NO. 2 SAFETY CIRCUIT



SECRET

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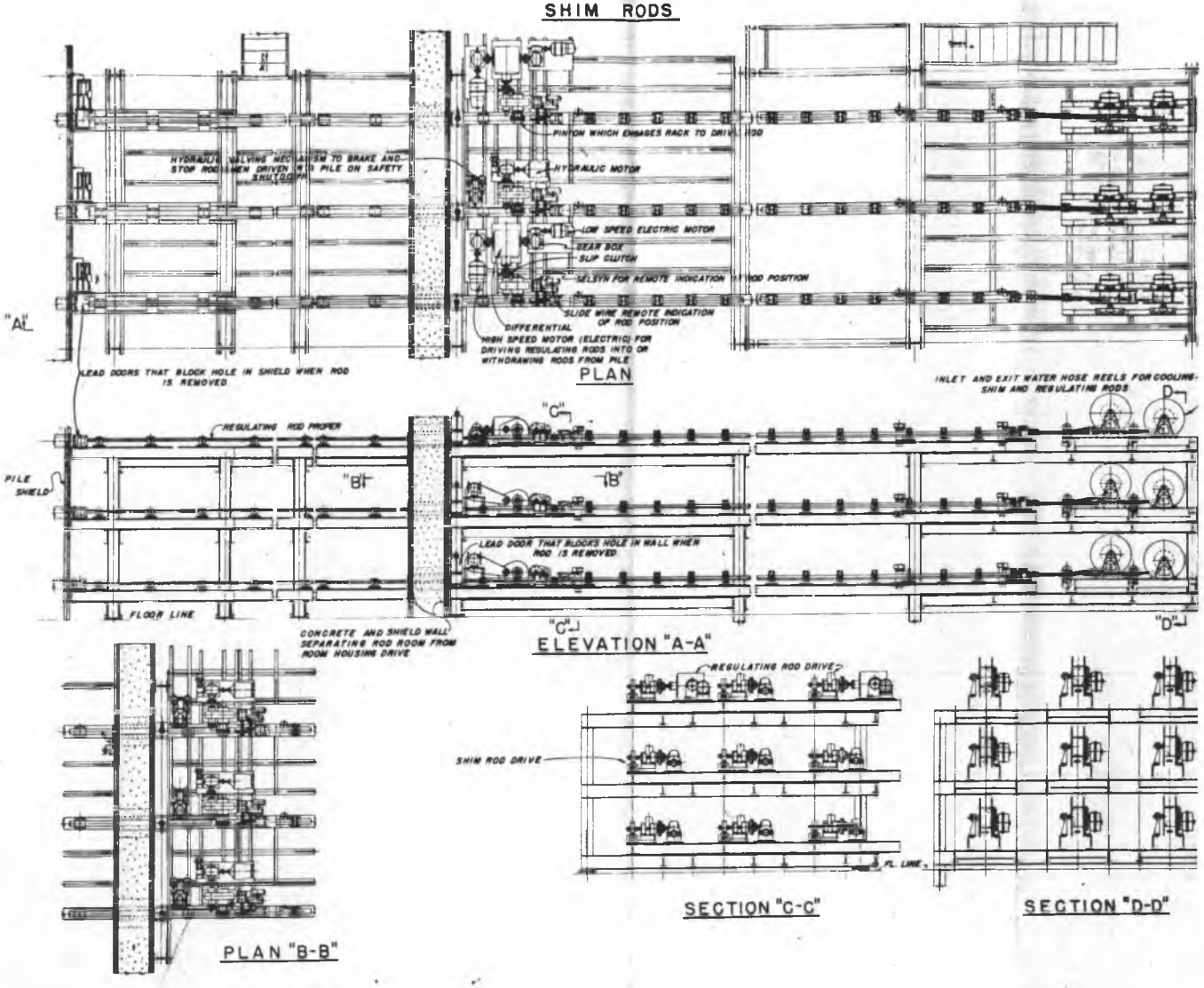
SECRET

DRIVING MECHANISMS FOR REGULATING AND SHIM RODS



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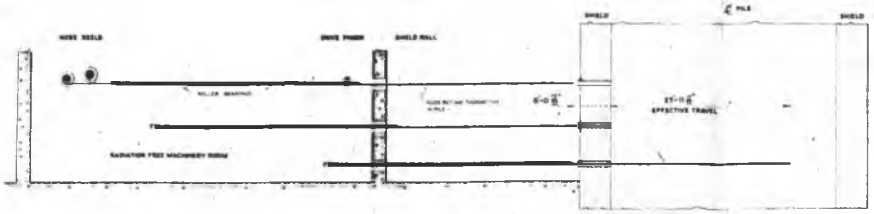
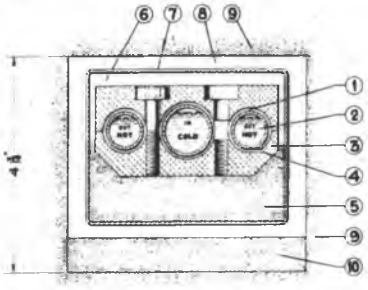


CONTROL ROD MOVEMENT
· SCHEMATIC ·



CROSS SECTION AT – A

LEGEND

ALUMINUM	CAST IRON
LEAD	STEEL
BORON	GRAPHITE
WATER	CONCRETE
MASONITE	

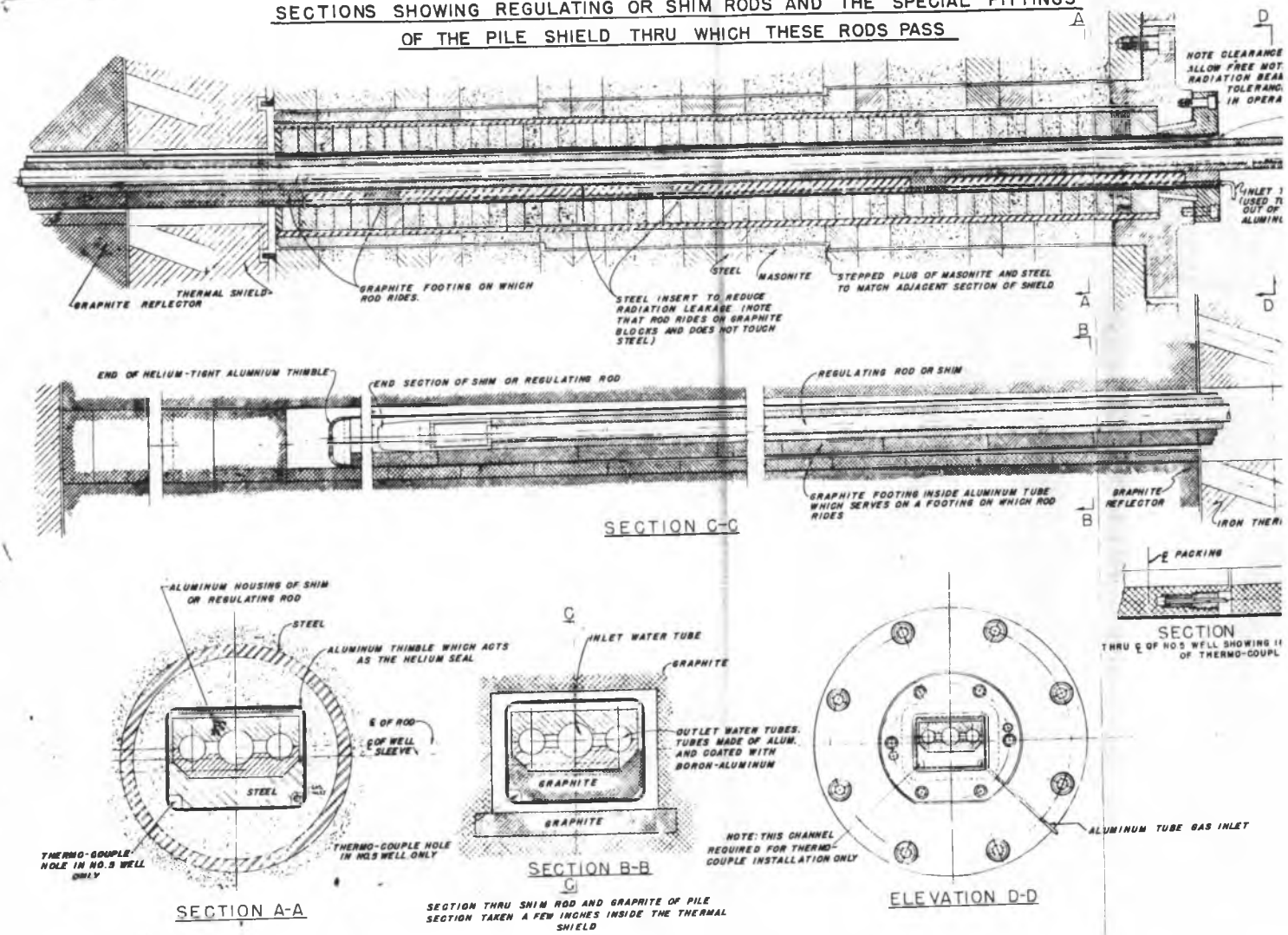
1– METALLIC BORON SPRAYED ON ALUMINUM TUBES ↘ ABSORBS THERMAL NEUTRONS ↘ DELIVERS UP HEAT OF CONDENSATION TO COOLING TUBES ↘ REMAINDER IS NEGLIGIBLE FRACTION OF ENERGY AS GAMMA RADIATION (IN CONTRAST TO CADMIUM) ↘ DEVELOPS NO RESIDUAL RADIOACTIVITY.
2– WATER REMOVES HEAT OF CONDENSATION FROM PILE.
3– ALUMINUM ↘ STRUCTURAL MATERIAL ↘ ABSORBS FEW NEUTRONS DEVELOPS RELATIVELY SMALL RADIOACTIVITY ↘ THIS QUICKLY DECAYS ↘ THUS SIMPLIFIES REPAIRS.
4– ALUMINUM COOLING TUBES SYMMETRICALLY ARRANGED ↘ MINIMIZE WARPING DUE TO THERMAL EXPANSION.
5– GRAPHITE LUBRICATES MOTION OF ROD.
6– CLEARANCE FOR MOTION OF ROD.
7– ALUMINUM THIMBLE ↘ LOW NEUTRON ABSORPTION ↘ PREVENTS ESCAPE OF RADIOACTIVE GASES FROM PILE ↘ NORMALLY FLUSHED OUT CONTINUALLY WITH CO_2 TO MINIMIZE ACTIVATION OF ARGON COMPONENT OF ATMOSPHERE.
8– CLEARANCE ↘ ALLOWS WITHDRAWAL OF THIMBLE FOR REPAIRS
9– GRAPHITE ↘ MODERATING MEDIUM OF PILE ↘ LAID UP IN BLOCKS 4½" THICK.
10– GRAPHITE FILLER ↘ HINDERS LEAKAGE OF NEUTRONS.
11– ALUMINUM CAP ↘ CLOSES END OF THIMBLE.
12– TAPERED TIP ↘ MINIMIZES CHANCE OF ROD TO CATCH AND STICK.
13– ACTIVE ZONE OF PILE ↘ ALUMINUM TUBES CARRY URANIUM SLUGS
14– DIRECTION OF FLOW OF WATER.
15– GRAPHITE BED ↘ CARRIES ROD WITH MINIMUM FRICTION.
16– GRAPHITE REFLECTOR OF NEUTRONS ↘ CONTAINS NO URANIUM PORTION OF ROD IN THIS ZONE HAS LITTLE INFLUENCE ON REACTION.
17– THERMAL SHIELD WITH COOLING TUBES CEMENTED IN BY LEAD.
18– BIOLOGICAL SHIELD.
19– SHIELD PLUG ↘ CARRIES THIMBLE AND ROD THROUGH SHIELD SHIELD ↘ MINIMIZES LEAKAGE OF RADIATIONS ABOUT THIMBLE REMOVED FOR REPAIRS BY CUTTING WELD AT OUTER FACE OF SHIELD
20– GRAPHITE BLOCKS ↘ LOCATED BETWEEN BOTTOM OF ROD AND TOP OF THIMBLE ↘ CARRY ROD WITH MINIMUM FRICTION.
21– IRON GAMMA RAY ABSORBERS ↘ OCCUPY SPACE BETWEEN GRAPHITE BLOCKS ↘ DEPRESSED SLIGHTLY TO AVOID SCRAPING
22– THIN SHEETS ↘ ALTERNATELY STEEL AND MASONITE ↘ HAVE SAME CHARACTERISTICS SIMILAR TO THOSE OF BIOLOGICAL SHIELD.
23– STEEL PIPE FURNISHES FRAMEWORK FOR CONSTRUCTION OF PLUG.
24– JOINT IN WATER PIPES.
25– RACK FOR DRIVING ROD.
26– CONCRETE WALL AND POSSIBLE LEAD COVERING ↘ PROTECT OPERATORS IN MACHINERY ROOM AGAINST RADIATIONS FROM ACTIVATED WATER
27– WINDOW ↘ TO BE SEALED WITH CASING AROUND ROD ↘ CASING EXTENDS THROUGH WALL ↘ HOLE THROUGH CASING MAY BE CLOSED BY DOOR OPERATED REMOTELY BY COMPRESSED AIR
28– PINION DRIVES ROD.
29– FLEXIBLE HOSE ↘ CARRY COLD WATER IN AND HOT WATER OUT

CONTROL ROD

FOR SHIM AND FINE CONTROL

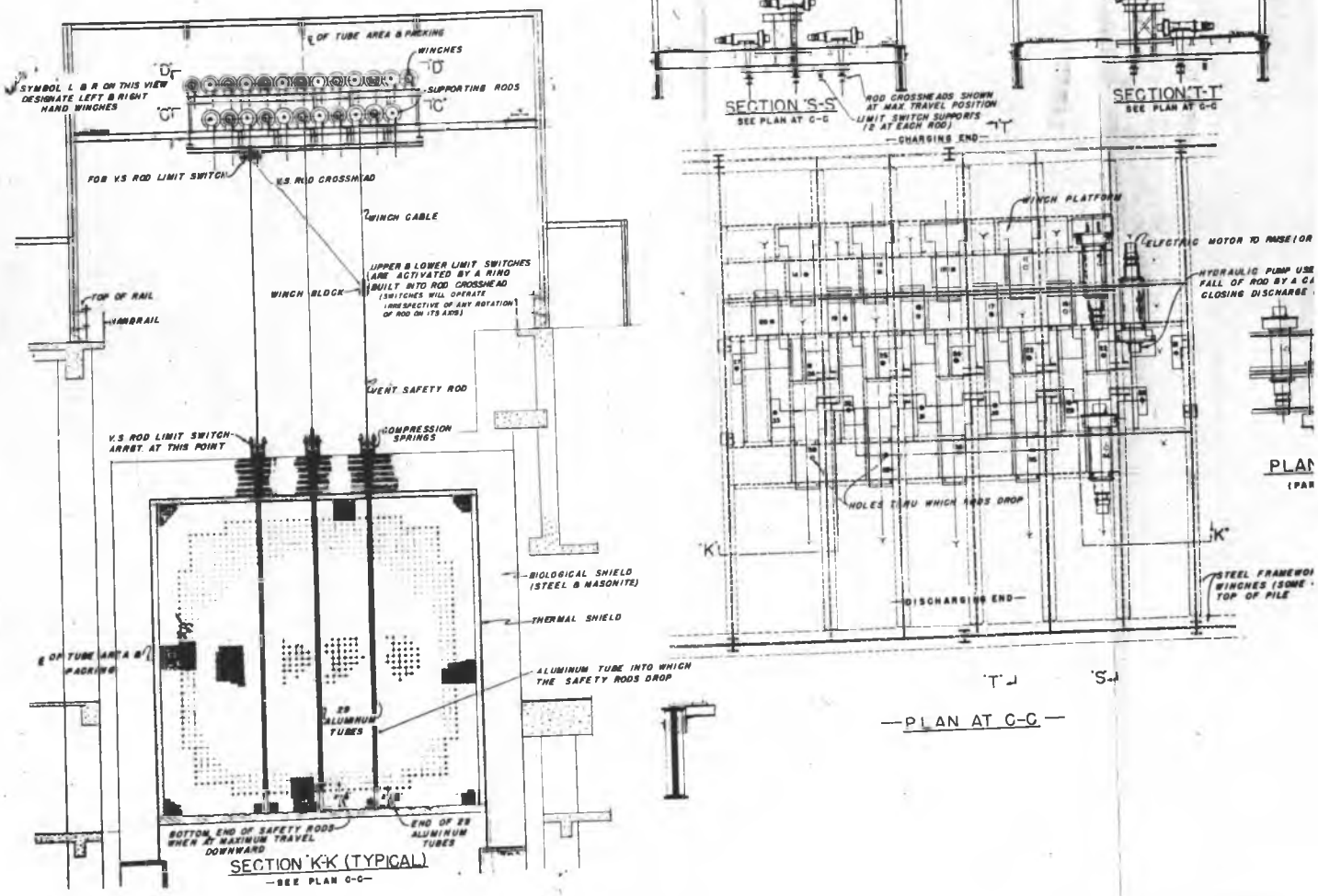
SECRET

SECTIONS SHOWING REGULATING OR SHIM RODS AND THE SPECIAL FITTINGS OF THE PILE SHIELD THRU WHICH THESE RODS PASS



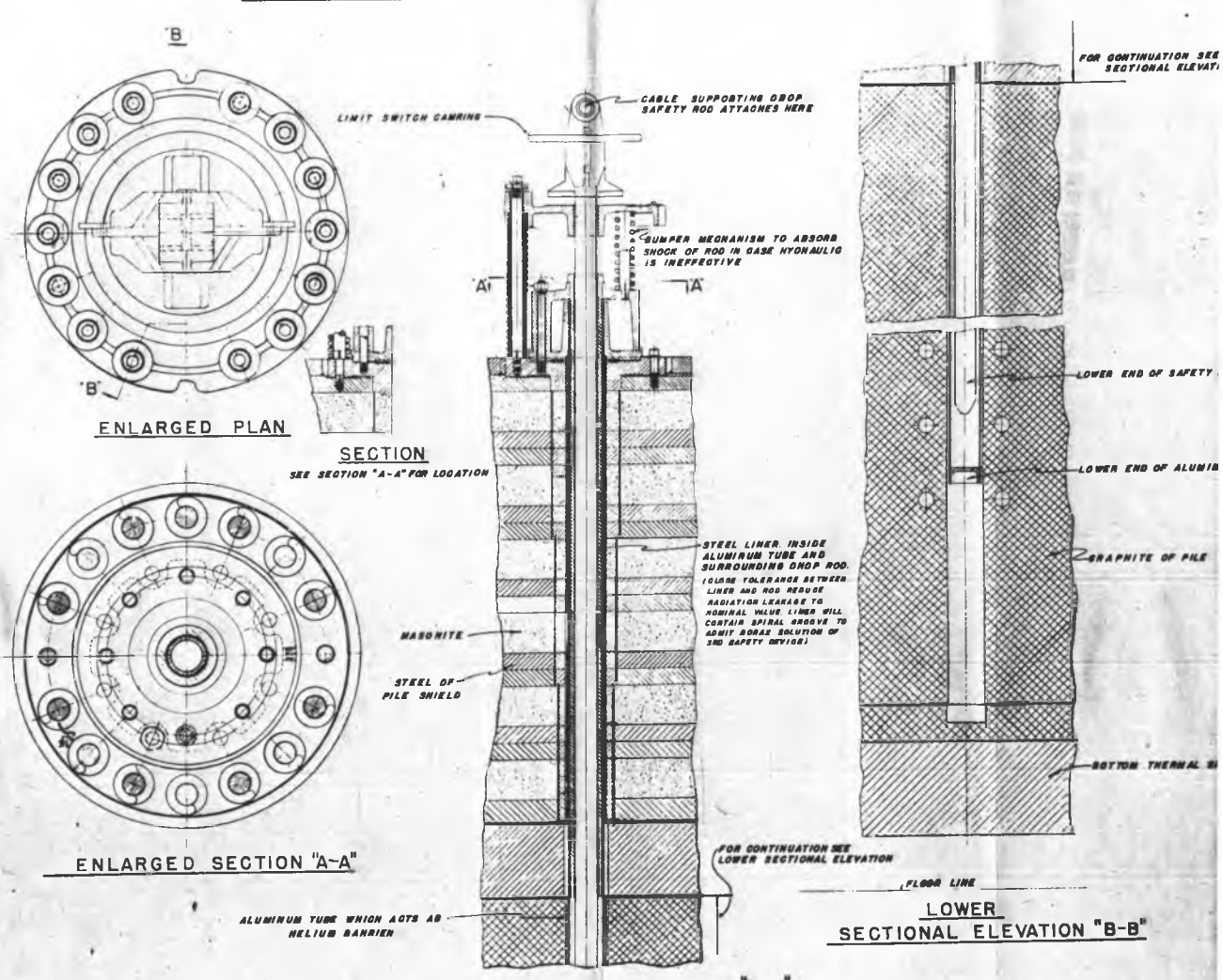
SECRET

PLAN AND ELEVATION OF VERTICAL SAFETY RODS



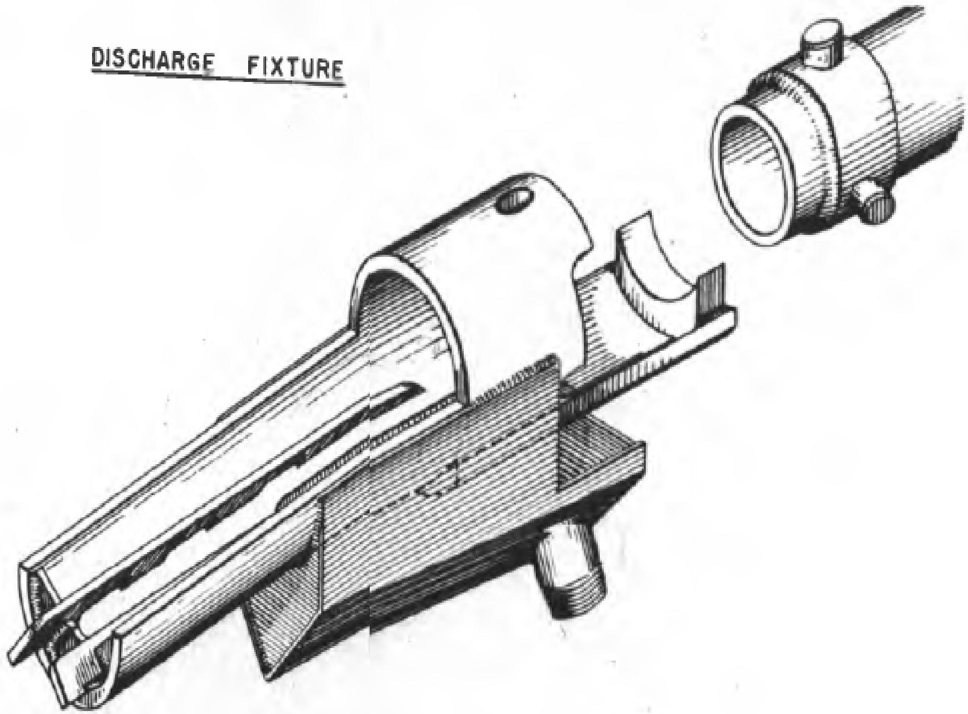
SECRET

SECTION THRU DROP SAFETY ROD AND SPECIAL FITTINGS OF THE PILE SHIELD THRU WHICH THE ROD PASSES



[redacted]

<u>DISCHARGE FIXTURE</u>



A40

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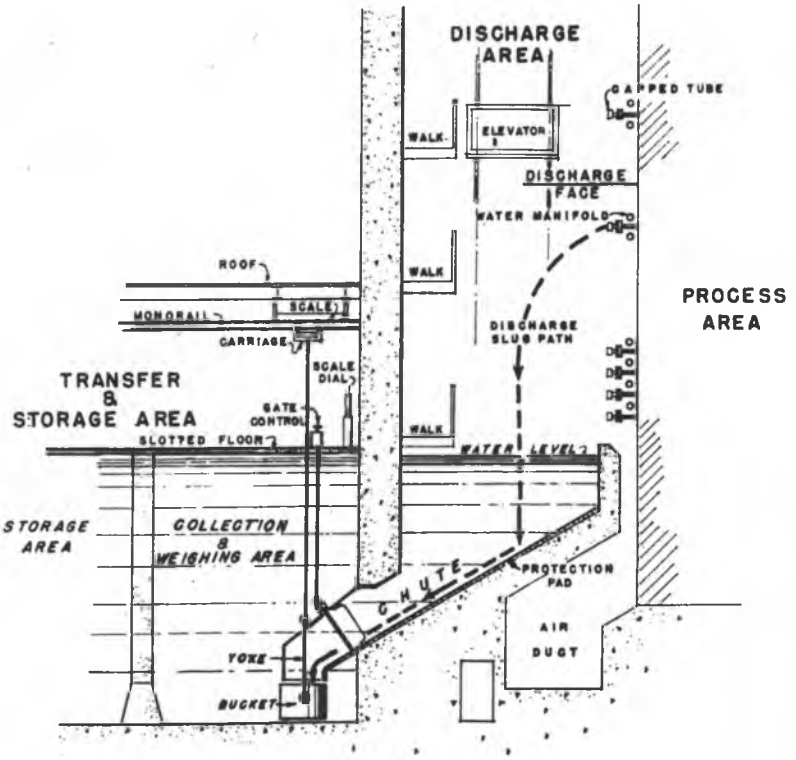
H-M-II-910-1
R 6/45

SECRET

SLUG HANDLING AFTER PILE DISCHARGE



SECTION

A41

SECRET

H-M-B-914-1

R 6/45

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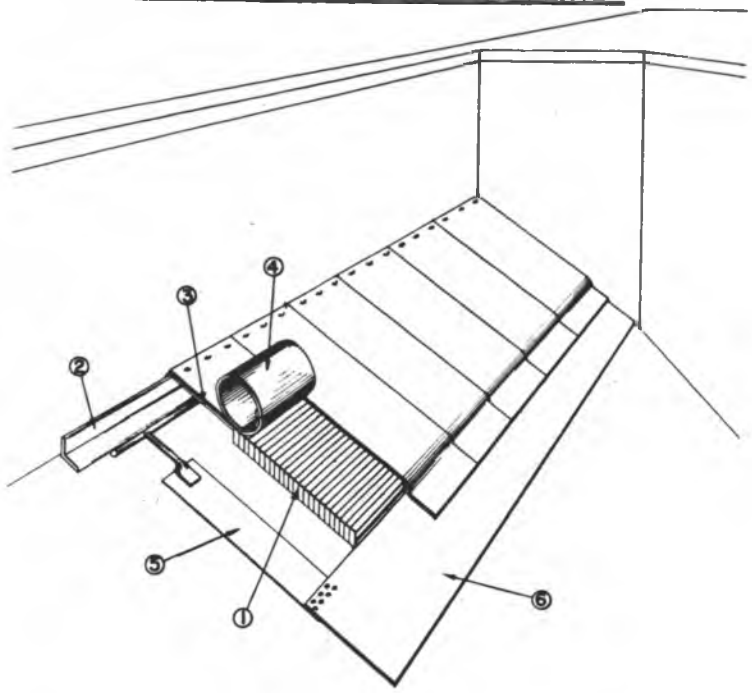
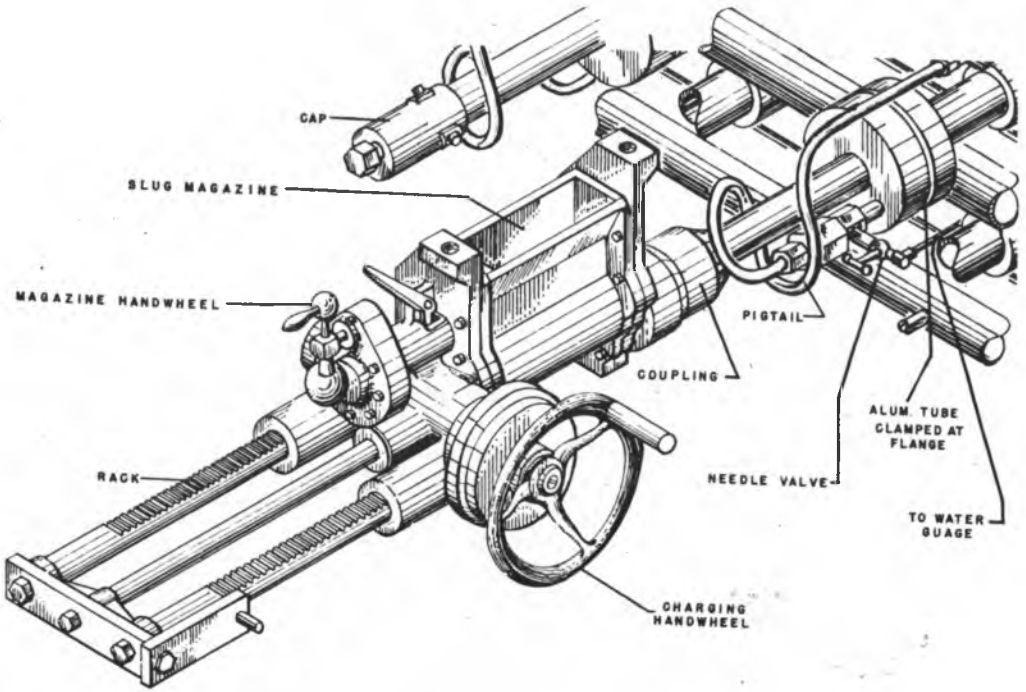
ARRANGEMENT OF MATTRESS PLATES



1 LAMINATED MATTRESS PLATE
2 MATTRESS PLATE ANCHOR ANGLE
3 MATTRESS PLATE EXTENSION
4 MATTRESS PLATE COVER
5 AUXILIARY MATTRESS PLATE HANGER
6 AUXILIARY MATTRESS PLATE

A42

~~SECRET~~
N-M-B-912-4
R 6/45

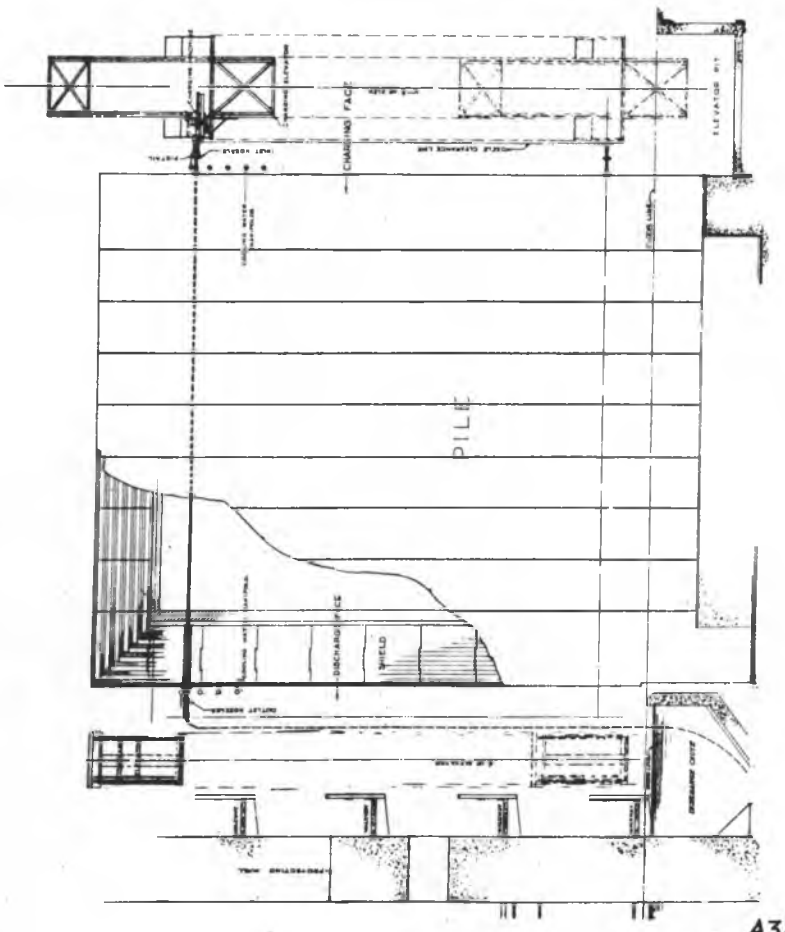


CHARGING MACHINE
&
INLET WATER FITTINGS

A39

SECRET

ELEVATION OF CHARGING MACHINE



A38

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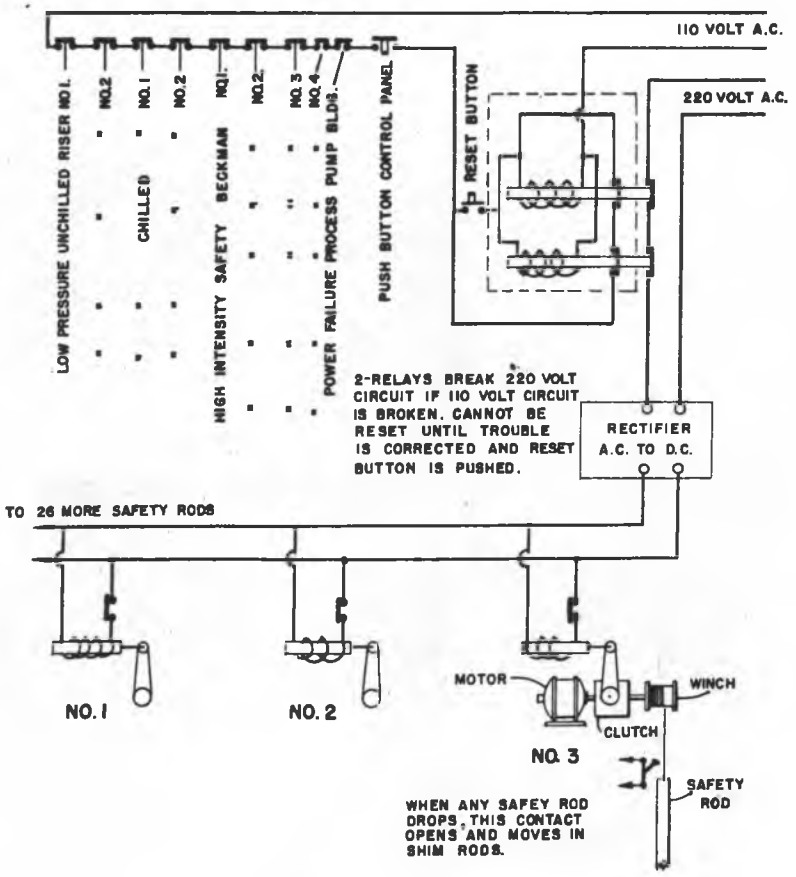
H-M-B-907-4

R 6/45

SECRET

NO I. SAFETY CIRCUIT



A37

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H-M-B-729-1

R 5/45

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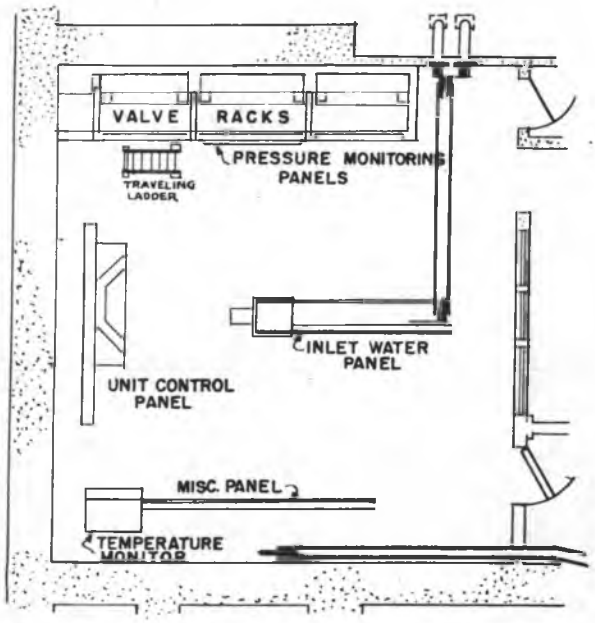
MAIN CONTROL ROOM



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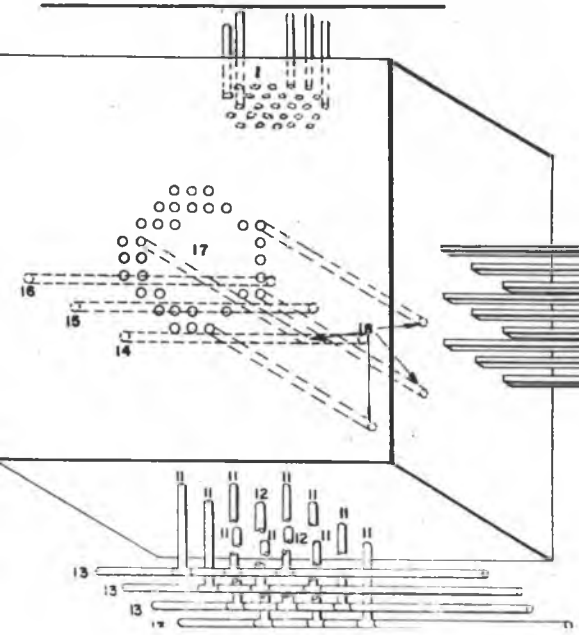
H-M-7

PILE SHOWING PRINCIPLE POINTS OF INSTRUMENTATION & CONTROL



1- SAFETY RODS (29) DROP INTO PILE WHEN SAFETY CIRCUIT IS BROKEN.

2, & 4, REGULATING RODS ELEC. OPERATION.

3,5,6,7,8,9,& 10 - SHIM RODS HYDRAULIC OPERATION.

11- EIGHT INCH RISERS (10) THROUGH BOTTOM SHIELDING FOR ION CHAMBERS.

12. SIXTEEN INCH RISERS (2) THROUGH BOTTOM SHIELDING FOR ION CHAMBERS.

13. EIGHT INCH PIPES (4) CONTAINING ION CHAMBERS.

14. EXPERIMENTAL HOLE "A" FOR NEUTRON CHAMBER.

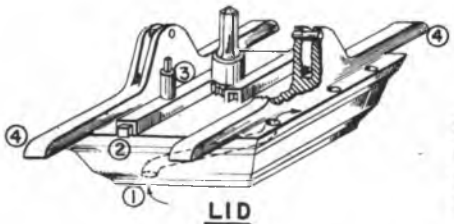
15. EXPERIMENTAL HOLE "D" FOR GAMMA CHAMBER TO BE USED DIFFERENTIALLY WITH "A" HOLE UNIT.

16. EXPERIMENTAL HOLE "F" FOR NEUTRON THERMOPILE.

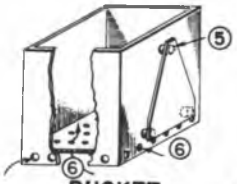
17. DISCHARGE END OF 2004 TUBES THERMOCOUPLE IN EACH TUBE.

18. CHARGING END OF 2004 TUBES- PRESSURE GAUGE CONNECTION FOR EACH TUBE.

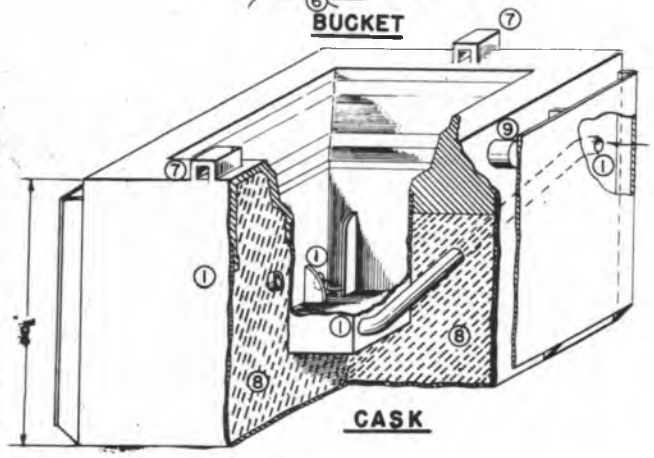
CASK ASSEMBLY



LID



BUCKET

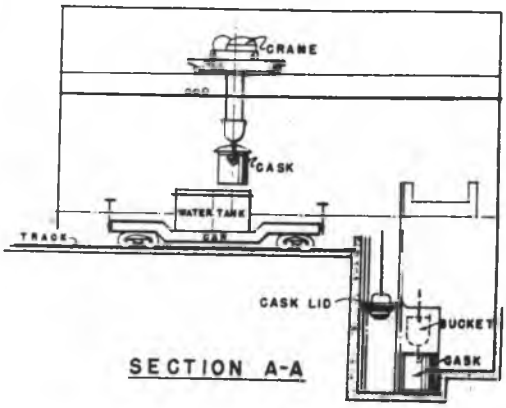


CASK

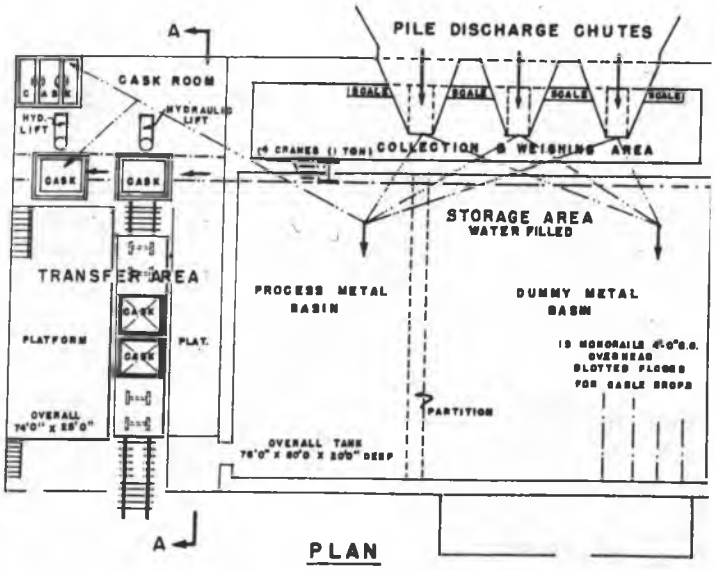
1. WATER CIRCULATING TUBE
2. LOCKING BAR
3. BALL LOCK
4. LID ARMS
5. LUG FOR LIFTING BUCKET
6. HOLES FOR WATER CIRCUI THROUGH BUCKET
7. CATCHES FOR LOCKING BA
8. LEAD FILLED CASK WALL
9. LUG FOR LIFTING CASK

SECRET

TRANSFER STATION & STORAGE BASIN



SECTION A-A

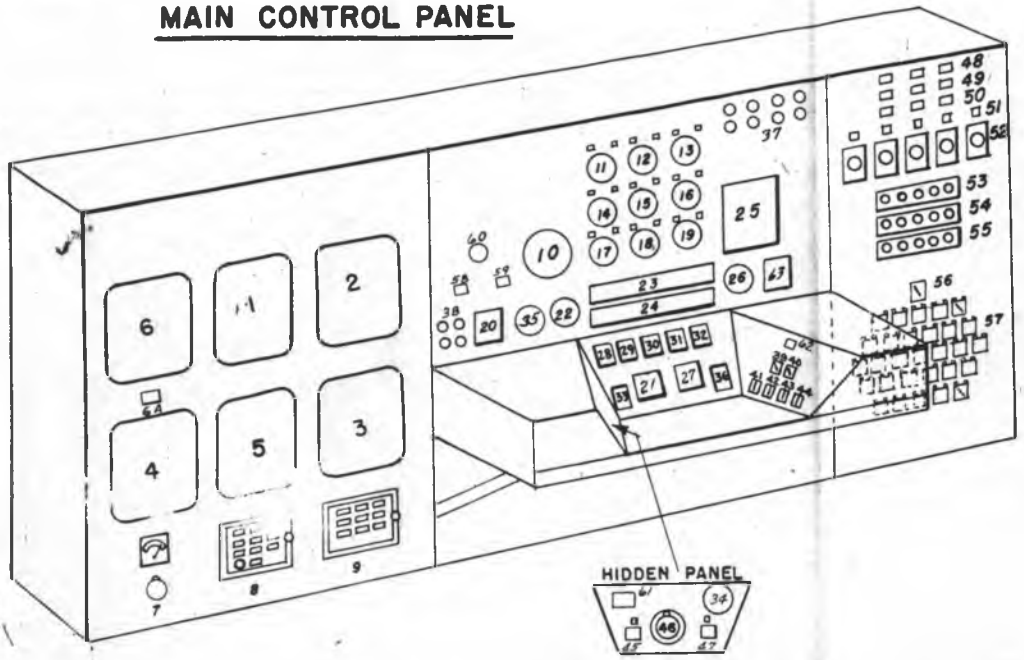


PLAN

SECRET

SECRET

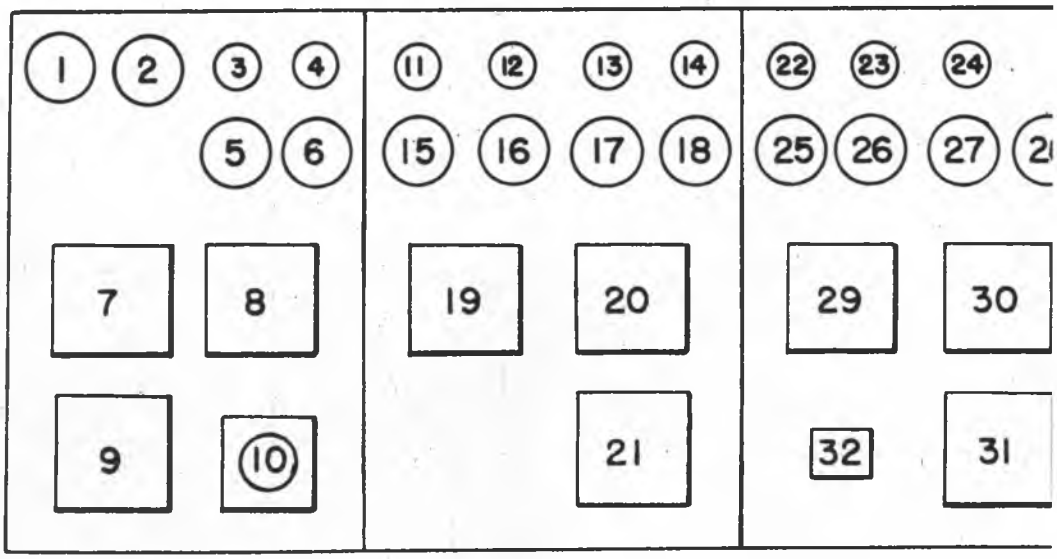
MAIN CONTROL PANEL



1) L&N recorder operated by Beckman micro-microammeter and neutron chamber under the pile, Beckman #2
2) L&N recorder operated by Beckman micro-microammeter and chamber monitoring water activity in the downcomer, Beckman #1
3) Multi-point L&N recorder operated by Beckman micro-microammeter and neutron chambers under the pile, Beckmans 3 and 4
4-5) Blank panels
6) Continuous single-point recorder recording position of regulating rod in use
6A) Toggle switch for selecting regulating rod to be recorded at 6
7) Voltmeter and switch for measuring battery voltage in galvanometer system
8) Switches to by-pass first "out" limit switches on shim rods
9) Nine switches for cutting the 9 Selsyns in and out of service
10) L&N circular chart recorder for differential power level indicator
11-19) Nine Selsyns indicating the position of 7 shim and 2 reg. rods. Reg. rods are 11 and 13. Green light over each Selsyn shows when rod is all in, red light shows when rod is all out
20) Renge switch for differential power level indicator
21) Shunt for level galvanometer
22) Duplicate Selsyn for #1 regulating rod
23) Ground glass scale for level galvanometer
24) Ground glass scale for deviation galvanometer
25) Twenty-eight drop annunciator
26) Duplicate Selsyn for #2 regulating rod
27) Shunt for deviation galvanometer
28) Indicating meter for Beckman #1
29) Indicating meter for Beckman #2
30) Indicating meter for differential power level indicator
31) Indicating meter for Beckman #3
32) Indicating meter for Beckman #4
33) Push button to drive in the 7 shim rod high speed. Can be locked down with k
34) Electric interval time
35) Electric clock with sweep second hand
36) Push button operating #1 safety circui be locked down with key
37) Alarm lights for discharge water monit
38) Indicating lights for doors into disch area at 0', 10', 20', and 30' levels
39) Switch to select regulating rod to be operated
40) Duplicate of 39 for other control rod locked so only 1 rod at a time can be
41) Switch for high speed, low speed sele one regulating rod
42) Switch for direction selection of one
43) Switch for high speed, low speed sele other regulating rod
44) Switch for direction selection of oth regulating rod
45) Switch to move a shim rod in either d Green light above switch indicates if controlled by this switch is in opera
46) Ten-point selector switch for selecti of the 7 shim rods is to be moved
47) Duplicate of 45 for second hydraulic
48) Green lights show when accumulator le above normal operating height
49) Amber lights show when the accumulato are just below normal operating heigh
50) Red lights show when levels have drop point where the "low" annunciator fla
51) Five indicator lights show green when rod power, shim rod power, #1 reg. ro #2 reg. rod power, and instrument pow
52) Keys for locking power off, on the ab systems
53,54&55) Fifteen key by-pass switches fo passing various safety circuits as ne during repairs and maintenance
56) Control for withdrawing or lowering rods individually or in groups, depe upon setting of individual rod contro
57) Controls for tripping 29 safety rods ually. Green light above each contr indicates when rod is in, and red li when rod is out
58,59) Switches to turn on shim rod oil
60) Selector switch to put "A" hole neut chamber on either #2 Beckman or the galvanometer
61) Switch to operate both shim rod pump taneously to drive rods at twice nor
62) Reset button for alarm lights (37)

~~SECRET~~

MISCELLANEOUS CONTROL PANEL



1) Helium exit pressure
2) Helium inlet pressure
3) #1 regulating rod exit water pressure
4) #2 regulating rod exit water pressure
5) #1 regulating rod exit water temp.
6) #2 regulating rod exit water temp.
7) Four-point recorder for:
   a) % air in helium 0-100%
   b) % air in helium 0-2%
   c) % H_2O in helium at pile exit
   d) % H_2O in helium at sample point 0-1%
8) Two-point recorder for:
   a) helium temperature into pile
   b) helium temperature out of pile
9) Two-point recorder, helium inlet and exit activity
10) Recording flowmeter, helium circulation rate into pile
11) #3 shim rod exit water pressure
12) #4 shim rod exit water pressure
13) #5 shim rod exit water pressure
14) #6 shim rod exit water pressure
15) #3 shim rod exit water t
16) #4 shim rod exit water t
17) #5 shim rod exit water t
18) #6 shim rod exit water t
19) Four-point recorder, exi temp. of rods #1, #2, an
20) Four-point recorder, exi temp. of rods #4, #5, an
21) Four-point recorder, miscellaneous exit water
22) #7 shim rod exit water p
23) #8 shim rod exit water p
24) #9 shim rod exit water p
25) #7 shim rod exit water t
26) #8 shim rod exit water t
27) #9 shim rod exit water t
28) Pile exit water pressure
29) Four-point recorder, exi temp. of rods #7, #8, an
30) Indicating temp. potenti and 32 DPDT toggle switc
31) Four-point temperature r controlled from 30
32) Selector switch for "B" a thermocouples

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11 M

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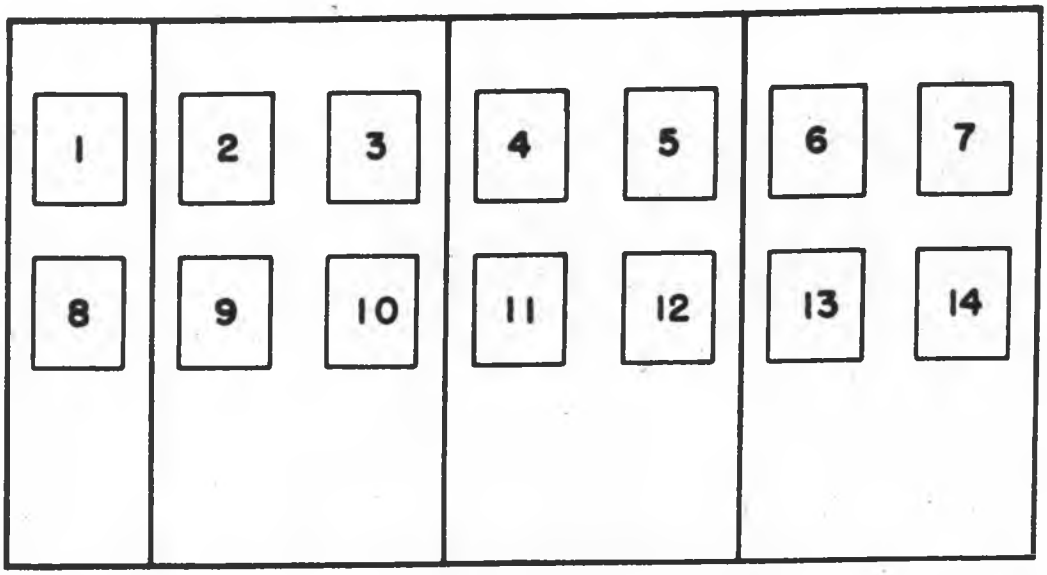
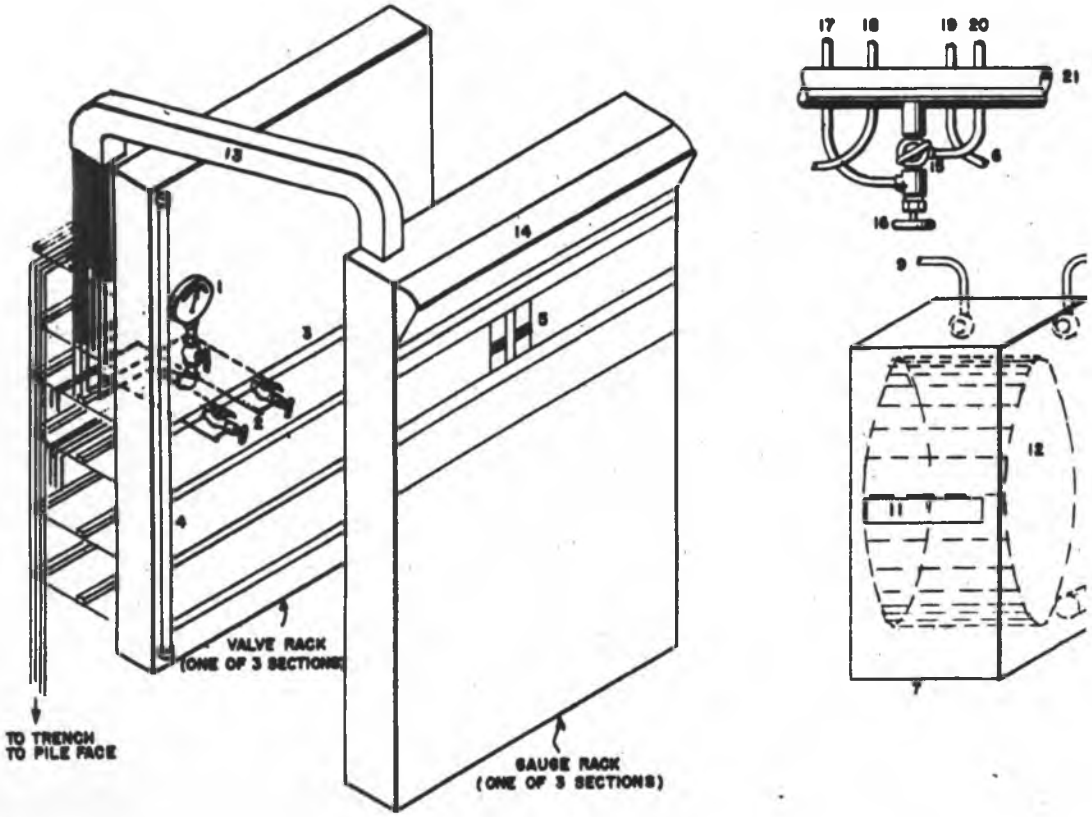
INSTRUMENT
MONITORING ROOM PANEL



1) Recorder For pH Of Waste Water Entering River
2) Recorder For Intermediate Retention Basin Monitor
3) Recorder For Inlet Retention Basin Monitor
4) Recorder Of Radiation Intensity 20' Far Side Discharge Area
5) Recorder For Stack Air Monitor
6) Recorder Integron Dosage Measurement
7) Recorder Integron Dosage Measurement
8) Recorder Of Radiation Intensity Top Of Pile And Transfer Area
9) Recorder Of Gamma Activity Of Retention Basin Exit Water
10) Recorder Of Beta Activity Of Retention Basin Exit Water
11) Recorder Of Radiation Intensity 0', 10', 20', 30' Near Side Discharge Area
12) Recorder For Exhaust Air Monitor
13) Recorder For Integron Dosage Measurement
14) Recorder For Integron Dosage Measurement

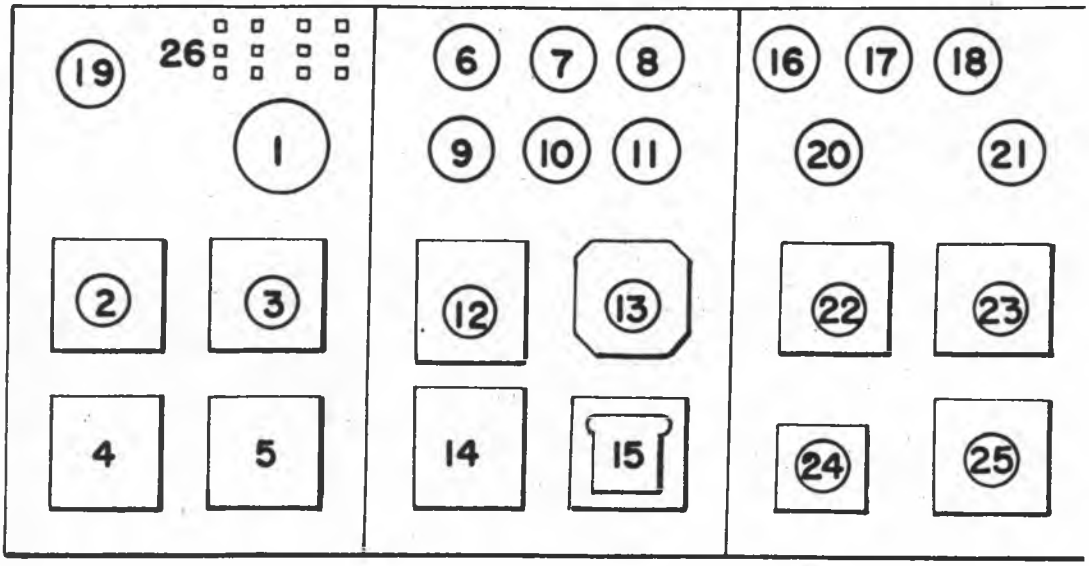
VALVE RACK AND GAUGE BOARD



1) Master gauge
2) Valve assembly, one for each tube and individual Panellit gauge
3) Horizontal gauge header
4) Master gauge riser connecting all horizontal gauge headers
5) Individual Panellit gauge, one for each tube
6) Detail of valve assembly
7) Detail of Panellit gauge
8&9) Series relay connections
10) Pressure connection
11) Transparent slot
12) Rotating pressure indicating element. Shows white at normal pressure, red on low pressure, and green on high pressure
13) Conduit for 3/16 outside diameter copper tubes to pressure gauge
14) Indicating lights
15) Two-way valve, connects Panellit gauge to either master gauge, or to tube pressure connection
16) Needle valve to shut off individual Panellit gauge as necessary
17) Line to Panellit gauge
18) Line from next valve on left to its corresponding tube
19) Line from next valve on right to its corresponding Panellit gauge
20) Line from tube at pile face
21) Header to master gauge

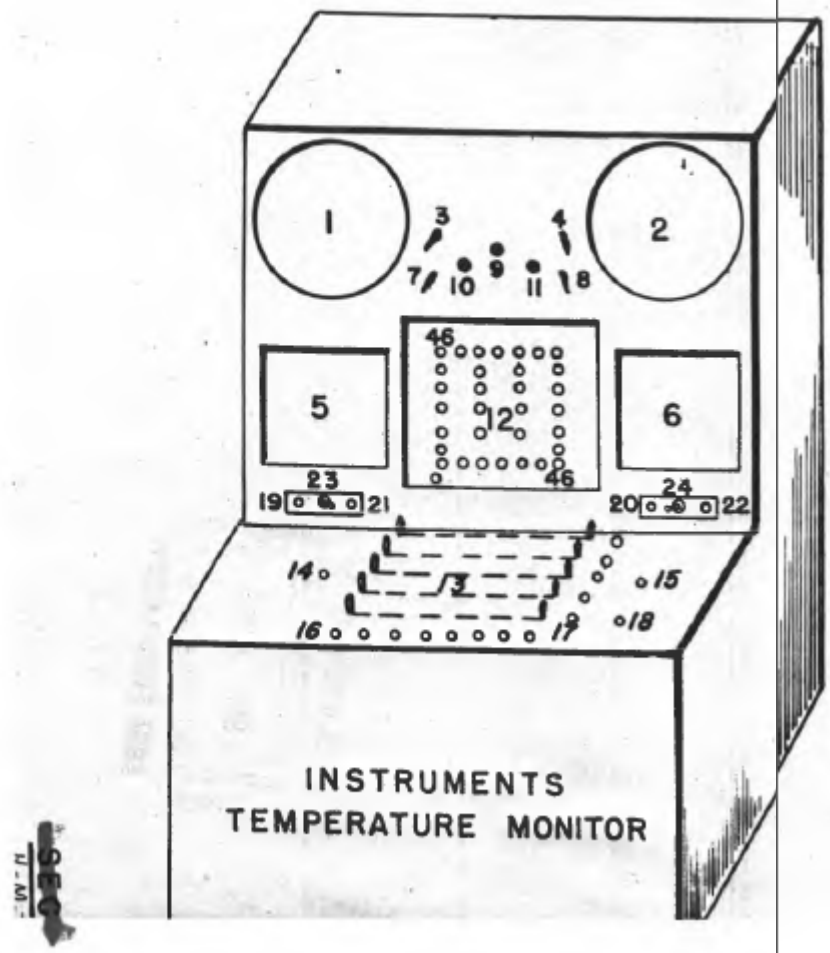
SECRET

INSTRUMENTS
INLET WATER PANEL



1) Water pressure, left-hand unchilled 20" riser
2) Total flow, rate of heat transfer (kw.), and temperature difference, recorder
3) Flow and temperature recorder, left-hand unchilled 20" riser
4) Kilowatt calculator (blank door)
5) Flow converter (blank door)
6) Main steam pressure
7) Stand-by filtered water pressure
8) Stand-by raw water pressure, valve pit
9) Water pressure, left-hand chilled 20" riser
10) Water pressure, chilled header at valve pit
11) Water pressure, unchilled header at valve pit
12) Flow and temperature recorder, left-hand chilled 20" riser
13) Two-pen pressure recorder, chilled and unchilled headers at valve pit
14) Temperature differential converter (blank door)
15) Two-point temperature recor temperature each side of va in by-pass between chilled unchilled headers
16) Water pressure, left-hand h tank
17) Water pressure, right-hand tank
18) Inlet water pressure, therm shield
19) Instrument air pressure
20) Water pressure, right-hand chilled 20" riser
21) Water pressure, right-hand unchilled 20" riser
22) Flow and temperature record right-hand chilled 20" rise
23) Flow and temperature record right-hand unchilled 20" ri
24) Two-point recorder, high ta levels
25) Flow recorder, water to the shield
26) Storage tank level indicating lights

SECRET
U.M.T



1&2) L&N single-point recorders

3&4) Retractable plugs for L&N recorders, 1 and 2 respectively

5&6) Brown high speed recorders

7&8) Retractable plugs for Brown recorders, 5 and 6 respectively

9) Jack for monitoring 2004 tubes

10) Jack for monitoring 1002 tubes

11) Jack for monitoring other 1002 tubes

12) Jack board containing a jack for each individual tube

13) Five rows of 40 plugs each for plugging into 200 or less jacks on 12

4&15) Jacks for plugging recorder into 200 tube system

16) Forty indicator lights

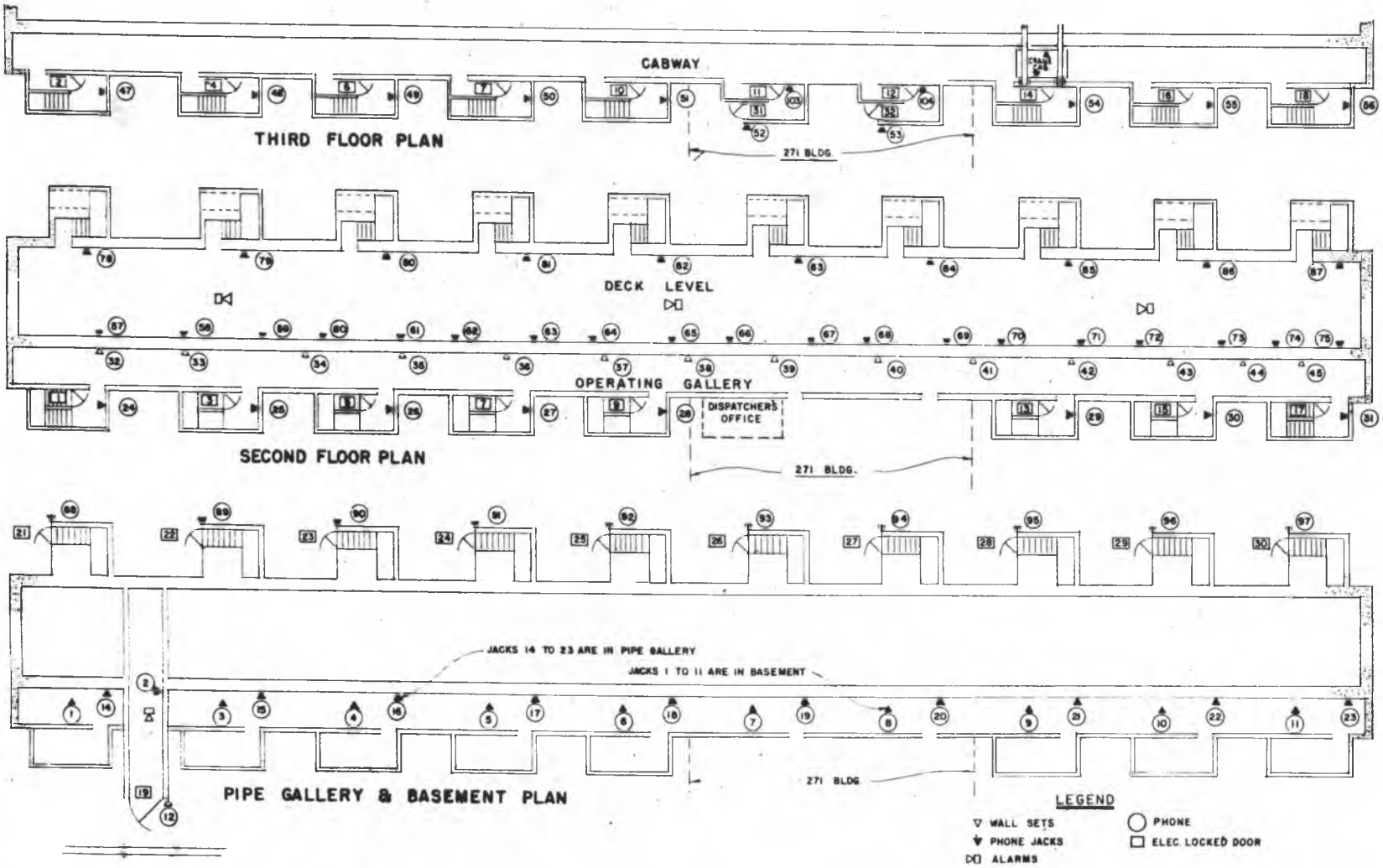
17) Row skip switches

18) 200-point repeat switch

19&20) Monitor starting switches

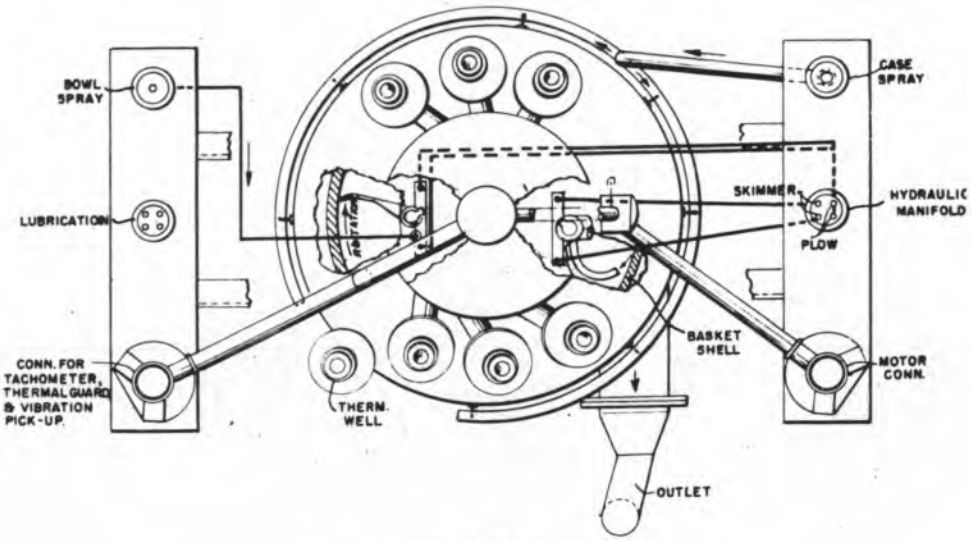
21) Row selector switch -- rows 01-23

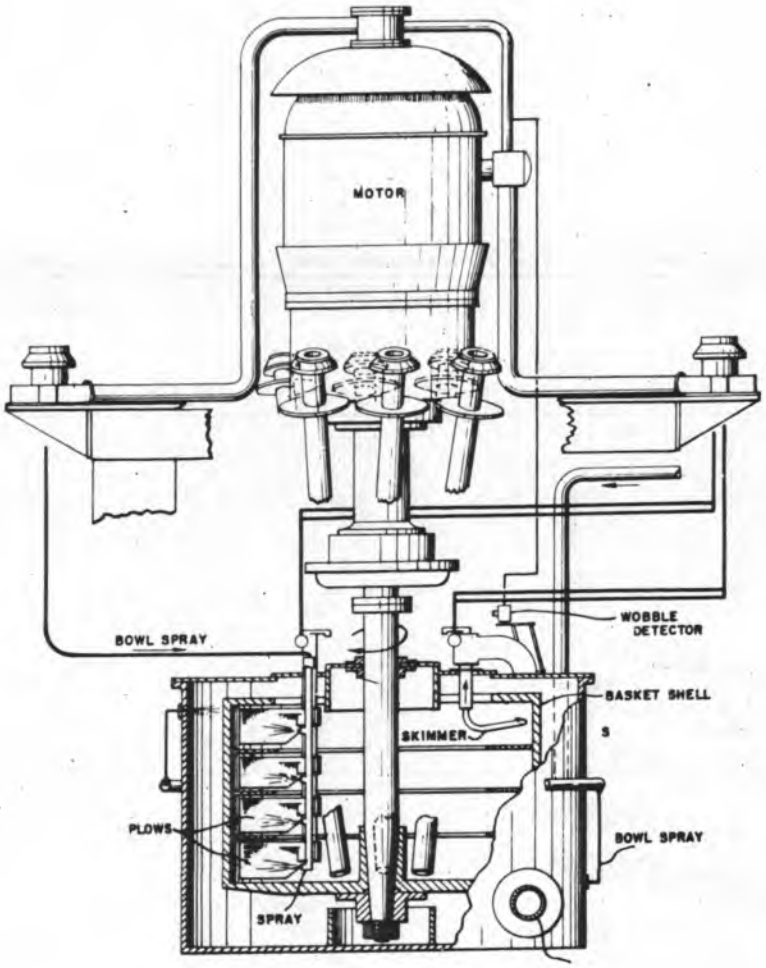
22) Row selector switch -- rows 24-46


CABWAY
THIRD FLOOR PLAN
271 BLDG
DECK LEVEL
OPERATING GALLERY
DISPATCHER'S OFFICE
SECOND FLOOR PLAN
271 BLDG.
JACKS 14 TO 23 ARE IN PIPE GALLERY
JACKS 1 TO 11 ARE IN BASEMENT
271 BLDG
PIPE GALLERY & BASEMENT PLAN
LEGEND
WALL SETS
PHONE JACKS
ALARMS
PHONE
ELEC. LOCKED DOOR

SECRET

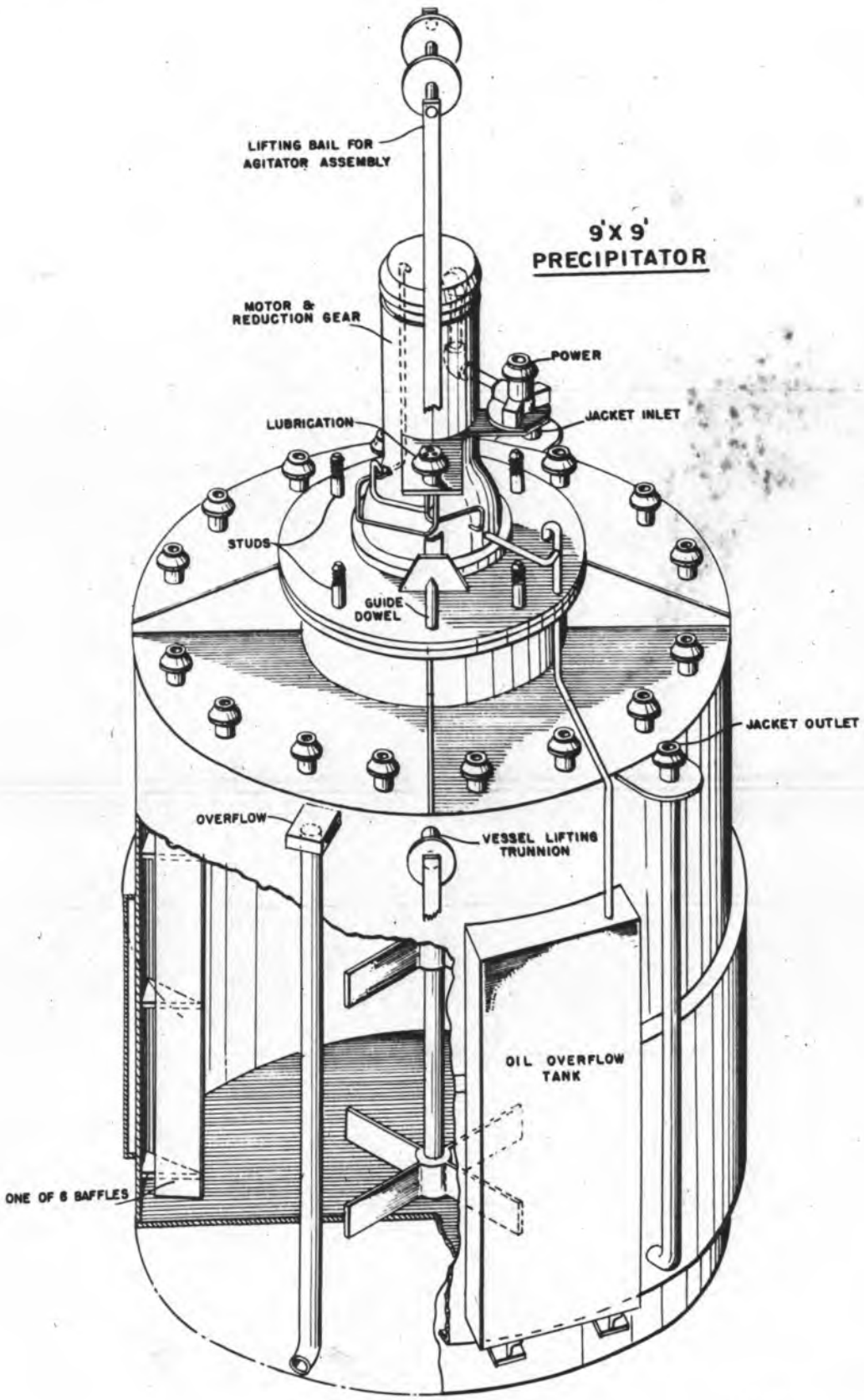
CENTRIFUGE



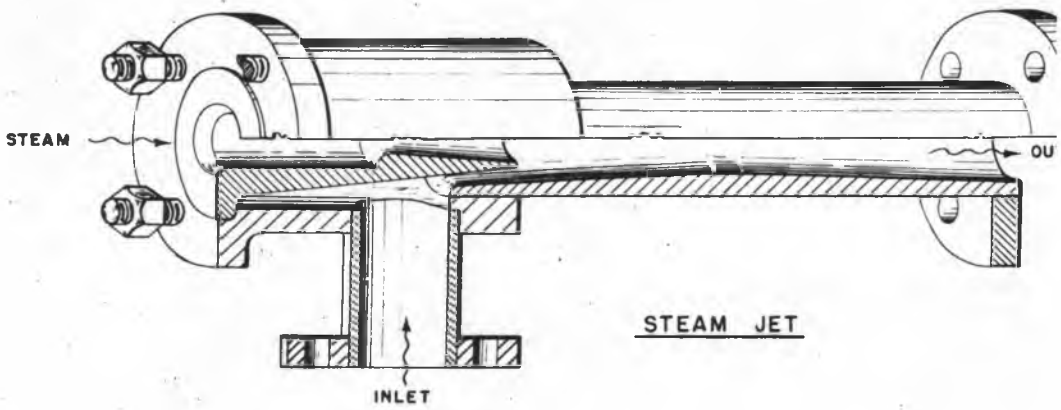


SE
H7

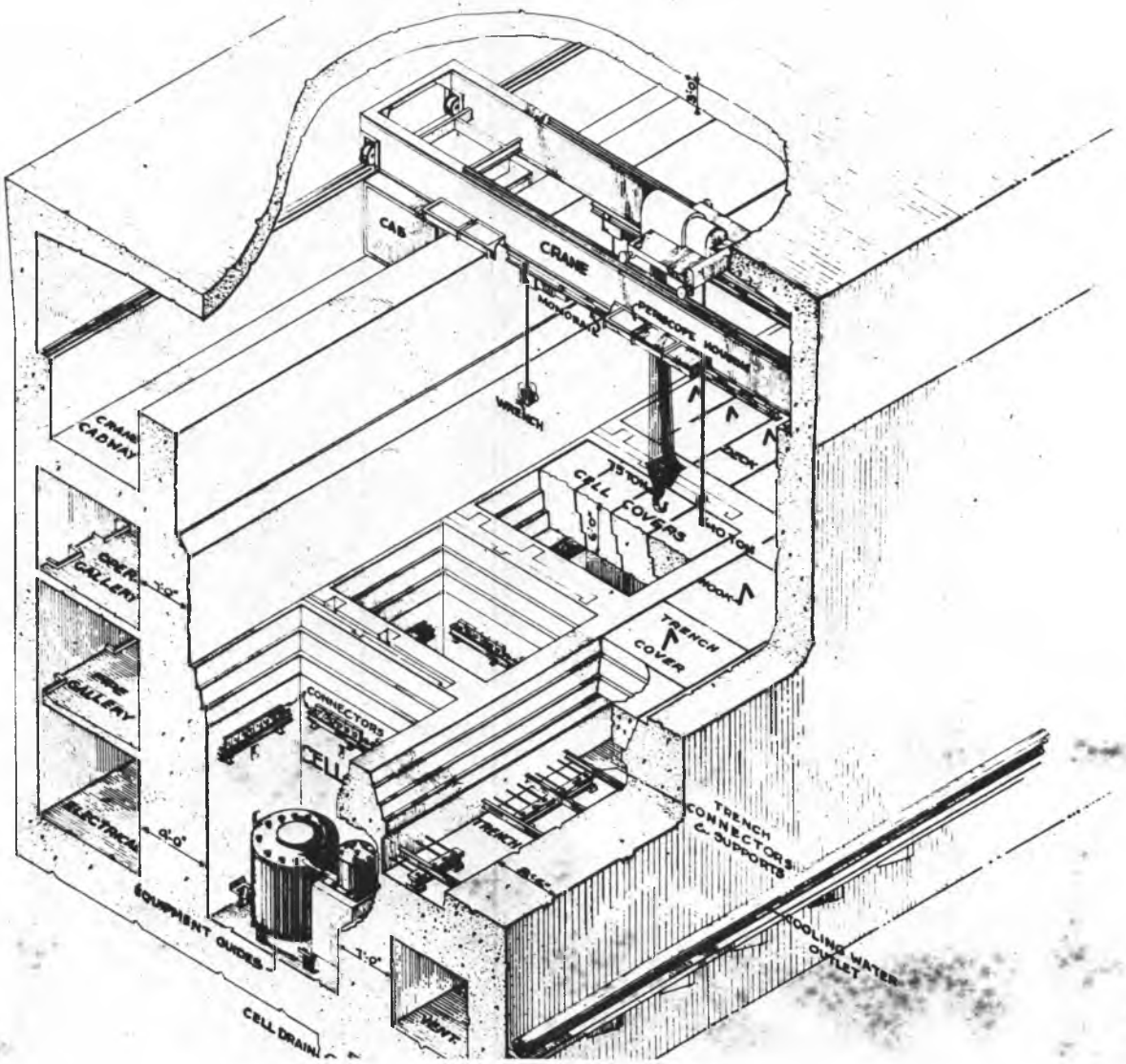
SECRET

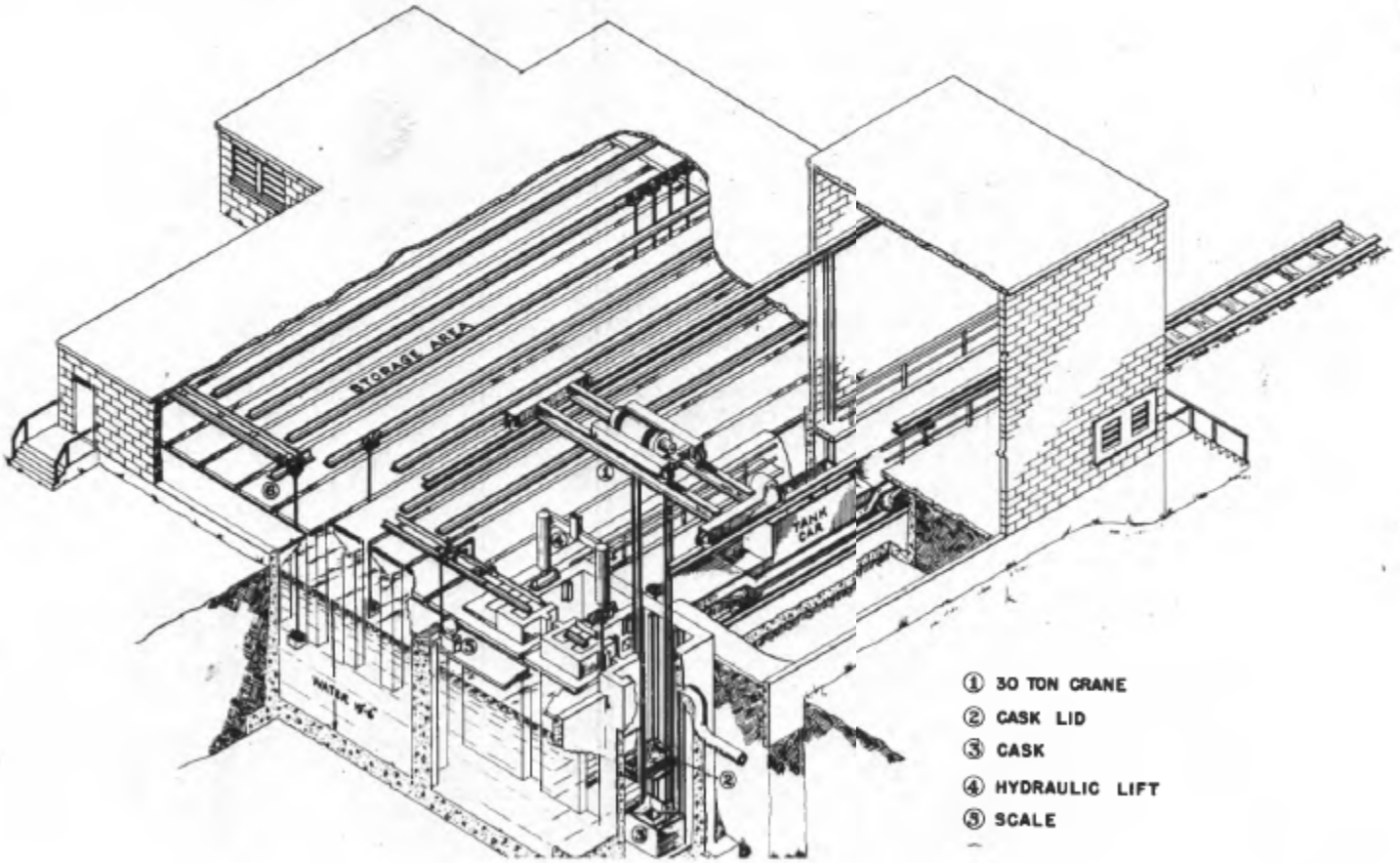


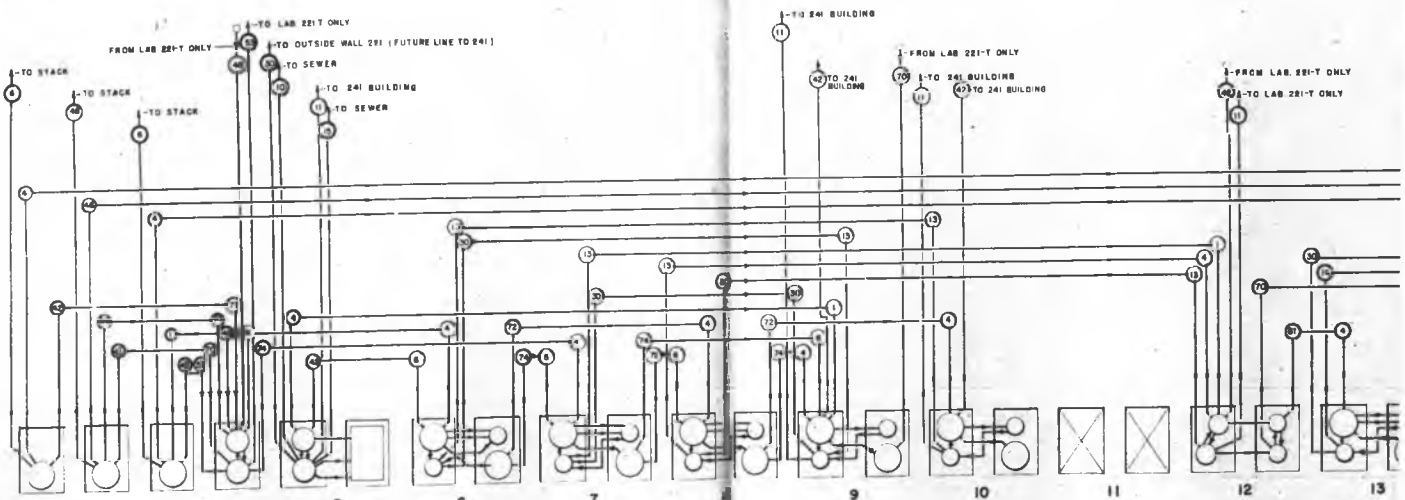
SEC
H-M-C



STEAM JET

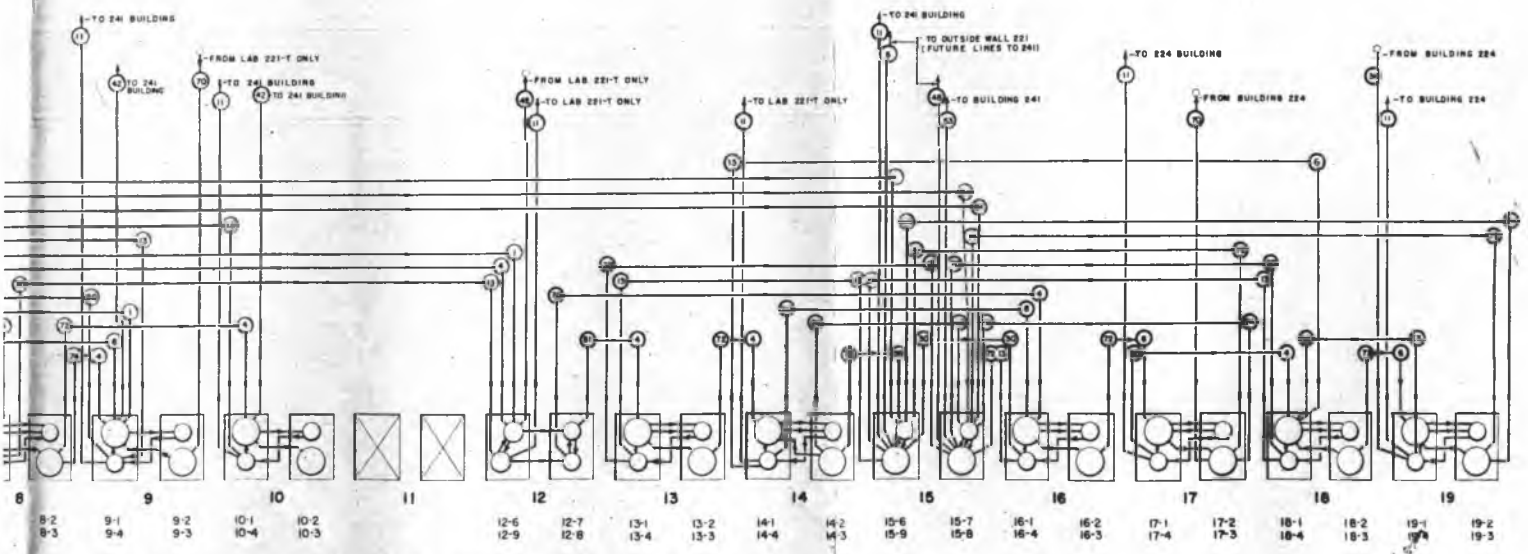

CAB
CRANE
CRANE CADWAY
WRENCH
CELL COVERS
HOOK
TRENCH COVER
CONNECTORS
CELL
TRENCH
TRENCH CONNECTORS & SUPPORTS
COOLING WATER OUTLET
EQUIPMENT DUCTS
CELL DRAIN
VENT


STORAGE AREA
TANK CAR
WATER 4°C
① 30 TON CRANE
② CASK LID
③ CASK
④ HYDRAULIC LIFT
⑤ SCALE



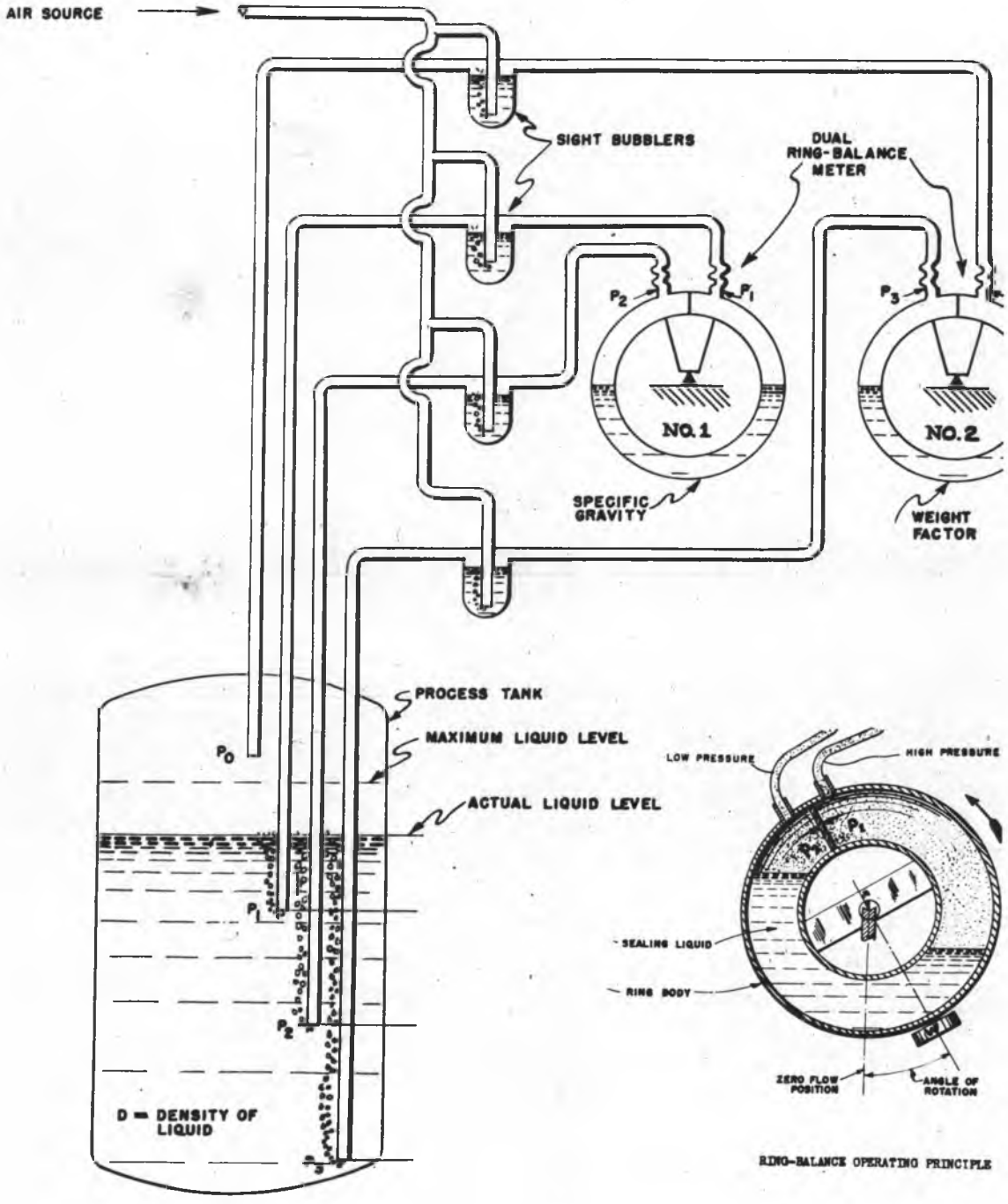
SECTION	3		4		5		6		7			8		9		10		11	12		13
EQUIPMENT PIECE NUMBER	3-5L	3-5R	4-5L	4-7 4-8	5-6 5-9	5-7	6-1 6-4	6-2 6-3	7-1 7-4	7-2 7-3	8-1 8-4	8-2 8-3	9-1 9-4	9-2 9-3	10-1 10-4	10-2 10-3			12-6 12-9	12-7 12-8	13-1 13-4

221 BLDG. PROCESS PIPING DIAGRAM



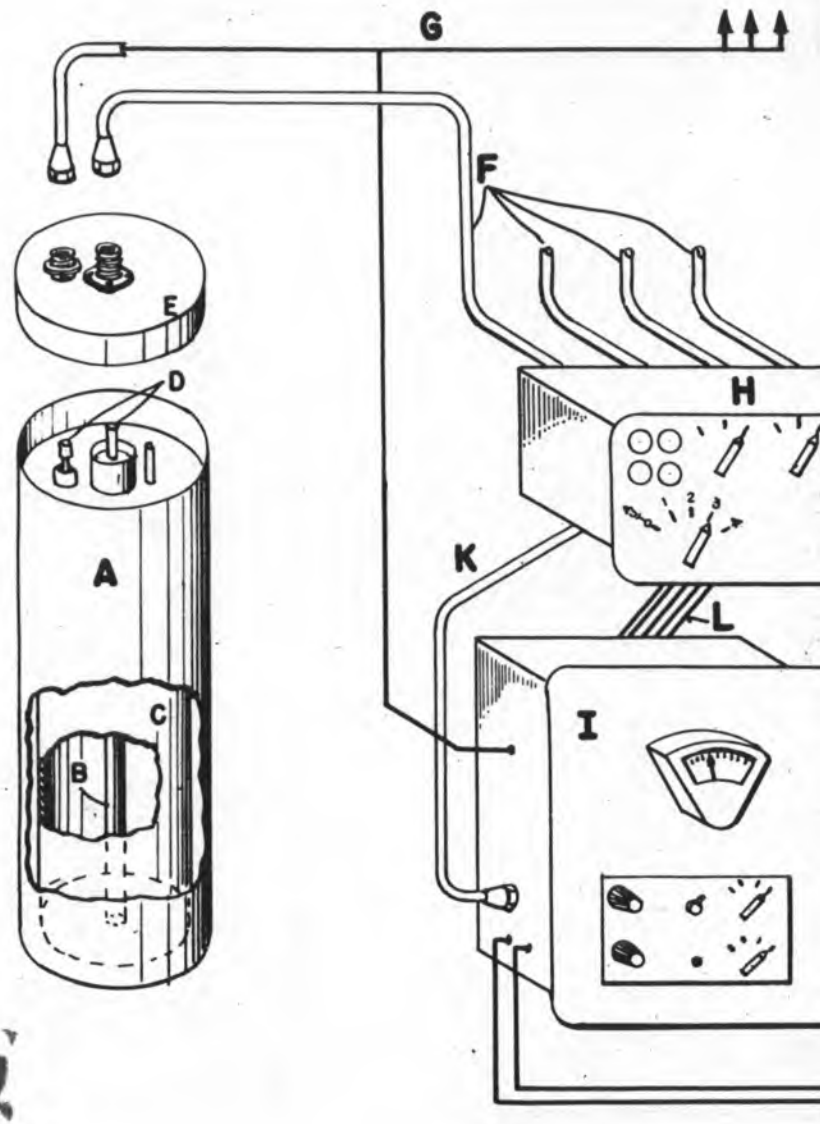
221 BLDG. PROCESS PIPING DIAGRAM

LIQUID LEVEL MEASUREMENT WITH SPECIFIC GRAVITY AND WEIGHT FACTOR



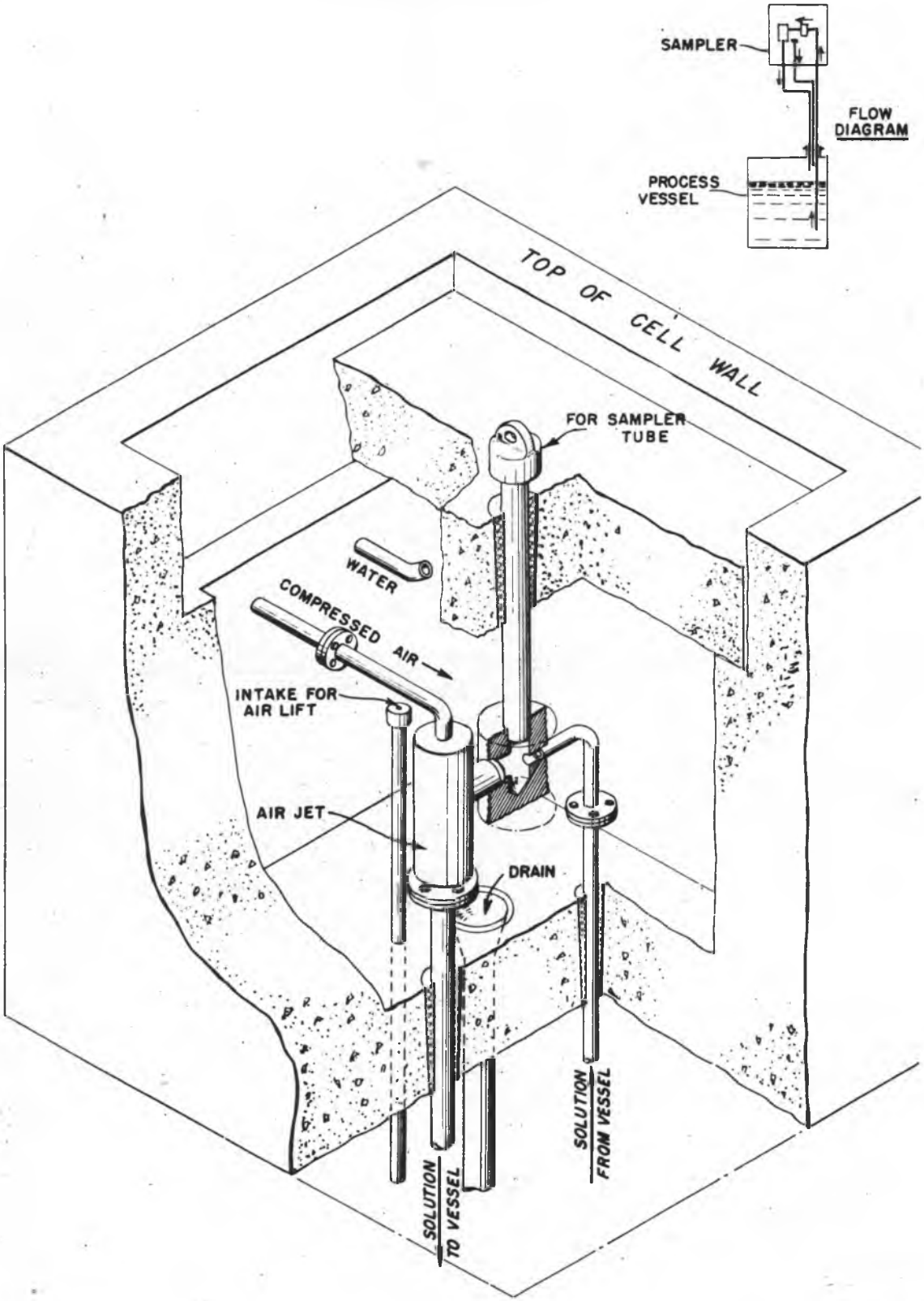
RING-BALANCE OPERATING PRINCIPLE

RADIATION INTENSITY MEASUREMENT EQUIPMENT FOR 221 BUILDING CELLS

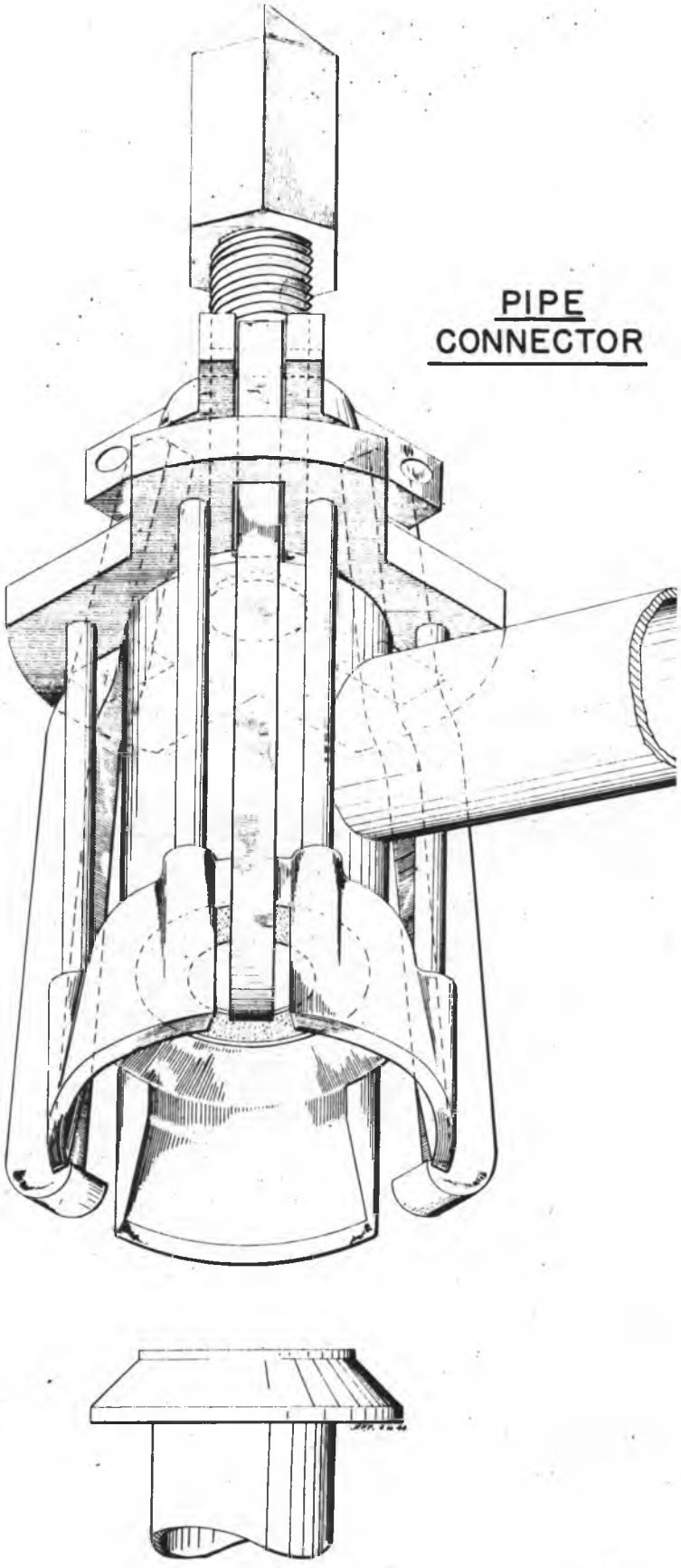


A— G.E. ION CHAMBER *(ONE OF FOUR)*
B- COLLECTOR ELECTRODE
C- HIGH VOLTAGE ELECTRODE
D- GLASS INSULATORS
E- CHAMBER COVER WITH CABLE CONNECTORS
F— LOW LOSS SHIELDED CABLE *(FOR 4 CHAMBERS)*
G— HIGH VOLTAGE LINE *(SHIELDED)* TO 4 CHAMBERS
H— MULTIPLE SWITCH
I— BECKMAN AMPLIFIER
J— MICROMAX RECORDER *(4 POINT)*
K— LOW LOSS CABLE - ION CURRENT FROM MULTIPLE SWITCH TO AMPLIFIER.
L— VOLTAGE SENSITIVITY SELECTION LINES FOR EACH CHAMBER

SAMPLER

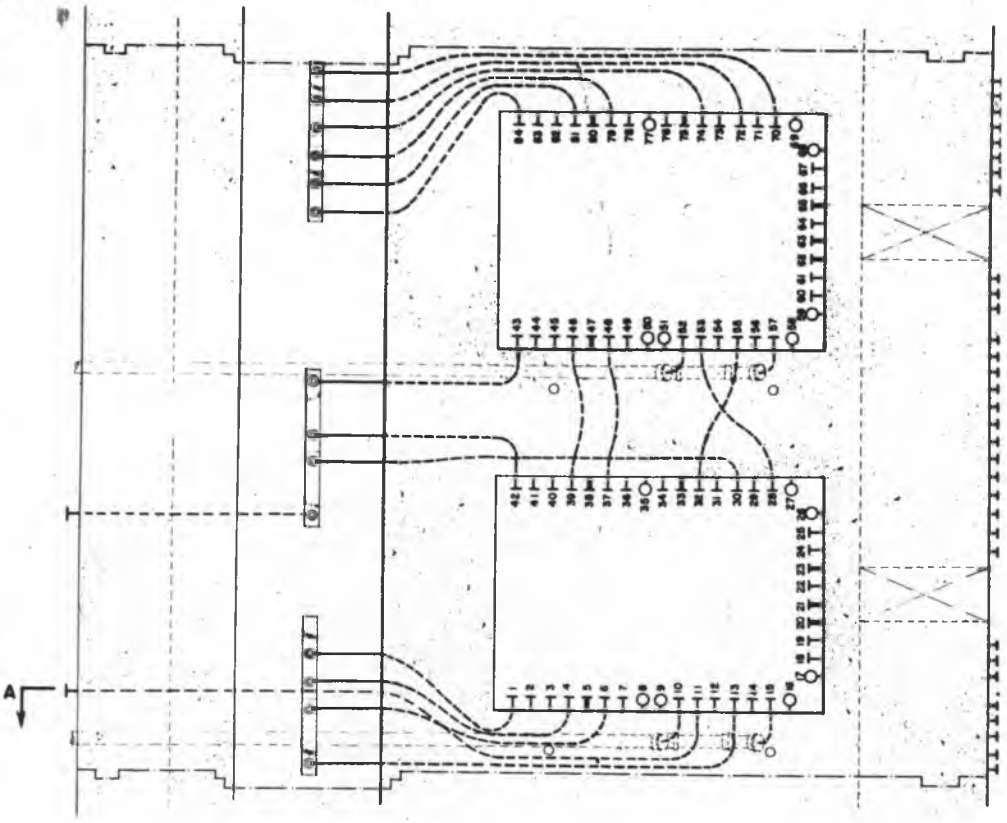

SAMPLER
FLOW DIAGRAM
PROCESS VESSEL
TOP OF CELL WALL
FOR SAMPLER TUBE
WATER
COMPRESSED AIR
INTAKE FOR AIR LIFT
AIR JET
DRAIN
SOLUTION TO VESSEL
SOLUTION FROM VESSEL

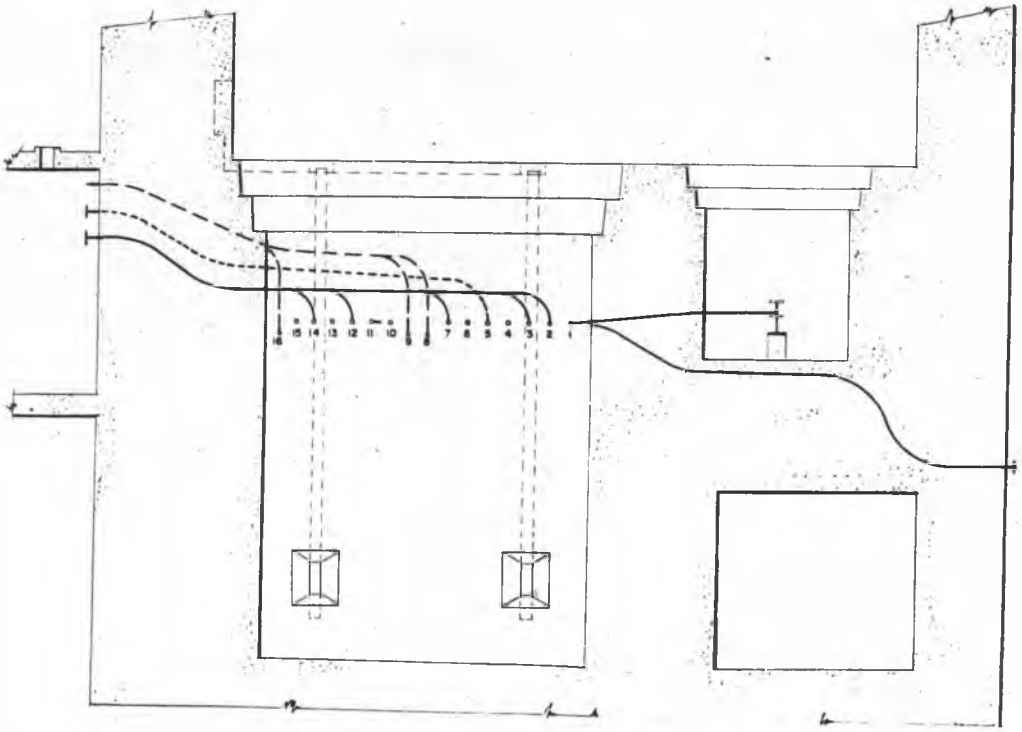
SECRET



PIPE
CONNECTOR

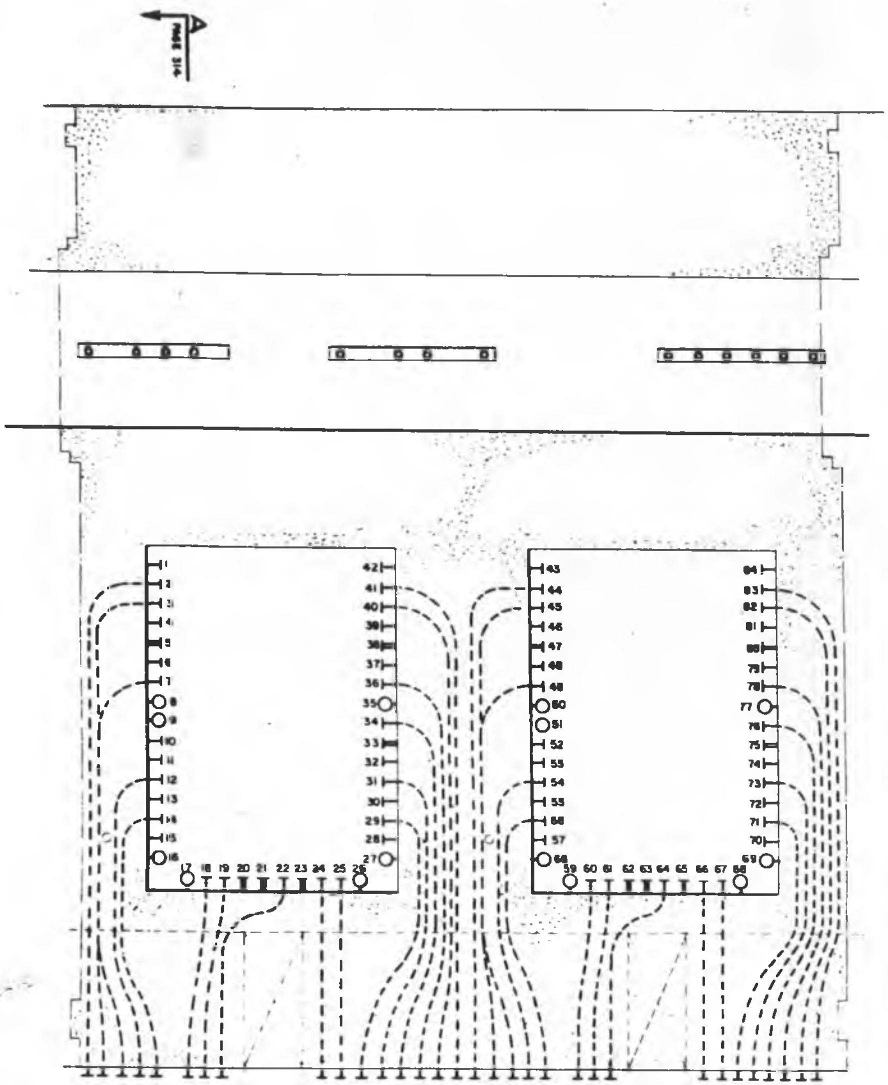
SECRET



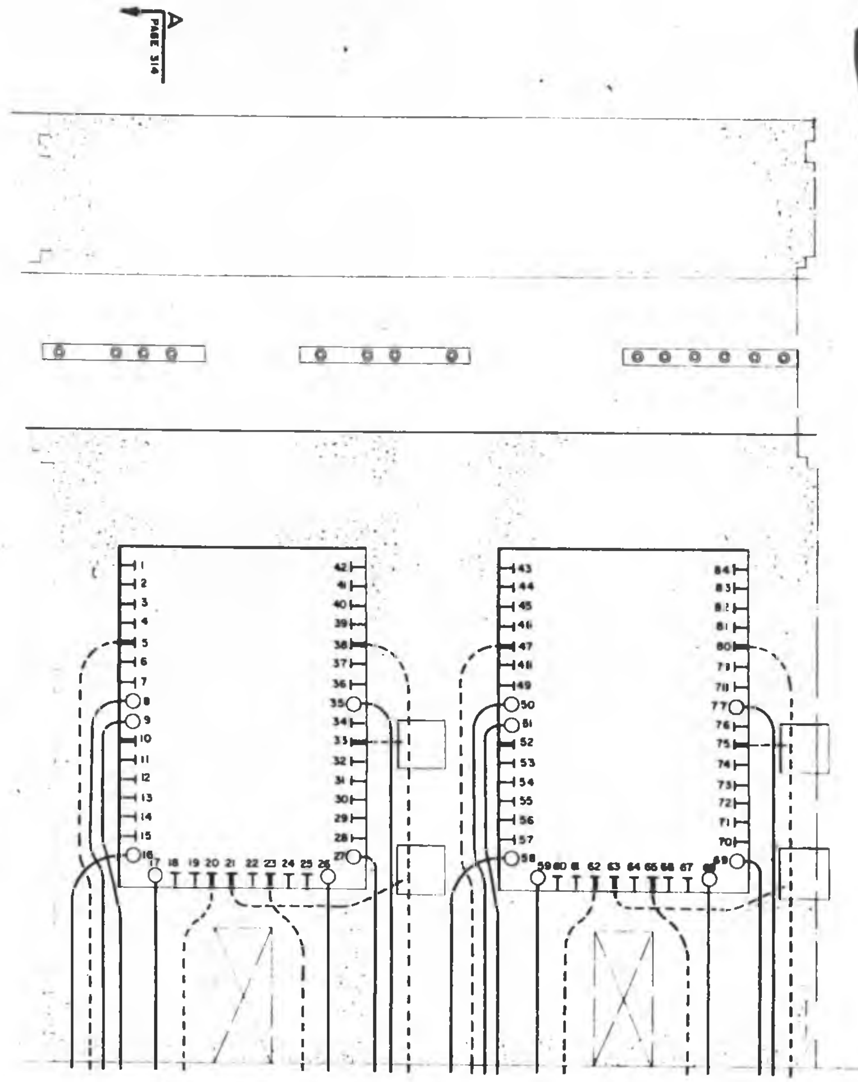


SECTION A-A

ELECTRICAL — — — —
INSTRUMENTS ---------
STEAM, CHEMICAL ———



STANDARD SECTION

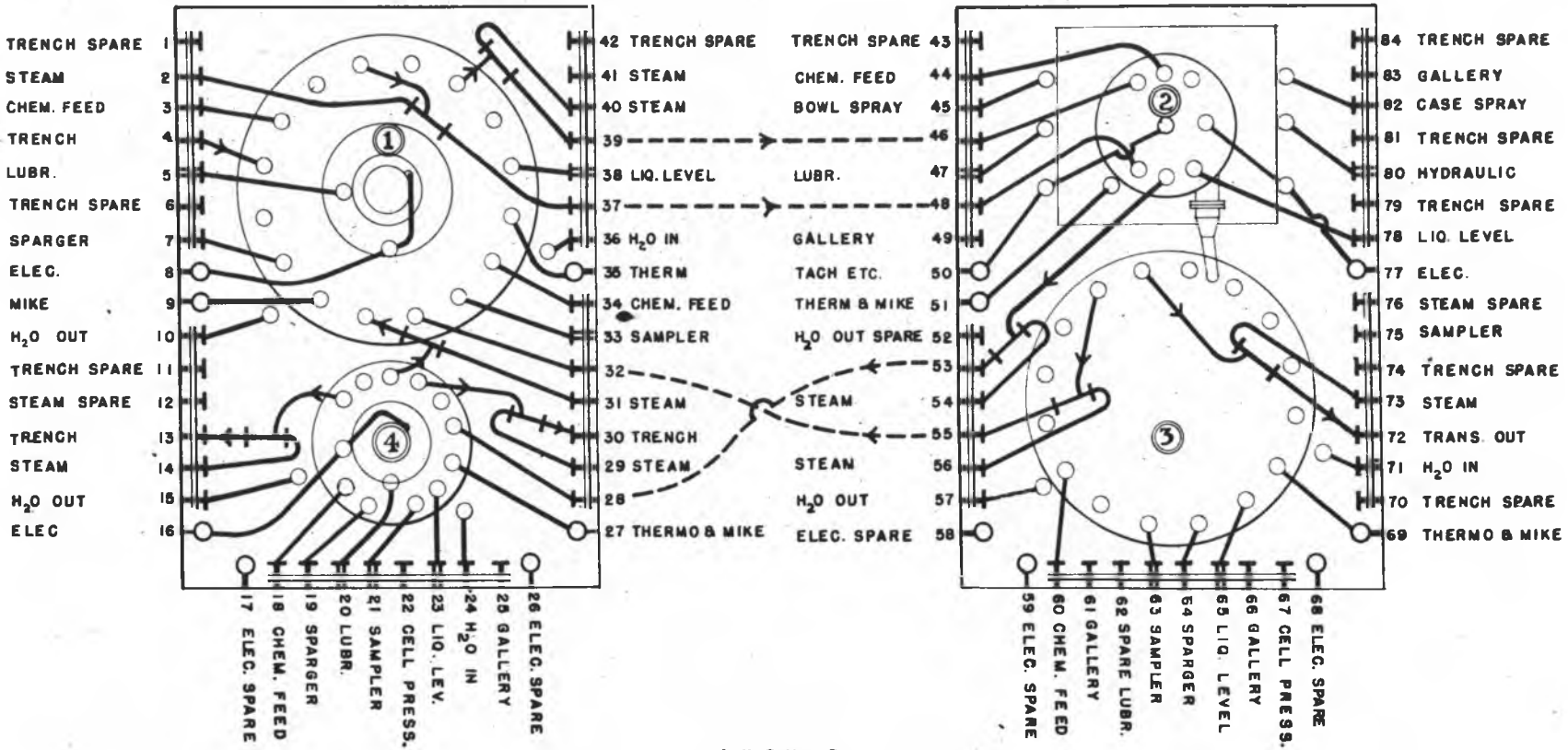


ELECTRICAL & INSTRUMENT LINES

SECRET

CELL NO. 25

CELL NO. 26

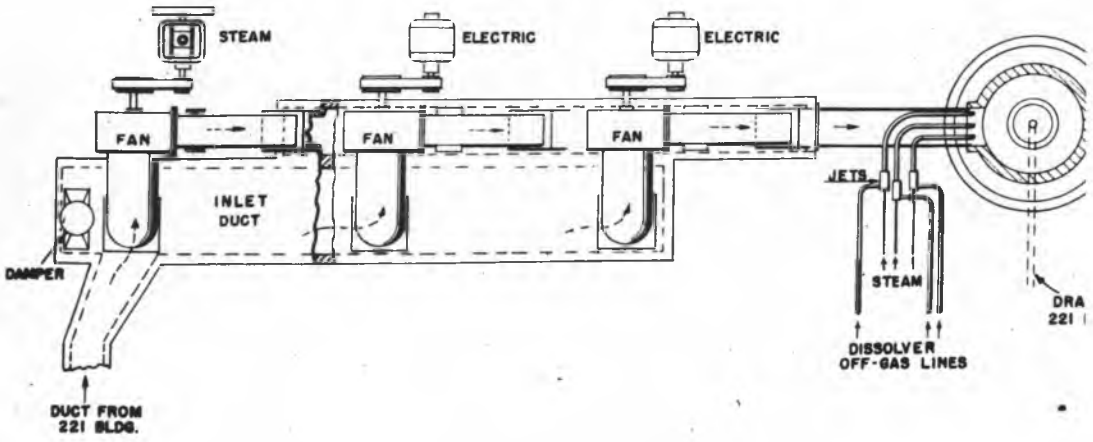


LEGEND

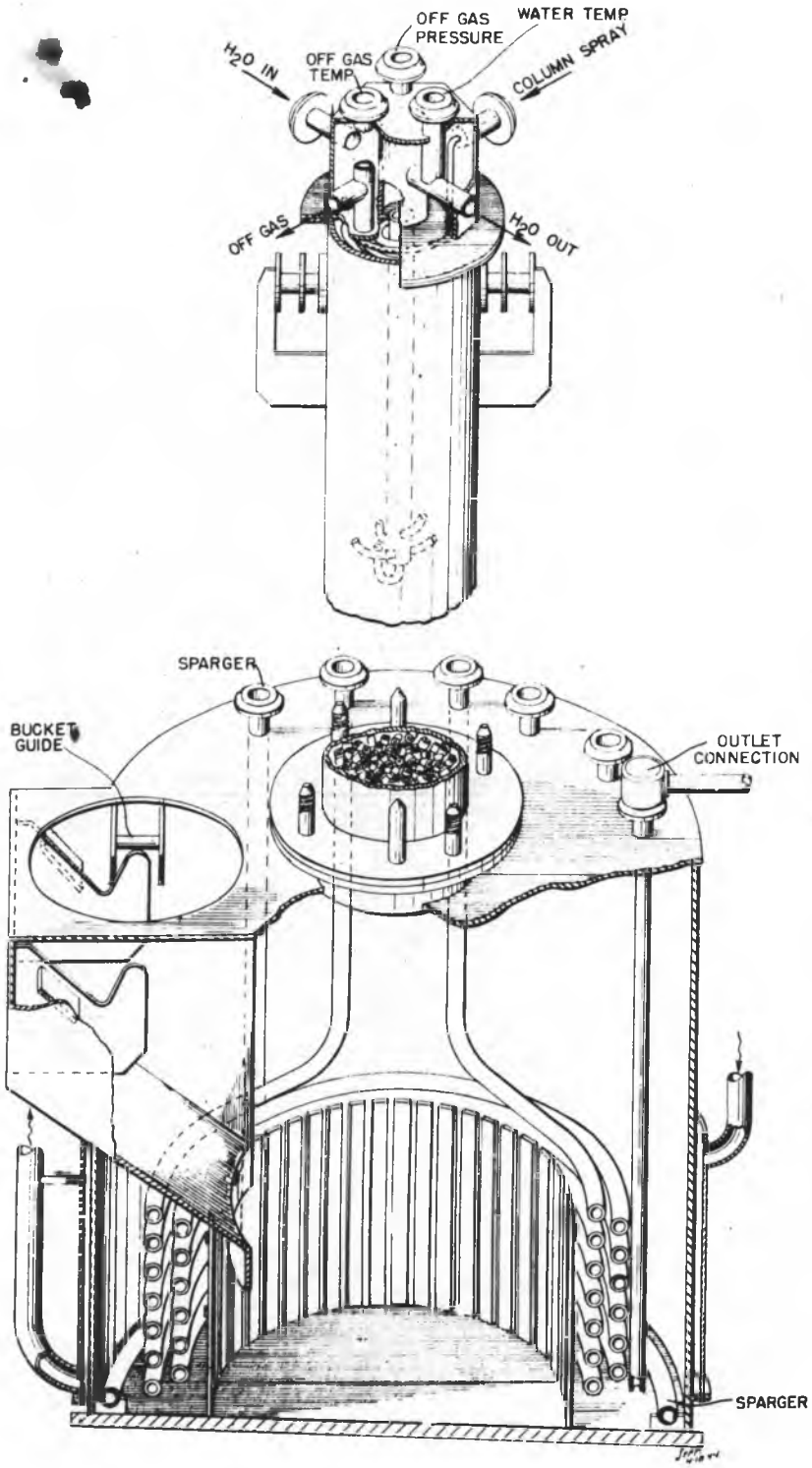
1. PRECIPITATOR
2. CENTRIFUGE
3. CATCH TANK
4. SOLUTION TANK

Section	Cell	Function
1	1 & 2	Storage of contaminated discarded equipment
2	3	Railroad tunnel for bringing in metal
2	4	Storage of slugs with fractured coating. This cell is kept filled with water (see 212 Building)
3	5 & 6	Coating removal, metal dissolving and reduc
4	7	Coating removal, metal dissolving and reduc
4	8	Metal solution storage
5	9	Sewage disposal, holding tanks
5	10	Sewage disposal, sewer cell
6	11 & 12	Spare. May be used for a by-product precipi tation before extraction
7	13 & 14	Extraction
8	15 & 16	Extraction (spare)
9	17 & 18	Treatment of waste metal solution
10	19 & 20	Treatment of waste metal solution (spare)
11	21 & 22	Spare, unequipped
12	23 & 24	Storage and oxidation of metal solution
13	25 & 26	First decontamination cycle, by-product precipitation
14	27 & 28	First decontamination cycle, product precipitation
15	29 & 30	Treatment of decontamination wastes
16	31 & 32	Second decontamination cycle
17	33 & 34	Second decontamination cycle
18 & 19	35, 36, 37 & 38	Third decontamination cycle (spare)
20	39 & 40	Spare, unequipped

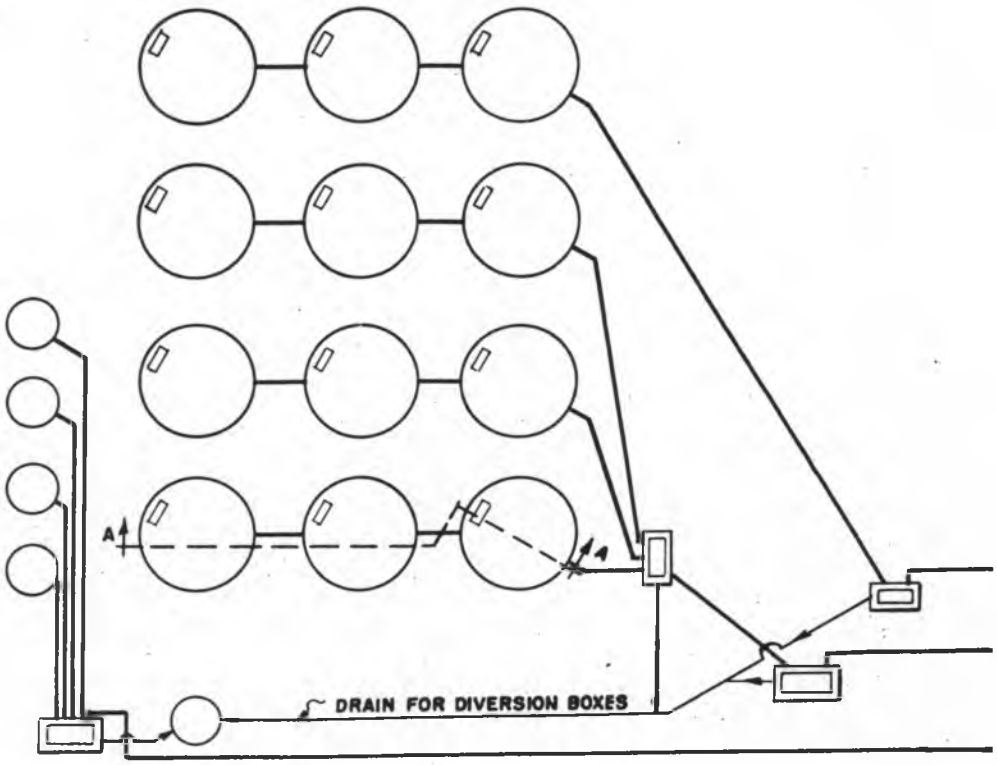
SECRET

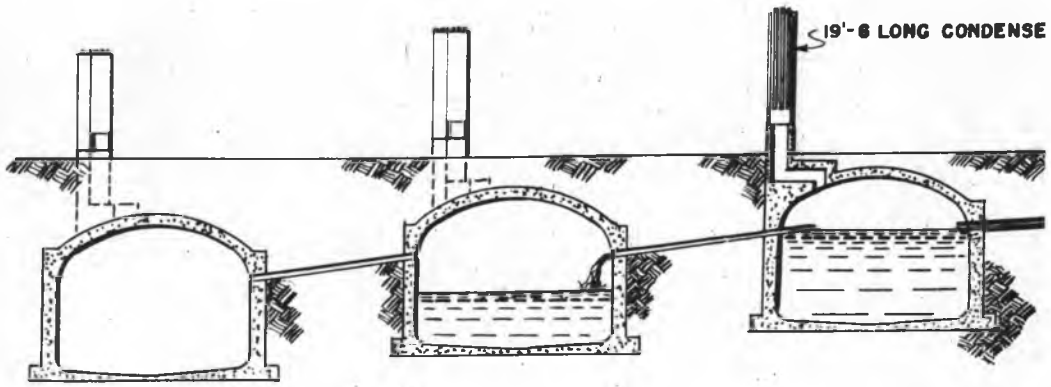


VENTILATION BUILDING LAYOUT



DISSOLVER



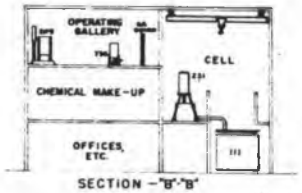


SECTION ON A-A OF 75'-0" DIA. STORAGE TANKS

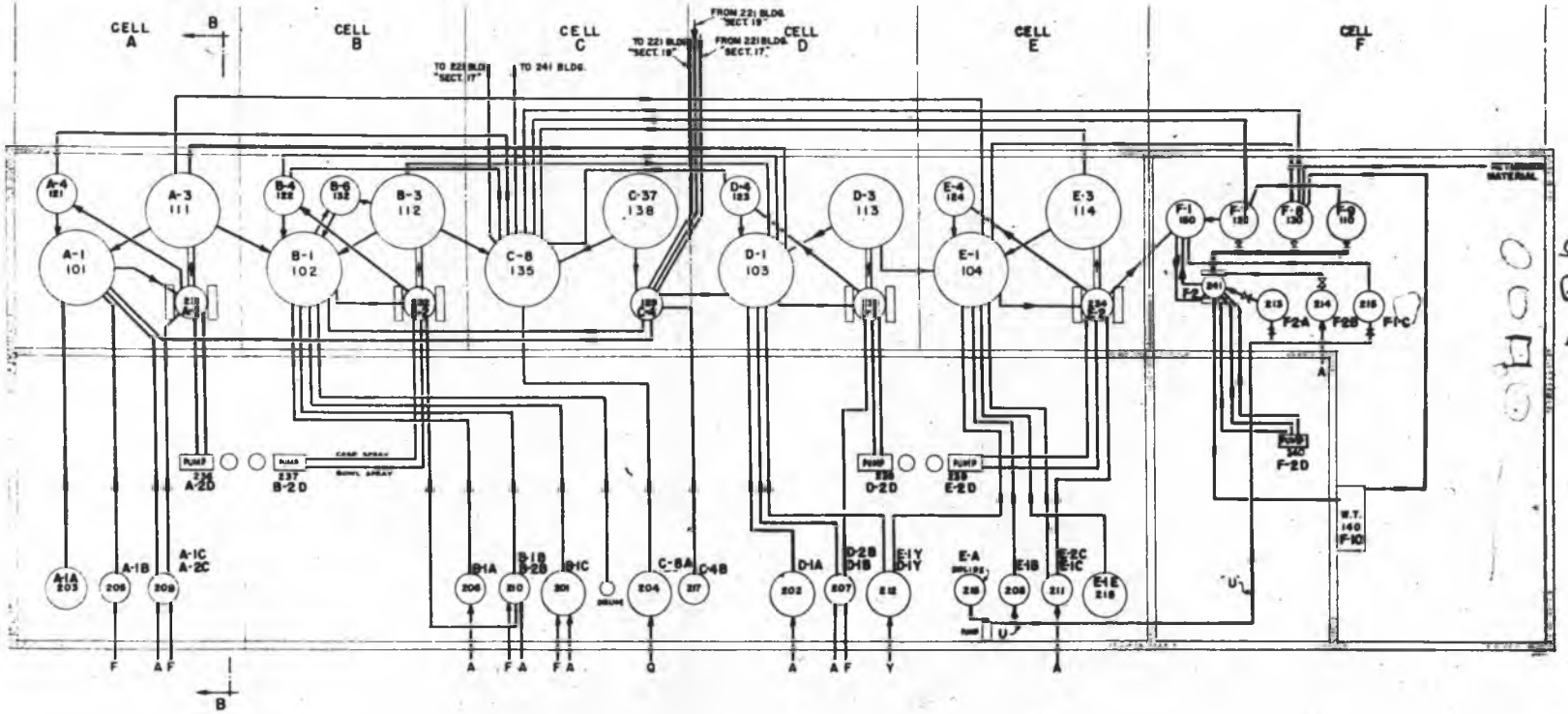
241 BUILDING

224 BUILDING

CHEMICAL & PROCESS PIPING

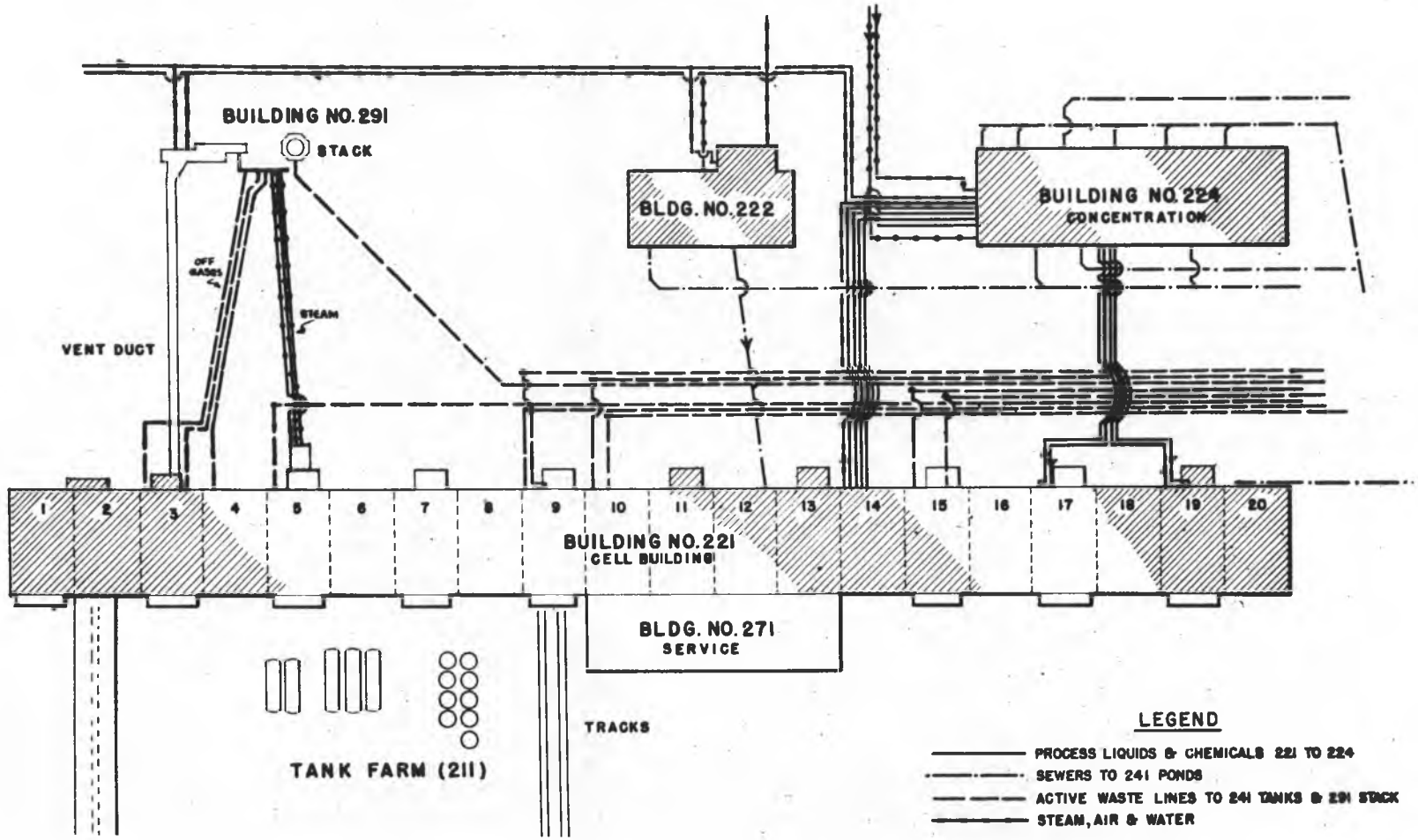


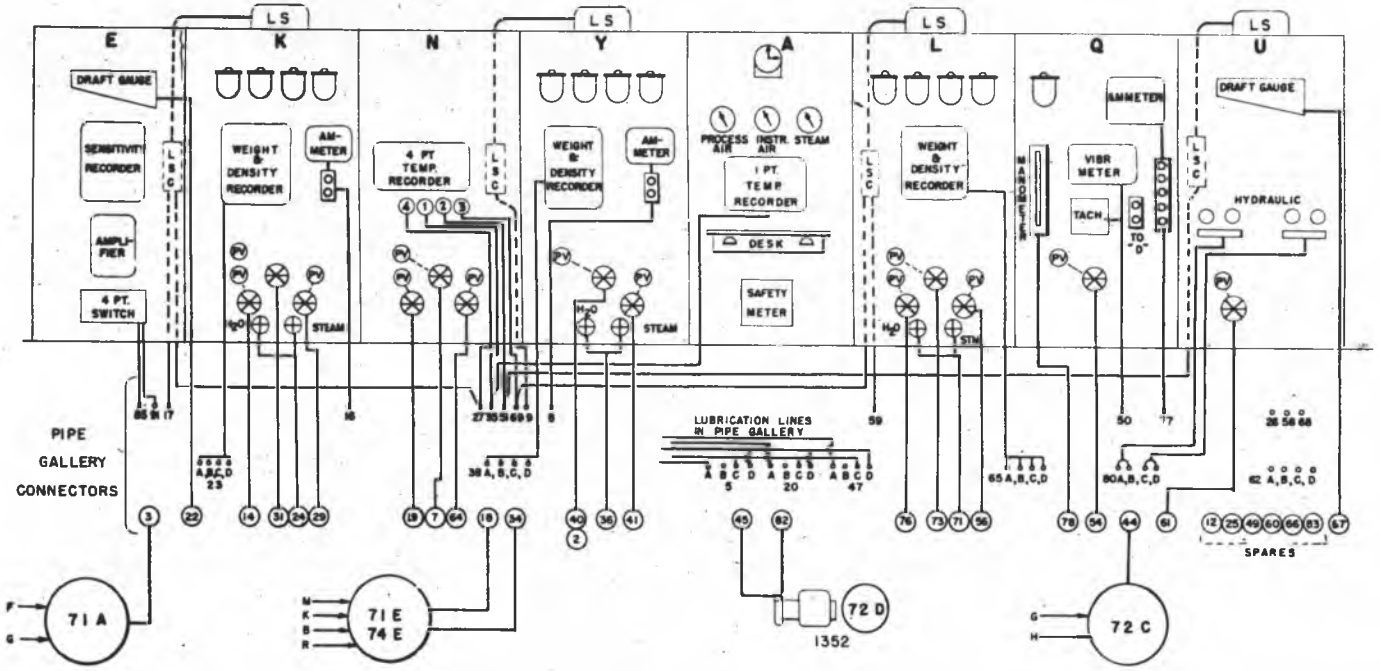
SECTION — "B"-"B"

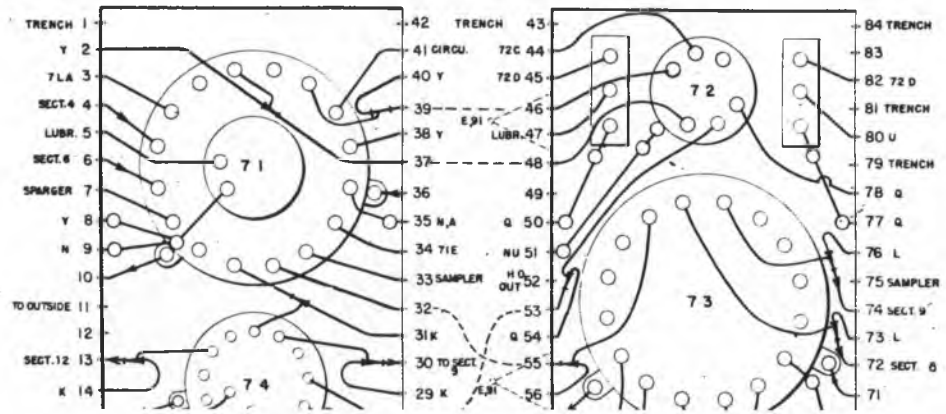


SECRET

OUTSIDE PIPING DIAGRAM & MAP OF IMMEDIATE AREA
BUILDING NO. 221







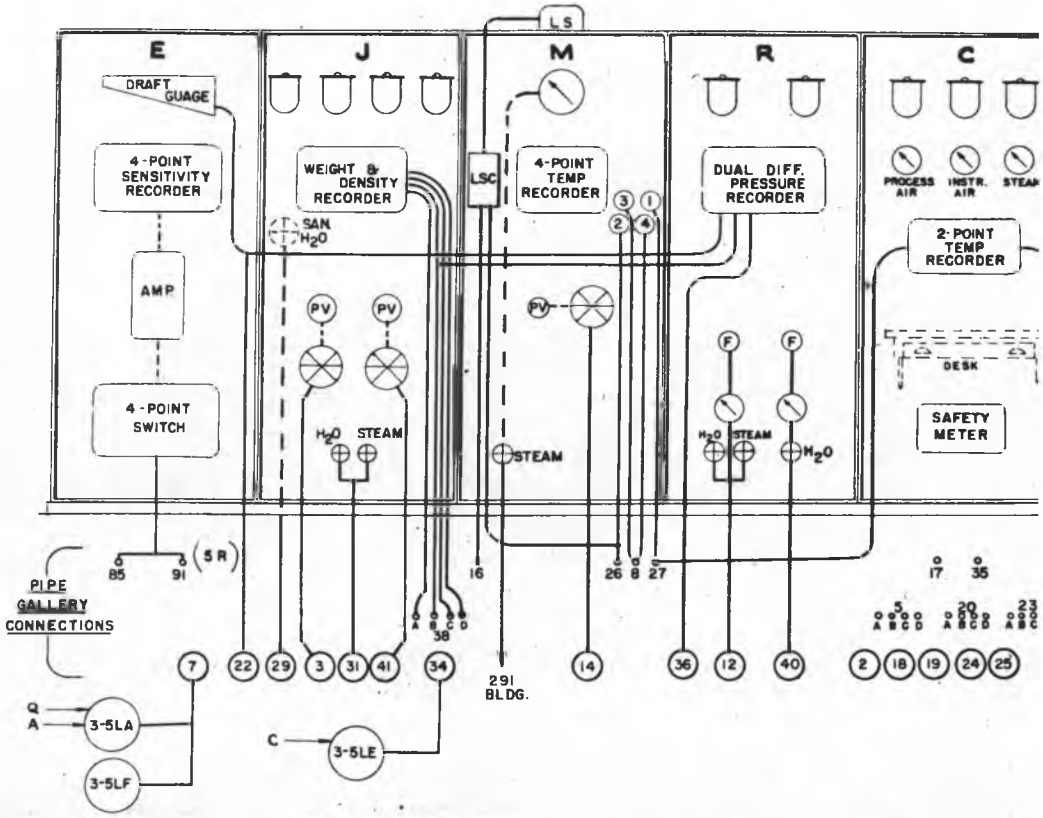
LEGEND

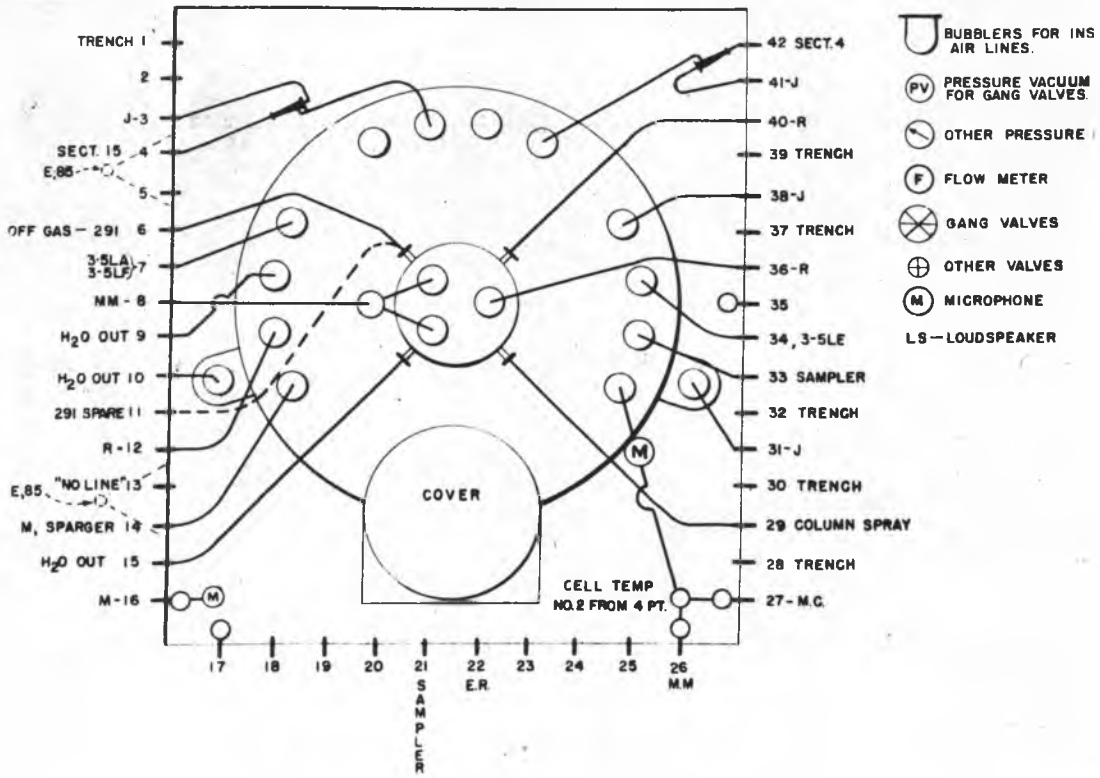
- BUBBLERS FOR INSTRUMENT AIR LINES
- PV PRESSURE VACUMM GAUGES FOR GANG VALVES
- OTHER PRESSURE GAUGES
- GANG VALVES
- OTHER VALVES
- M MICHROPHONES
- LS - LOUDSPEAKER
- LSC - LOUDSPEAKER CONTROL

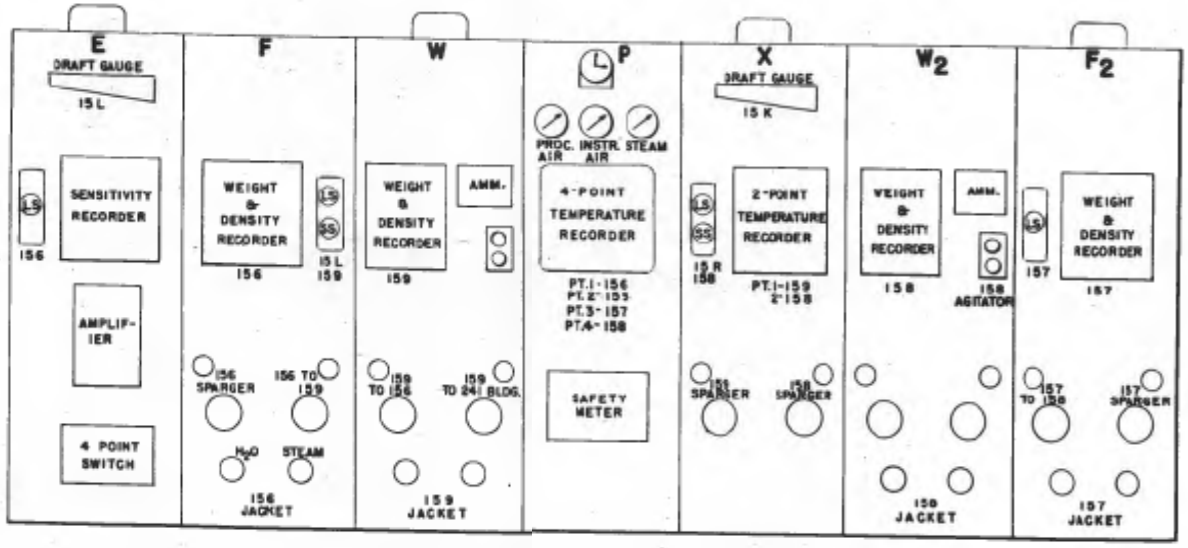
SECRET

SECRET

CONTROL PANEL
ARRANGEMENT SECTION 3-L







HTC-906

SECTION 15 - GAUGE BOARD

[redacted]

APPENDIX B

CHARTS AND TABULATIONS

[redacted]

MANHATTAN DISTRICT HISTORY

BOOK IV - PILE PROJECT

VOLUME 3 - DESIGN

APPENDIX B

CHARTS AND TABULATIONS

No.	Description
1	Principal Dimensions of Pile
2	Tabulation of Permanent Plant Road Mileage
3	Tabulation of Richland Commercial Establishments
4	Tabulation of Religious Groups Represented in United Protestant Church
5	Tabulation of Design Costs
6	Wilmington Area Engineer's Organization Chart
7	du Pont Design Division Organization Chart

[redacted]

[redacted]

PRINCIPAL DIMENSIONS OF PILE

The following dimensions were to be the principal ones of the Pile as submitted in the Metallurgical Laboratory design suggestion:

Axial length of active cylinder	23 feet
Radius of active cylinder	16 feet
Thickness of reflector	16½ inches
Total weight of metal	200 metric tons
Weight of graphite in Pile	850 metric tons
Weight of graphite in reflector	315 metric tons
Radius of metal rods	0.67 inch
Number of rods in Pile	1695
Weight of aluminum in Pile	8.7 metric tons

[redacted]

TABULATION OF PERMANENT PLANT ROAD MILEAGE

CLASSIFICATIONS AND TYPE OF SURFACES	MILES
New Construction Inter and Intra-Area Roads (Road Mix and Plant Mix)	198.01 miles
New Construction Richland Village (Road Mix, Penetration and Gravel Surfaced)	53.20 miles
Existing Roads Improved (Gravel Surfaced and Road Mix)	16.00 miles
Existing Roads Maintained (Gravel Surfaced and Road Mix)	27.75 miles
Patrol Trails Improved and Maintained (Packed Sand and Gravel)	49.90 miles
Total	344.86 miles

[redacted]

TABULATION OF RICHLAND COMMERCIAL ESTABLISHMENTS

ESTABLISHMENTS	NUMBER
Food Stores	5
Drug Stores	3
General Merchandise Store	1
Variety Store	1
Shoe Repair Shop	1
Barber & Beauty Shop	1
Women's & Children's Apparel Shop	1
Men's Clothing & Shoe Store	1
Hardware Store	1
Optical Shop	1
Electrical Shop	1
Garage & Service Station	1
Service Stations	3
Western Union Office	1
Railway Express Agency	1
Laundry	1
Milk Depot	1
Post Office	1
Bank	1

[redacted]

TABULATION OF RELIGIOUS GROUPS REPRESENTED

IN UNITED PROTESTANT CHURCH

1. Methodist
2. Baptist
3. Presbyterian
4. Nazarene
5. Episcopalian
6. Christian
7. Congregational
8. Evangelican
9. Church of Christ
10. United Brethren
11. Salvation Army
12. Lutheran
13. Pentecostal
14. Assembly of God
15. Adventist
16. Miscellaneous Protestant Groups

[redacted]

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TABULATION OF DESIGN COSTS

AREA	ENGINEERING DESIGN
100	$927,926.64
1700	18,773.06
200	535,691.35
2700	8,045.60
300	53,687.32
3700	16,091.20
500	34,864.26
600	195,776.22
700	40,227.99
800	16,091.20
900	107,274.64
1100	348,642.58
TC	211,667.41
CC (HC	158,230.09
CC (GC	5,363.73
CC (YC	5,363.73
TOTAL	$2,681,866.00

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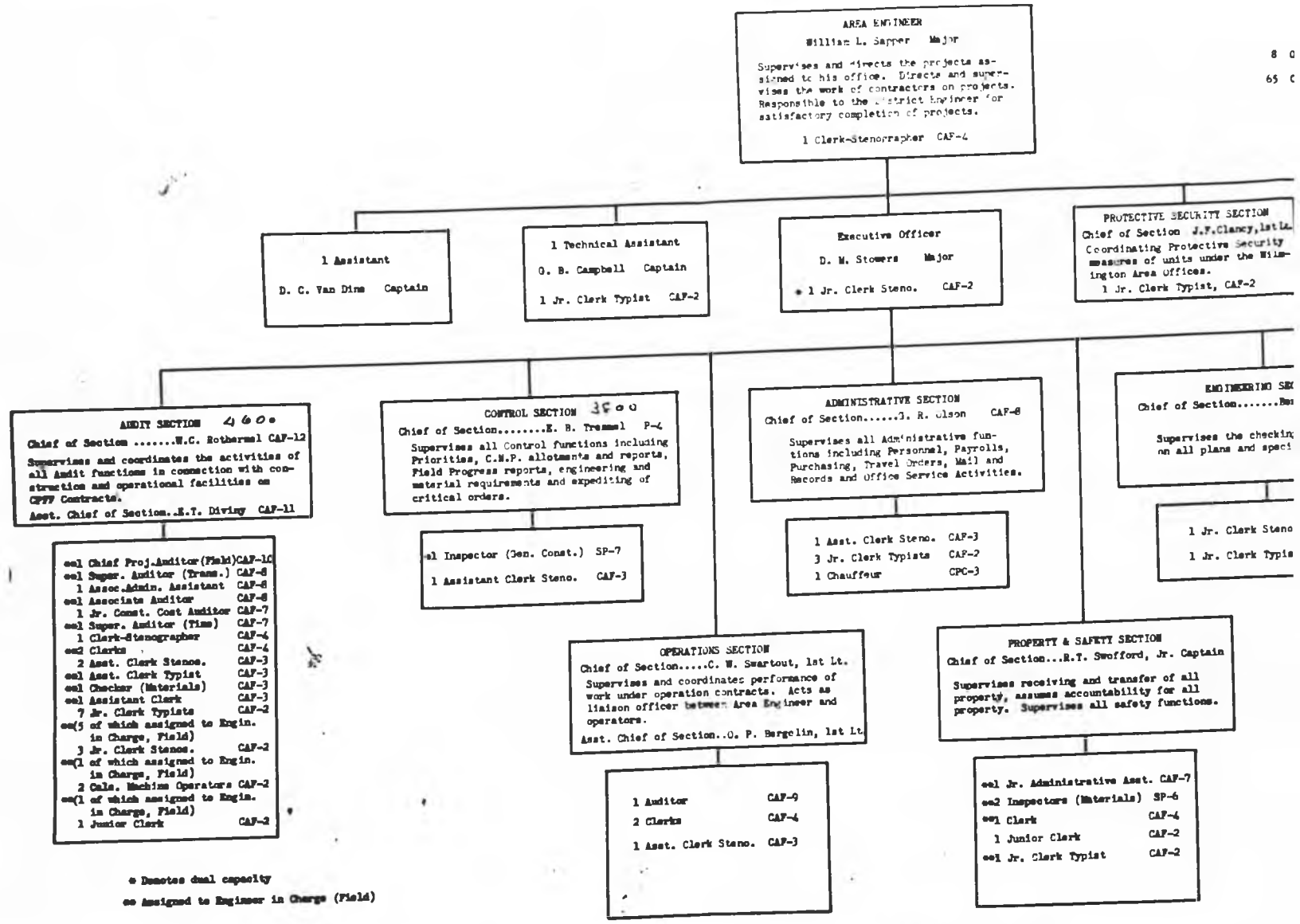
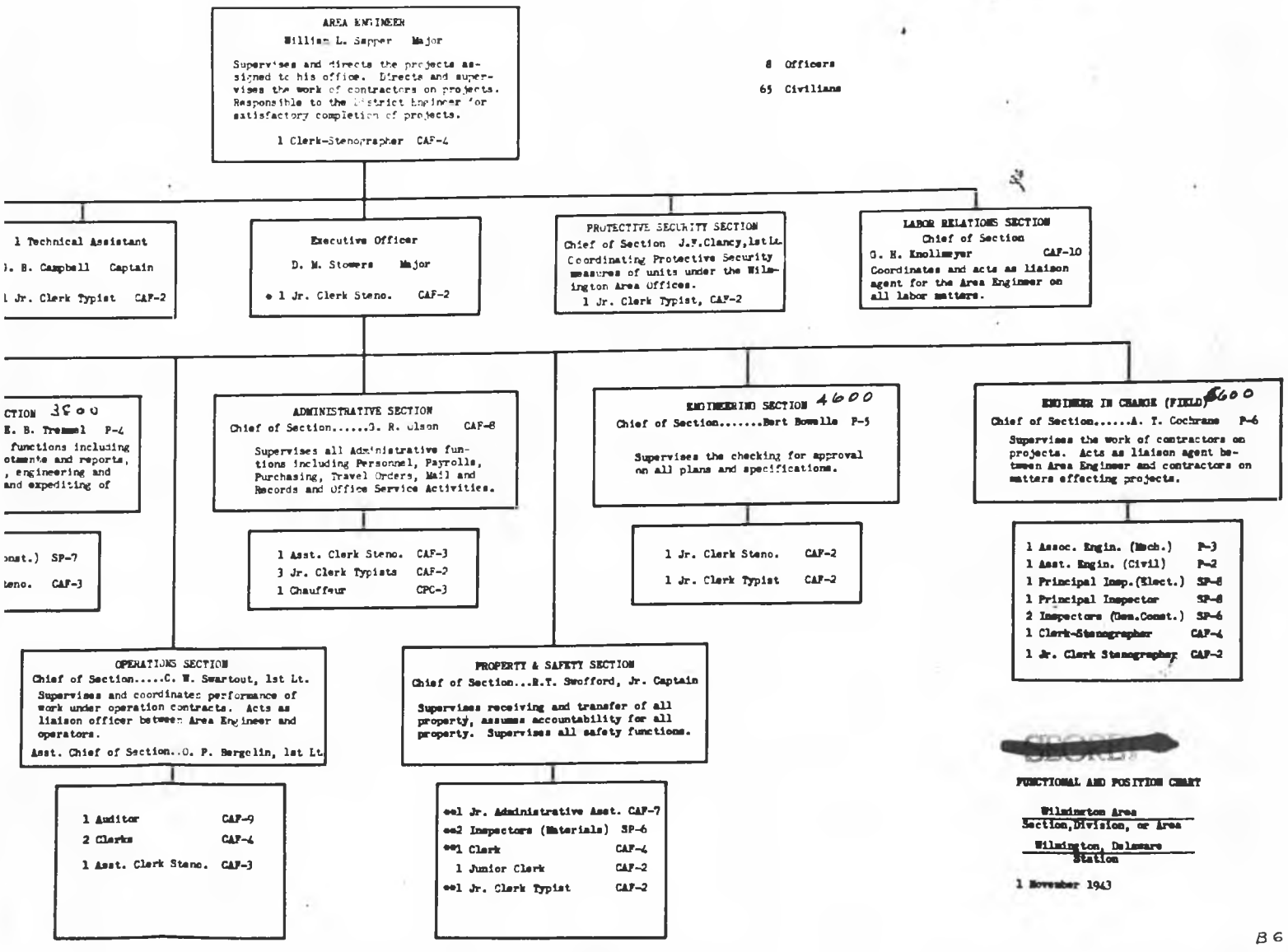

AREA ENGINEER
William L. Sapper Major
Supervises and directs the projects assigned to his office. Directs and supervises the work of contractors on projects. Responsible to the District Engineer for satisfactory completion of projects.
1 Clerk-Stenographer CAF-4
1 Assistant
D. C. Van Dine Captain
1 Technical Assistant
O. B. Campbell Captain
1 Jr. Clerk Typist CAF-2
Executive Officer
D. M. Stowers Major
* 1 Jr. Clerk Steno. CAF-2
PROTECTIVE SECURITY SECTION
Chief of Section J.F.Clancy,1st Lt.
Coordinating Protective Security measures of units under the Wilmington Area Offices.
1 Jr. Clerk Typist, CAF-2
AUDIT SECTION 4600
Chief of Section .....W.C. Rothermel CAF-12
Supervises and coordinates the activities of all Audit functions in connection with construction and operational facilities on CPFF Contracts.
Asst. Chief of Section..E.T. Diving CAF-11
eel Chief Proj.Auditor(Field)CAF-10
eel Super. Auditor (Trans.) CAF-8
1 Assoc.Admin. Assistant CAF-8
eel Associate Auditor CAF-8
1 Jr. Const. Cost Auditor CAF-7
eel Super. Auditor (Time) CAF-7
1 Clerk-Stenographer CAF-4
ee2 Clerks CAF-4
2 Asst. Clerk Stenos. CAF-3
eel Asst. Clerk Typist CAF-3
eel Checker (Materials) CAF-3
eel Assistant Clerk CAF-3
7 Jr. Clerk Typists CAF-2
ee(5 of which assigned to Engin. in Charge, Field)
3 Jr. Clerk Stenos. CAF-2
ee(1 of which assigned to Engin. in Charge, Field)
2 Calc. Machine Operators CAF-2
ee(1 of which assigned to Engin. in Charge, Field)
1 Junior Clerk CAF-2
CONTROL SECTION 3500
Chief of Section.....E. B. Tremmel P-4
Supervises all Control functions including Priorities, C.N.P. allotments and reports, Field Progress reports, engineering and material requirements and expediting of critical orders.
el Inspector (Gen. Const.) SP-7
1 Assistant Clerk Steno. CAF-3
ADMINISTRATIVE SECTION
Chief of Section.....J. R. Olson CAF-8
Supervises all Administrative functions including Personnel, Payrolls, Purchasing, Travel Orders, Mail and Records and Office Service Activities.
1 Asst. Clerk Steno. CAF-3
3 Jr. Clerk Typists CAF-2
1 Chauffeur CPC-3
OPERATIONS SECTION
Chief of Section.....C. W. Swartout, 1st Lt.
Supervises and coordinates performance of work under operation contracts. Acts as liaison officer between Area Engineer and operators.
Asst. Chief of Section..O. P. Bergelin, 1st Lt.
1 Auditor CAF-9
2 Clerks CAF-4
1 Asst. Clerk Steno. CAF-3
PROPERTY & SAFETY SECTION
Chief of Section...R.T. Swofford, Jr. Captain
Supervises receiving and transfer of all property, assumes accountability for all property. Supervises all safety functions.
eel Jr. Administrative Asst. CAF-7
ee2 Inspectors (Materials) SP-6
ee1 Clerk CAF-4
1 Junior Clerk CAF-2
eel Jr. Clerk Typist CAF-2
* Denotes dual capacity
ee Assigned to Engineer in Charge (Field)



FUNCTIONAL AND POSITION CHART

Wilmington Area
Section, Division, or Area

Wilmington, Delaware
Station

1 November 1943

E. I. DU PONT DE NEMOURS & CO. (INC.)
ENGINEERING DEPARTMENT
Design and Construction Divisions
Manhattan District - Organization Chart.

KEY			
CONTRACT		PROJECT	LOCATION
1	..	9536	Hanford
23	..	9733	Clinton
1	..	58	Clinton
2	..	9595	Wilmington
3	..	9634	Wilmington
4	..	9641	Unknown
4	..	9721	W.R.O.W.
4	..	9722	A.O.W.
4	..	9734	M.C.W.
4	..	9735	Purchasing only
6	..	9757	Wilmington
8	..	9233	Wilmington
22	..	9803	Wilmington
Not signed		9891	Wilmington

CHIEF ENGINEER
E. G. Ackart

ASSISTANT CHIEF ENGINEER
G. M. Read

GENERAL MANAGER
CONSTRUCTION DIVISION
M. F. Wood

MANAGER
DESIGN DIVISION
T. C. Gary

ASSISTANT MANAGER
J. P. Martel

SUPERVISING ENGINEER
F. W. Pardee, Jr.

SUPERVISING ENGINEER
J. C. Lawrence

DESIGN PROJECT MANAGER
9641
9721
9722
9734
9735

P-9
M. G. Amick

DESIGN PROJECT MANAGER
9536
9733
58

TNX
H. T. Daniels

DESIGN PROJECT MANAGER
9595
9757
9634
9803
9891

C-1 & C-2
W. S. McVay

APPENDIX C

REFERENCES

SECRET

MANHATTAN DISTRICT HISTORY

BOOK IV - PILE PROJECT

VOLUME 3 - DESIGN

APPENDIX C

REFERENCES

No.	Description	Location
1.	Site Investigations and Travel Schedule of Col. Matthias	Area Engineer H.E.W. Classified Files Case "000"
2.	Preliminary Site Report	Area Engineer H.E.W. Classified Files Case "CCC" "NNN" "ppp"
3.	Ichthyology Reports	District Office Files Area Engineer H.E.W. Classified Files
4.	Feasibility Report of 26 November 1942	District Office Files Metallurgical Information Office, Chicago, Illinois
5.	Design of Helium-Cooled Plant Report #CE - 277	District Office Files Metallurgical Information Office, Chicago, Illinois
6.	Design of Helium-Cooled Plant Report #CE - 324	District Office Files Metallurgical Information Office, Chicago, Illinois
7.	Design of Liquid-Cooled Plant Report #CE - 407	District Office Files Metallurgical Information Office, Chicago, Illinois
8.	Ichthyological Studies	District Office Files Area Engineer H.E.W. Classified Files

SECRET

[redacted]

No.	Description	Location
9.	Specifications for Process Water-Pumps	Wilmington Engineering Dept. Wilmington, Del. Spec. 2002
10.	Survey of Separation Processes Report #CN 1017	District Office Files Metallurgical Information Office, Chicago, Illinois
11.	Survey of Separation Processes Report #CN 1603	District Office Files Metallurgical Information Office, Chicago, Illinois
12.	Survey of Separation Processes Report #CN 2519	District Office Files Metallurgical Information Office, Chicago, Illinois
13.	Bismuth Phosphate Process	Area Engineer, H.E.W Tech. Manual Sec. C
14.	Report on Richland Village Design by G. A. Pehrson, 8 June 1943	Area Engineer H.E.W. Office Engineer

[redacted]

APPENDIX D

GLOSSARY

MANHATTAN DISTRICT HISTORY

BOOK IV - X-10 PROJECT

VOLUME 3 - DESIGN

APPENDIX D

GLOSSARY

Activated Carbon. - Activated carbon is charcoal produced by the destructive distillation of vegetable matter such as wood, with or without the addition of chemicals.

Aluminum. - Aluminum is the chemical element of atomic number 13. The metallic aluminum was chosen for the Pile cooling tubes and slug jackets because of its low neutron absorption cross section (0.124×10^{-24} square centimeters) and its resistance to corrosion by water at the temperatures encountered in the Pile reaction.

Aluminum-Silicon Alloy. - This is the eutectic alloy of the aluminum-silicon system. It consists of 88 per cent aluminum and 12 per cent silicon. The alloy is used as a bonding medium in the canned slug since it has a lower melting point than aluminum and virtually the same corrosion resistance.

Billets. - A billet is a bar of metal. In this volume, it refers specifically to the form in which metallic uranium is received at the Hanford Engineer Works.

Boron. - Boron is the chemical element of atomic number 5. It is used, in the form of a coating, in the safety and control rods of the Hanford Piles because of its high slow neutron absorption cross section (700×10^{-24} square centimeters).

Cadmium. - Cadmium is the chemical element of atomic number 48. It is a white ductile metal belonging to the zinc family. Cadmium was suggested as a possible control means, since it has a high neutron-capture cross section approximately 3000 x 10^{-24} square centimeters.

Carbon. - Carbon is the chemical element of atomic number 6. It is a non-metallic element, one of which forms is graphite which is used in the Pile as the moderator. Carbon has a low neutron-capture cross section of 0.0045 x 10^{-24} square centimeters, thus making it possible to use it without too high a neutron loss.

Columbium. - Columbium is the chemical element of atomic number 41. Columbium is one of the fission products encountered in the separation of plutonium from the fission products and uranium by use of the fractional volatilization process.

Cross Section. - See Neutron-Capture Cross Section.

Deaeration. - Deaeration is the term used to refer to the process by which dissolved gases are removed from water. In this process, the carbon dioxide content is reduced from about 70 parts per million to about 2 parts per million, and the oxygen content from about 14 to about 0.05 parts per million. Deaeration is obtained by passing the water in a finely dispersed state through towers in which a vacuum is maintained by means of steam jets.

Decay Period. - The decay period for any substance is the time required for the radioactivity of that particular substance to decrease to a safe level, as determined by health and safety

requirements. The activity of the slugs arises from the fission products and other elements formed with the production of plutonium. Some of this activity is transferred to the effluent water and circulating helium.

Demineralization. - Demineralization is the term used to refer to the process by which dissolved salts and acids are removed from water. Demineralization is obtained by passing the water through two exchangers, the first removing the dissolved salts of calcium, magnesium and sodium, and the second removing the acids formed in the first exchanger, except for the carbonic acid which is formed in the second exchanger.

Deuterium. - Deuterium is that isotope of hydrogen of atomic number 2. Its symbol is H^2 or D and it is the principal component of heavy water. Deuterium has a neutron-capture cross section of only 0.0009×10^{-24} square centimeters.

Dissolving. - Dissolving is that step in the separation process for the recovery of plutonium in which the aluminum jackets are removed from the metallic uranium pieces and the uranium, containing plutonium and many other elements, is placed in solution in preparation for the subsequent process steps.

Electrochemical Series. - An arrangement of the metals in the order of the amount of electromotive force set up between the metal and solution when the metal is placed in a normal solution of any of its salts.

Elutriation. - Elutriation is one of the final steps in the separation and isolation of plutonium. This step consists of purification

by washing the precipitate and decanting the wash liquor.

Extraction. - Extraction is that step in the separation process in which the plutonium is separated from the uranium and from the large majority of the many other elements present.

Flash Vaporization. - Flash vaporization refers to that type of vaporization which is instantaneous. In the original Pile design for a water-cooled unit employing water recirculation, this type of vaporization would have been used in removing dissolved gases from the water through a sudden reduction of pressure from about 20 pounds per square inch to near atmospheric with the temperature of the water at the boiling point of the water.

Heavy Hydrogen. - See Deuterium.

Hydrogen. - Hydrogen is the simplest chemical element known, of atomic number 1. Its neutron-capture cross section is 0.325×10^{-24} square centimeters.

Hydrogen Peroxide. - Hydrogen peroxide is a clear, colorless liquid found in the Pile exit water. Before water could be recirculated through the Pile structure, it would be necessary to remove a portion of the oxygen to prevent erosion of equipment.

Imhoff Tank. - An Imhoff tank is a tank for sewage clarification, consisting of a sedimentation chamber with sloping floor leading to slots through which the solids settle to the sludge-digestion chamber.

Impact Wrench. - The impact wrench used in the Separation Building for maintenance of equipment and replacement of parts consists of an electrically driven wrench which can be lowered from the

operating crane and placed on the actuating nut of the piping which has to be loosened or tightened. The impact feature of the wrench enables a stubbornly turning fitting to be pounded loose in much the same way a sledge hammer would act.

Ion Chamber. - An ionization chamber measures the total number of ions directly produced in it. These ions are charged particles of matter due to the removal from or addition to the particles of one or more electrons. The chamber usually consists of two plane electrodes between which there is a strong enough electric field to draw all the ions to the electrodes before they recombine but not strong enough to produce secondary ions.

Isolation. - Isolation is the final step in the separation process for plutonium, in which the element is separated from the last of its associated elements and prepared for shipment.

Labyrinth. - A labyrinth as used in reference to the Pile Area consists of the entrance to the Pile discharge face protected by concrete. This entrance is so designed that radiation present in the discharge area must bounce at least twice before it can escape, thus reducing the energy of the radiations to a safe level.

Neutron Absorber. - A neutron absorber is one which possesses the ability to absorb neutrons well, i.e., it has a large neutron-capture cross section.

Nitrogen. - Nitrogen is the chemical element of atomic number 7. It is a gaseous element occurring in the atmosphere and has a high neutron-capture cross section of 1.75×10^{-24} square centimeters, which prohibits the use of circulation of air through the Pile

structure to remove impurities.

Outgassing. - Outgassing is the process of driving hidden gases out of substances by means of heating or evacuating.

Polymerization. - Polymerization is a reaction in which two or more molecules of the same substance combine to form a compound, from which the original substance may or may not be regenerated, the new molecular weight being a multiple of that of the original compound.

Primary Radiation. - The primary radiation of radioactive materials consists of the original alpha, beta or gamma emitted by these materials.

Proportional Counter. - A proportional counter is an ionization chamber in which one of the electrodes is so designed that there is, besides the primary ions, a large number of secondary ions formed, thus increasing the total pulse of current. It is possible to design and operate such counters in such a way that the total number of ions formed is proportional to the number of primary ions formed.

Reactor. - The term reactor is used synonymously with reacting unit, the unit in which the chain reaction is sustained.

Secondary Radiation. - Secondary radiation is the result of ionization of other particles due to the primary radiation, and the scattering and reflection of the primary rays by particles.

Silica Gel. - Silica gel is a form of colloidal silica (silicon dioxide) like coarse sand in appearance but possessing many fine pores and therefore extremely absorbent.

Syphon (Steam-Jet). - A steam-jet syphon is a device used in the Separation Building for transferring solutions in which a jet of steam is used to create vacuum for suction. These syphons are used so that necessary maintenance work on pumps can be eliminated.

Thimbles. - The aluminum wells into which the vertical safety rods drop are known as thimbles.

Uranium Hexafluoride. - Uranium hexafluoride had been developed industrially and in large enough quantities to suggest its use as a coolant for an enriched-uranium plant. Fluorides are good coolants.

Xenon. - Xenon is the chemical element of atomic number 54. Xenon-135 is a member of the tellurium-iodine-xenon-cesium-barium decay chain which is encountered in the Pile reaction. It is radioactive with a half life of 9.4 hours. It led to a poisoning of the Pile because of its high neutron absorption cross section (approximately $5{,}000{,}000 \times 10^{-24}$ square centimeter).