NPD Systems

Building and Structures

General

The NPD plant complex was designed with Canadian climate conditions in mind. Under these conditions equipment is normally housed within a building or buildings and heating systems provided.

Powerhouse

This is the main building and houses the Reactor, Turbine-Generator unit and most of the associated equipment. The general building arrangement is shown on Fig. 1.

Because of space limitations and shielding requirements, concretes having densities greater than the normal 150 lbs/ft^3 were developed. Some of the concrete used has a density of 220 lbs/ft^3, while in other areas, even higher shielding values were required and concretes having a density of 300 lbs/ft^3 were developed.

Since high density concretes are expensive to use and are not as strong structurally as ordinary concretes, their use was limited to those areas where the higher density was required. Some of these locations are indicated on Fig. 2.

The Powerhouse main section is divided into two parts; the "Conventional End" which contains the Turbo-Generator unit and its associated systems, and the "Reactor End" which contains the Reactor-Boiler and associated systems.

The Turbine Hall is separated from the Reactor Hall by a partial wall which serves as a ventilation barrier. A single 25 ton overhead crane services both these areas by being able to pass over the partial wall. The crane gantry is completely closed on one side, and when not in use it is parked directly above the partial wall, thus completing the ventilation barrier. See Fig. 2.

Below grade the two plant areas are separated from each other by a four foot thick concrete wall which shields the Condenser Room from radiation arising from sources within the Boiler Room. See Fig. 2.

Turbine-Generator units are generally heavy, high speed machines with small clearances between rotating and stationary parts. Because of this, foundations for these units must be strong and very rigid; not only to support the machine weight but to minimize both transverse and longitudinal deflections.

At NPD the Turbo-Generator block is constructed of reinforced concrete and extends approximately six feet below the Condenser Room floor, where it rests on and is anchored to, solid bedrock. Outlines of the block are shown on Figs. 3 and 4.

The "Reactor End" of the Powerhouse is much more complicated structurally than the "Conventional End", having areas of free access, controlled or limited access and no access at all.

The areas of no access are the Reactor Vault and Dump Pipe Rooms. The arrangement of these areas is shown on Figs. 2 and 5. The Reactor Vault walls and roof constitute the Primary Shield. The Reactor Vault south wall is ordinary concrete 7' thick. The north wall, which separates the Vault from the Boiler Room, is 220 lbs/ft^3 concrete, 4.5' thick. This wall also has a labyrinth opening through which the feeder pipes pass. See Figs. 2, 5 and 6.

The roof of the Reactor Vault required special construction materials because of space limitations. The roof was built up as illustrated on Fig. 7. All cracks were then caulked with lead wool and the whole floor of the Fuelling Machine Room, which is the room directly above the vault, was sealed with fibreglass and epoxy.

The Fuelling Machines have access to the Reactor Vault by means of slots through the Reactor Vault roof. When fuelling operations are not in progress these slots are closed off by specially constructed shielding gates. See Figs. 2 and 8.

The entire Reactor Vault and Dump Pipe Room (Figs 2 & 5) has a liner of aluminum sprayed steel plate to prevent absorption of excess water from the concrete into the Vault atmosphere.

The east and west walls of the Reactor Vault hold the 4' thick Rotating End Shields. These shields provide the means of access to the Reactor faces for inspection, maintenance, etc. The rooms on the outside of these shields are known as the End Access Room (west) and Tube Withdrawal Room (east). See Fig. 5.

Since the shielding walls separating the Reactor Vault from the end rooms and Boiler Room are "Shutdown Shields" these areas are not accessible during high power operation.

The Rotating End Shields each have 17 removable plugs, one for each "Reactor circle". See Fig. 9. Roller bearings at the outer circumference and a variable speed, geared, roller drive mechanism mounted under each shield, provide for rotation either clockwise or anti-clockwise.

Shielded periscope and/or light plugs may be installed in the Rotating Shields, in place of the normal removable plugs, for viewing the Reactor face, Vault, etc. Special equipment is also available for working on or inside the Reactor from either or both end rooms. Emergency connections on the Fuelling Machines may also be reached through the Rotating End Shield holes.

Fig. 10 depicts the Rotating End Shield arrangement while Figs. 11 and 12 indicate the various End Shield settings in degrees and the proper plug to remove, for axial alignment with any given Reactor Lattice position.

The roof of the Fuelling Machine Room also forms part of the Reactor Hall floor. Because there may be radioactive sources in this room, and, because of radiation streaming from the Reactor Vault whenever the F/M Gates are open, the roof hatch is formed from slabs of 230 lbs./ft^3 concrete.

The roof hatch of the Decontamination Room also forms part of the Reactor Hall floor. This, and hatch openings in the Decontamination Room floor provide equipment access to the Spent Fuel Storage area.

The Boiler Room hatch forms a large portion of the Reactor Hall floor. The main slabs of this hatch are formed with 220 lbs/ft^3 concrete while the key or filler slabs are formed of 300 lbs/ft^3 concrete. In order to reduce the radiation to acceptable levels in the Reactor Hall this hatch was built 3' thick. Because of the weight of these slabs they must never be stacked when they are removed from their normal positions and stored elsewhere in the Reactor Hall. Fig. 13 shows the hatch plan and storage method

Floor loading within the Powerhouse is generally limited to 300 lbs/ft^2. Heavy loads such as shielded shipping flasks may only be stored in a few limited areas, such as, either side of the main truck entrance doors in the Reactor Hall; over the ion exchange cavities (which are built into the top of the main wall dividing the Reactor Vault and Fuelling Machine Room from the Boiler Room. See Fig. 2); on the Spent Fuel Storage Room washdown area and, on the bottom of the Spent Fuel Storage Bay itself. Fig. 2 depicts a spent fuel shipping flask in this latter position.

Zoning, in conjunction with instruments to monitor for radioactive contamination, is used to prevent or minimize the unnecessary spread of such contaminants. Zones are established according to the probability of the existence of radioactive contamination. There are four Zones. Zone 1 having the least possibility or probability of becoming contaminated radioactively while Zone 4 has the highest probability. Figs. 14 and 15 indicate the location of Fixed Contamination Monitors at NPD.

Shielding doors are used in several locations at NPD. These doors are normally locked closed, prohibiting personnel access, when high radiation levels may exist in an area or room. Such doors are to be found on the Boiler Room, Fuelling Machine Room and Vault Cooling Room. Figs. 16 and 17 show shielding door arrangements.

Pumphouse

The Pumphouse is located on the bank of the Ottawa River. remote from and at a lower elevation than the Powerhouse. This arrangement was necessary because submersed suction pumps are employed to deliver the required water supplies for the Powerhouse.

The systems supplied are: Circulating Water (Main and Reject Condensers); Process Water for normal cooling; Domestic Water, mainly for human usage but also used for some cooling and as an alternate supply to the Make-up Water system; Standby Water for emergency cooling and fire fighting.

Fig. 18 is a block diagram of the Pumphouse which indicates how the intake wells are formed by the building substructure. Fig. 19 is a plan view showing the various screens arrangement for preventing debris from entering the suctions of the pumps.

More details of the Pumphouse may be found in D.M. 220. Details of the various pumps etc., may be found in D.M. 711, 712, 713, 714 and 715. Information may also be found in Training lessons dealing with these systems.

Outdoor Structures

Relief Duct

The Boiler Room at NPD is designed to withstand ≈5 psig internal pressure. In the event of a major rupture of the Heat Transport System during high power operation, the escaping hot water flashing into steam would create pressures greater than the building could withstand. For this reason, a Relief Duct leads from the Boiler Room to an outside pit, which is designed to divert most of the force skyward.

A diaphram is employed to seal the outer end of the Relief Duct where it enters the pit. This diaphram is released by rising pressure in the Boiler Room. A gate or door, located in the duct, is designed to drop after the initial pressure surge has passed thus resealing the Boiler Room. See Figs. 20 and 21.

Stack - Fig. 22

The Stack at NPD is constructed in the same manner and serves much the same purpose as any industrial stack. In a standard industrial plant a stack may be used to aid in the dispersal of smoke, dust, gases, vapours, etc. In a nuclear plant the stack is used to aid in the dispersal of radioactive airborne contaminants.

The Stack at NPD is constructed of concrete and is 150 feet high. An outside metal ladder leads to a manwalk near the top.

Standard Department of Transport clearance lights give visual warning to night-flying aircraft. Burned out lamps may be changed from grade level by means of a cable elevator device.

Access to the inside of the Stack is provided near grade level by means of a steel door.

Dousing Tank

In the event of a break in a hot Heat Transport System the escaping steam could raise the pressure in the Reactor Vault and/or Boiler Room to dangerous levels. To condense this steam and thus suppress the pressure, water would be allowed to cascade into the affected area. Also, if all the D_2O was rapidly removed from a hot Heat Transport System by some accident or other, light water would flow into the system to flood the fuel.

The immediate, and, automatically supplied source of water for both the above situations, would come from the Dousing Tank.

This storage tank, which is situated adjacent to the Mechanical Maintenance shop on the east side of the Powerhouse, is 32 ft. in diameter, 50 ft. high and has a capacity of 250,000 Imperial gallons.

There are five 20" mains each connected to a standpipe inside the tank. These standpipes determine how much water is available for Dousing (steam suppression) and which particular area the water will flow to. 100,000 gallons is the total available for Dousing, the remainder is available for Light Water Injection (flooding) via a 10" main which is not connected to a standpipe. See Fig. 23.

To prevent freezing of the water during winter months the storage tank is covered on the outside with 4" thick styrofoam insulation. The insulation is protected by corrugated aluminum sheeting on the tank wall and smooth aluminum sheeting on the top. 20 electric immersion heaters located in dry wells around the periphery of the tank at approximately two feet from the bottom, make up for heat losses.

A 3" fill pipe, 10" overflow and 8" drain are provided. See Figs. 23 and 24.

A drain hole is provided at the bottom of each 20" standpipe to ensure that these lines will drain whenever the tank is drained for inspection. If the standpipes were not drained with the tank, the weight of water contained within the standpipes would impose an unnecessary load on the tank wall.

The tank is equipped with four pressure/vacuum vents at the top through which air is admitted to the tank to prevent formation of a vacuum whenever water is draining from the tank. If the water was being used for dousing these vents would be open until the highest standpipe had emptied. The vacuum vents would then close as air, gas or steam would be admitted to the tank via the empty 20" main. The vacuum vents are designed to open at 5 oz. The pressure relief mechanisms protect the tank from overpressurization and are designed to lift at 8" H_2O. The pressure/vacuum vents are protected from the weather by insulated aluminum housings in which electric heaters have been placed to prevent ice formation on the vents. The vents are depicted on Fig. 25.

Meteorological Tower

The Meteorological equipment was designed to provide information which, (1) could be used in the event of an unplanned release of radioactivity, or (2) could be used to plan activity releases.

The elevation of the tower (140') and the location of instruments was based on Stack height.

Wind speed and wind direction instruments are mounted at the 140' elevation. Air temperature difference detectors are mounted at the 140' and 20' elevation.

The "Met Tower" is a steel structure built up of pipe sections set in a triangle and fastened to each other with welded cross straps at 15" intervals.

One of the three sides or faces of the tower serves as a ladder. A safety belt guide has been attached to this face and the cross ties serve as ladder rungs.

The tower is set in a concrete base and held erect by three sets of guy wires. See Fig. 26.

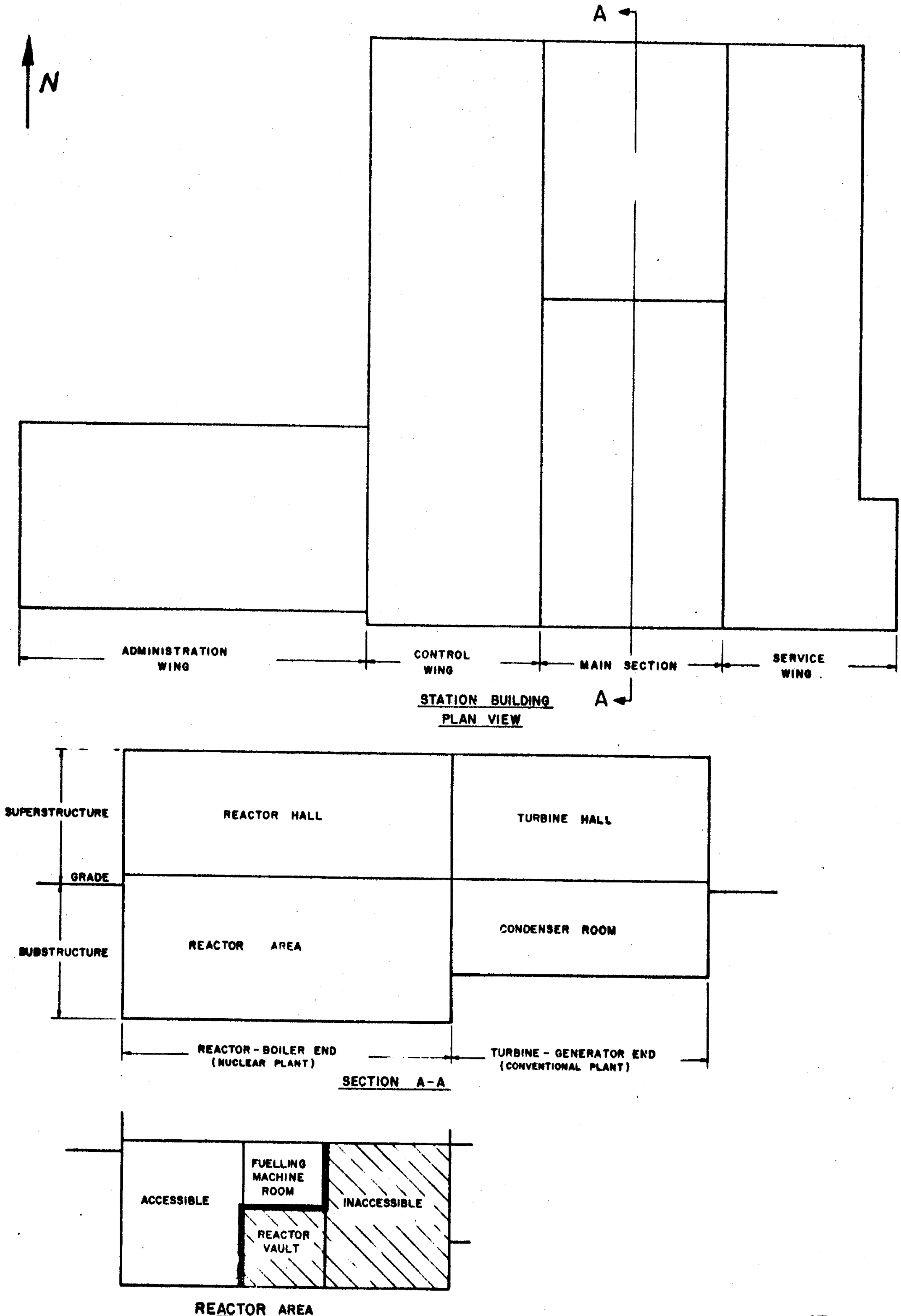
Additional information on the Meterological system is contained in Design Manual 611.

For the person requiring additional or more specific information on Buildings and Structures the 200 series Design Manuals are available.

A list of Powerhouse room numbers and names is included as Appendix A.

Appendix B is a list of room arrangement drawing numbers.

R. Whitney



STATION BUILDING BLOCK DIAGRAM NPD

FIG 1

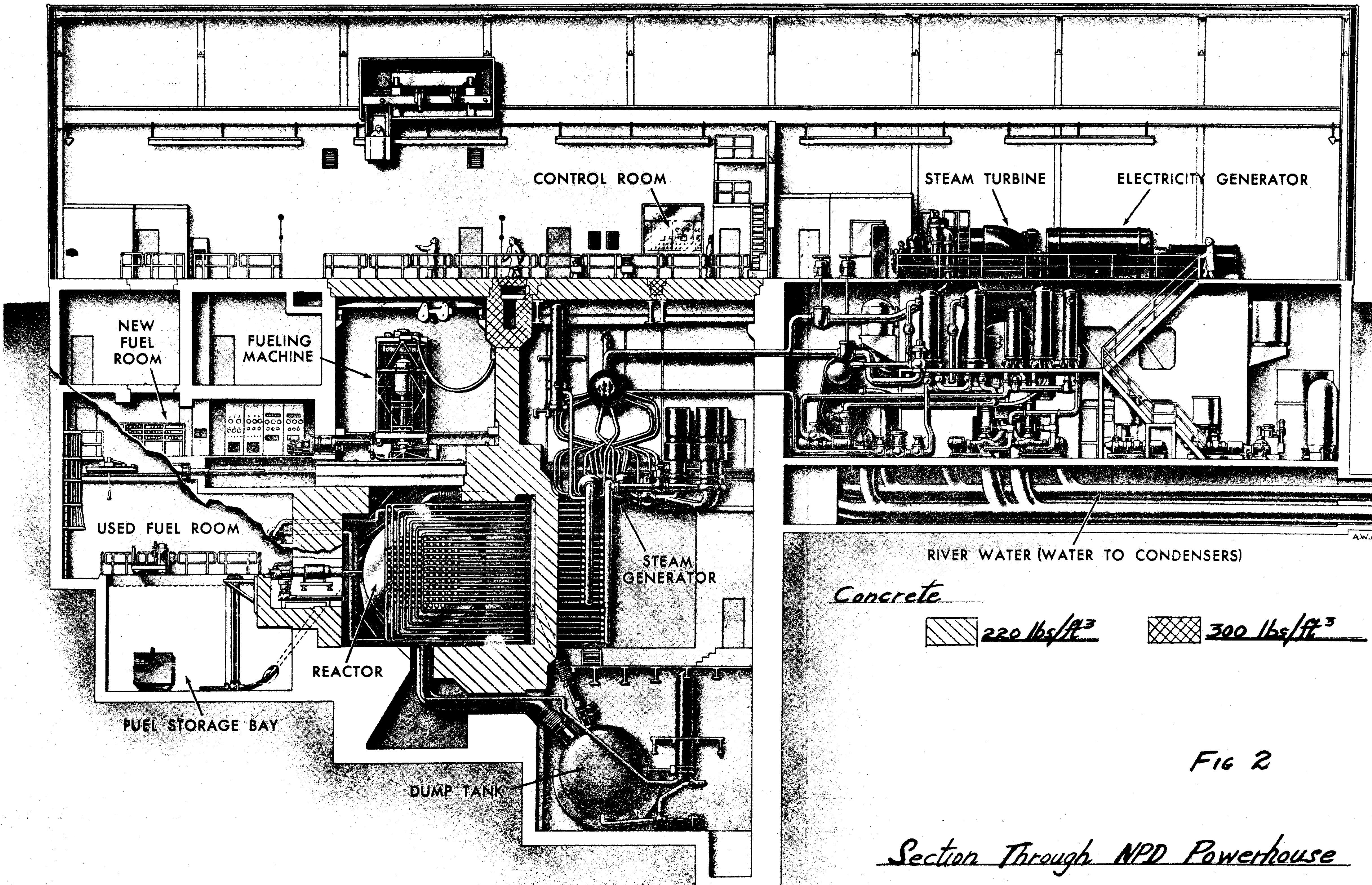
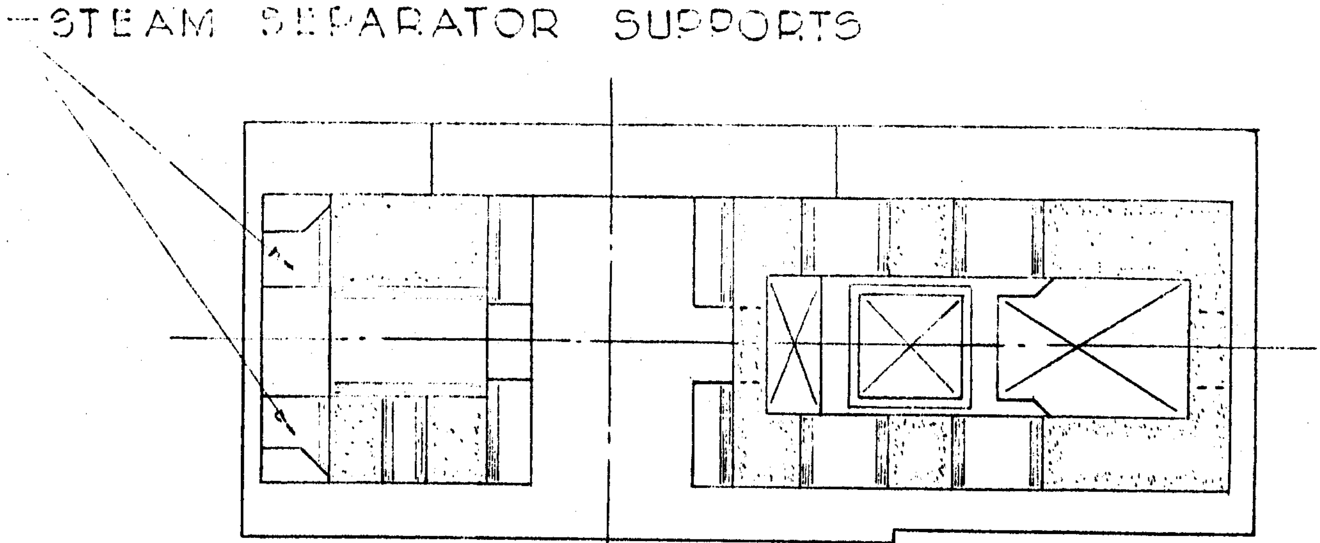
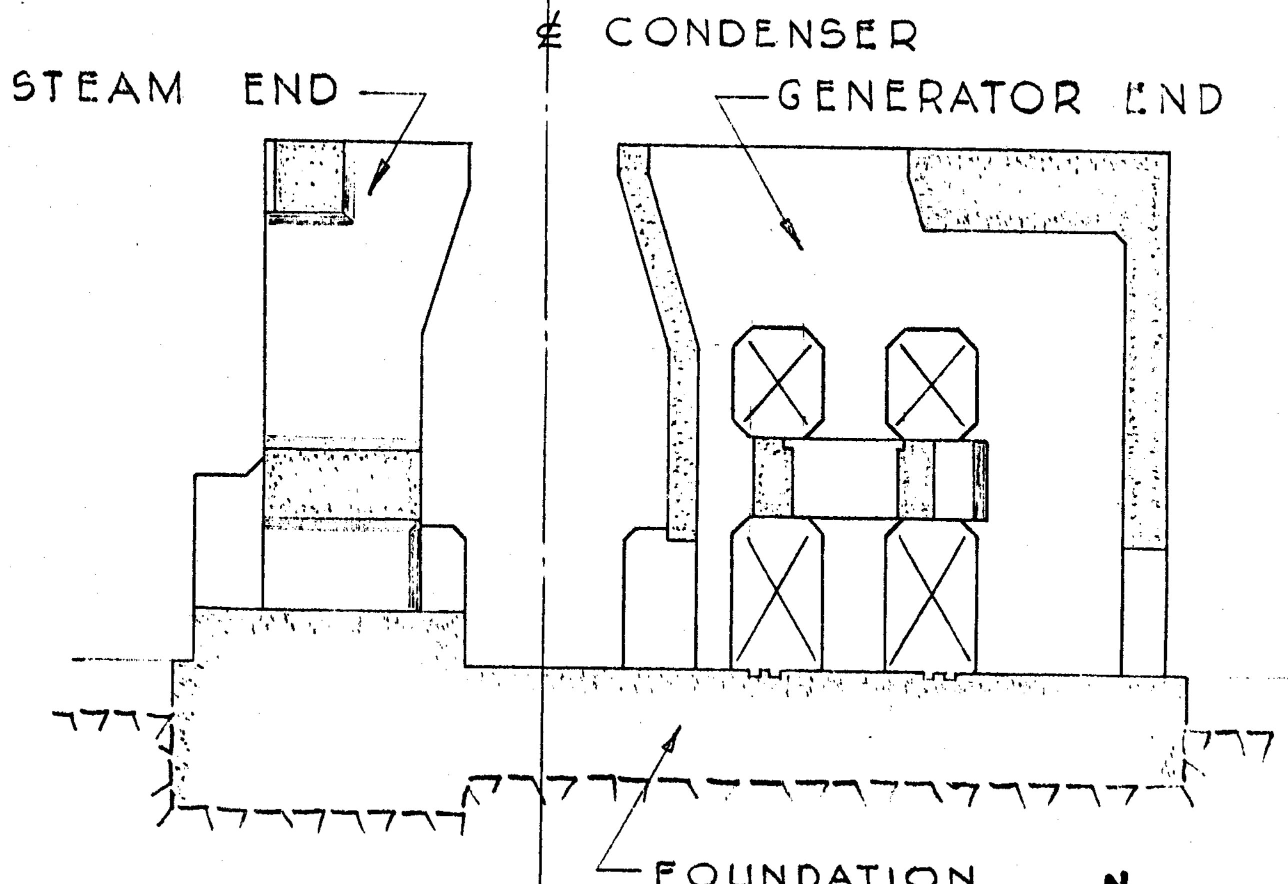


Fig 2

Section Through NPD Powerhouse

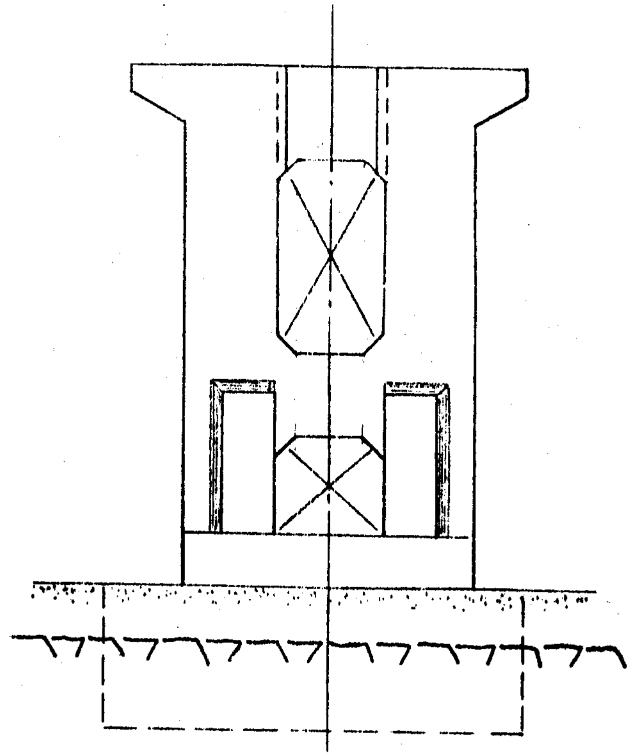


PLAN

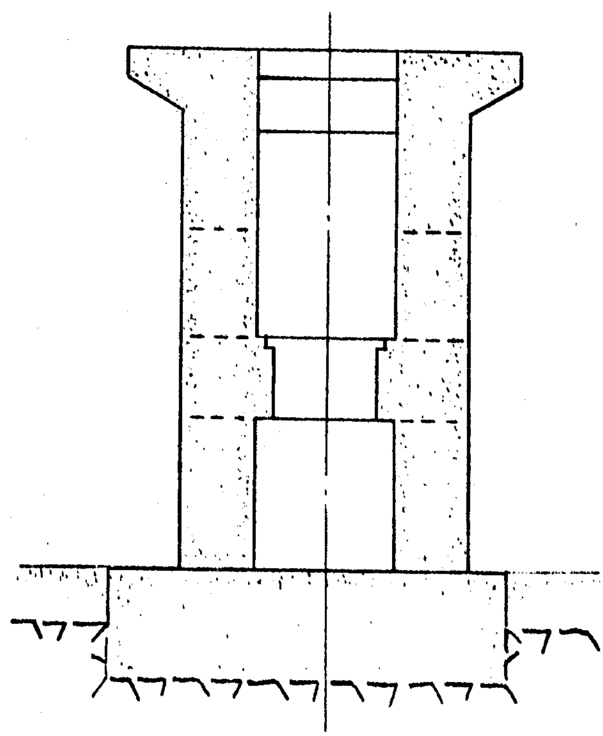


LONGITUDINAL SECTION

Fig 3

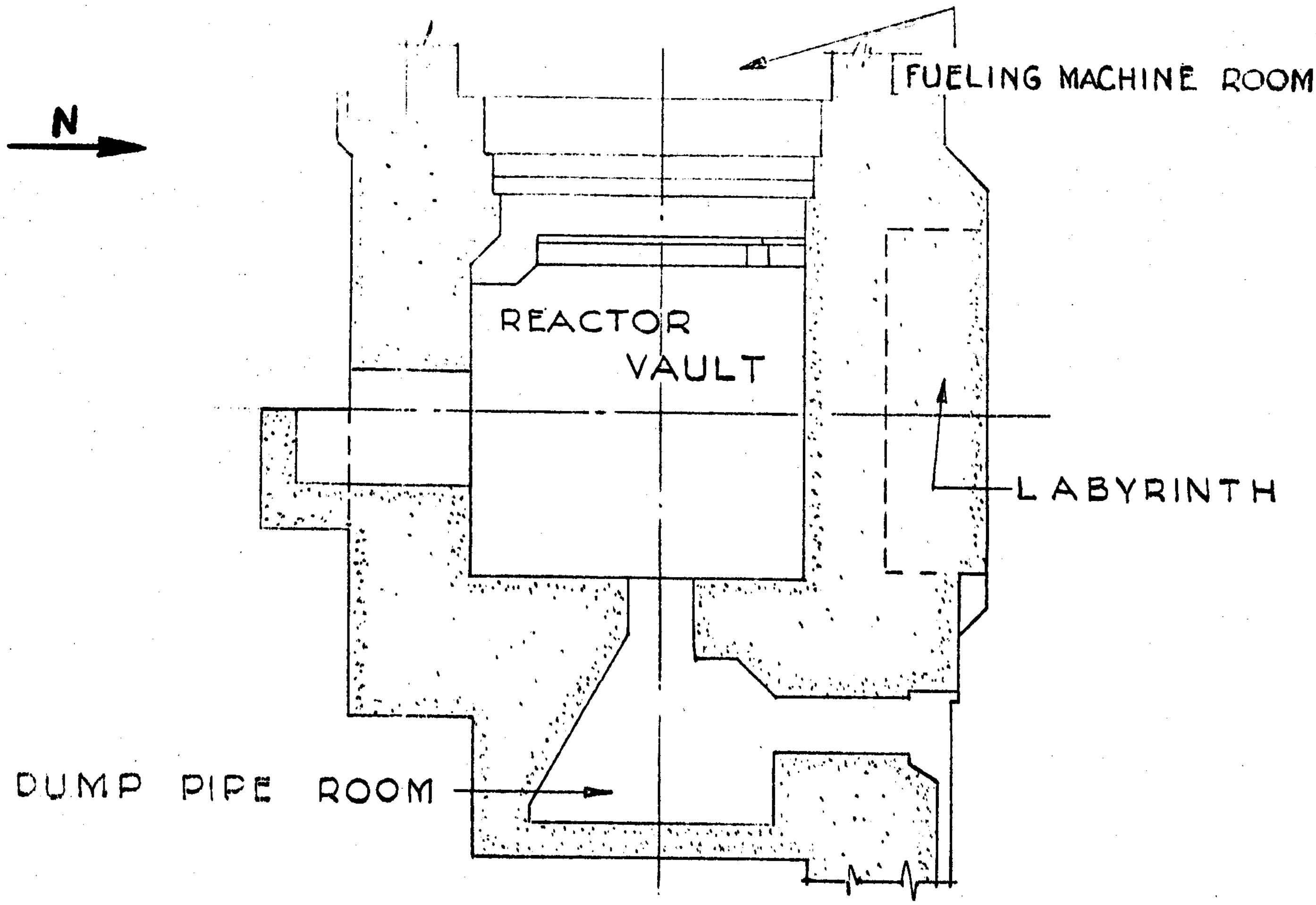


ELEVATION
(STEAM END)

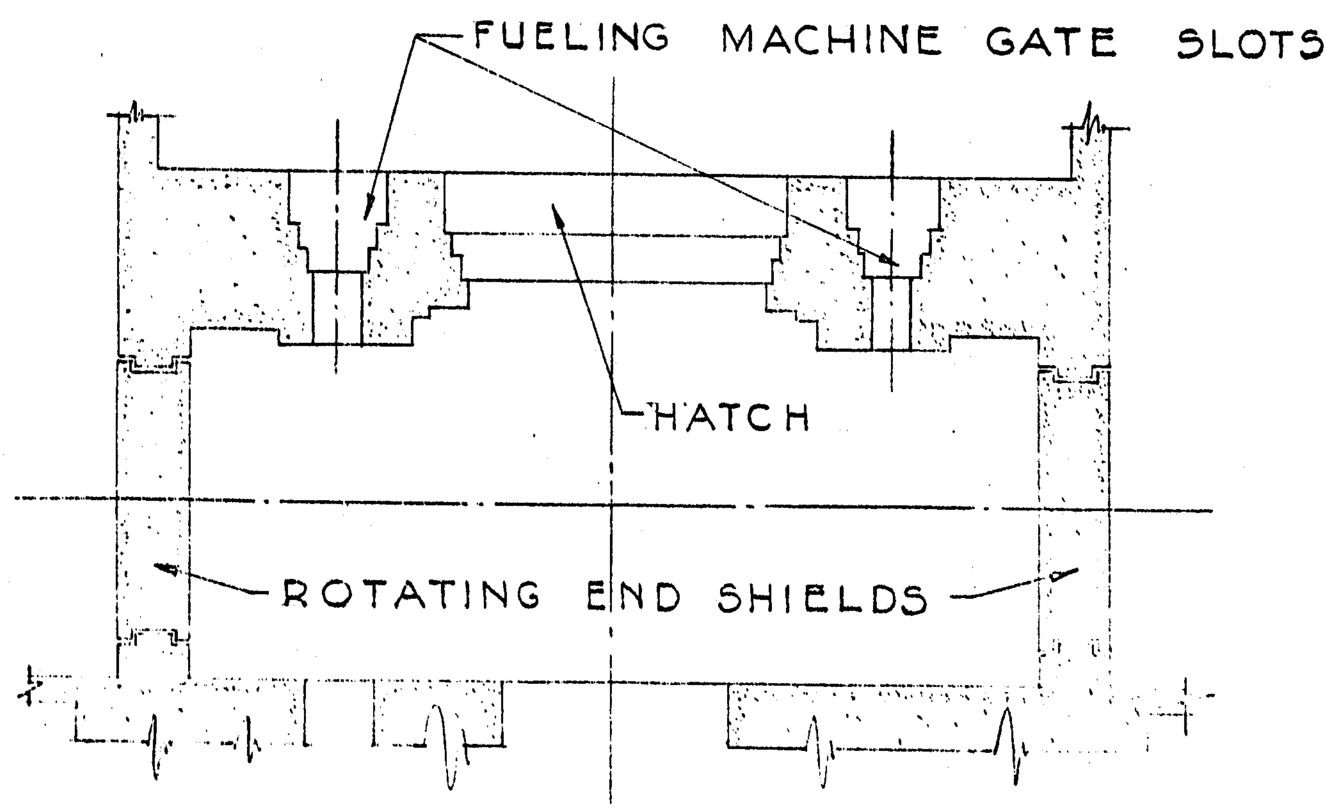


CROSS SECTION
(GENERATOR END)

FIG 4



LONGITUDINAL SECTION



CROSS SECTION

FIG. 5

Labyrinth Arrangement Plan

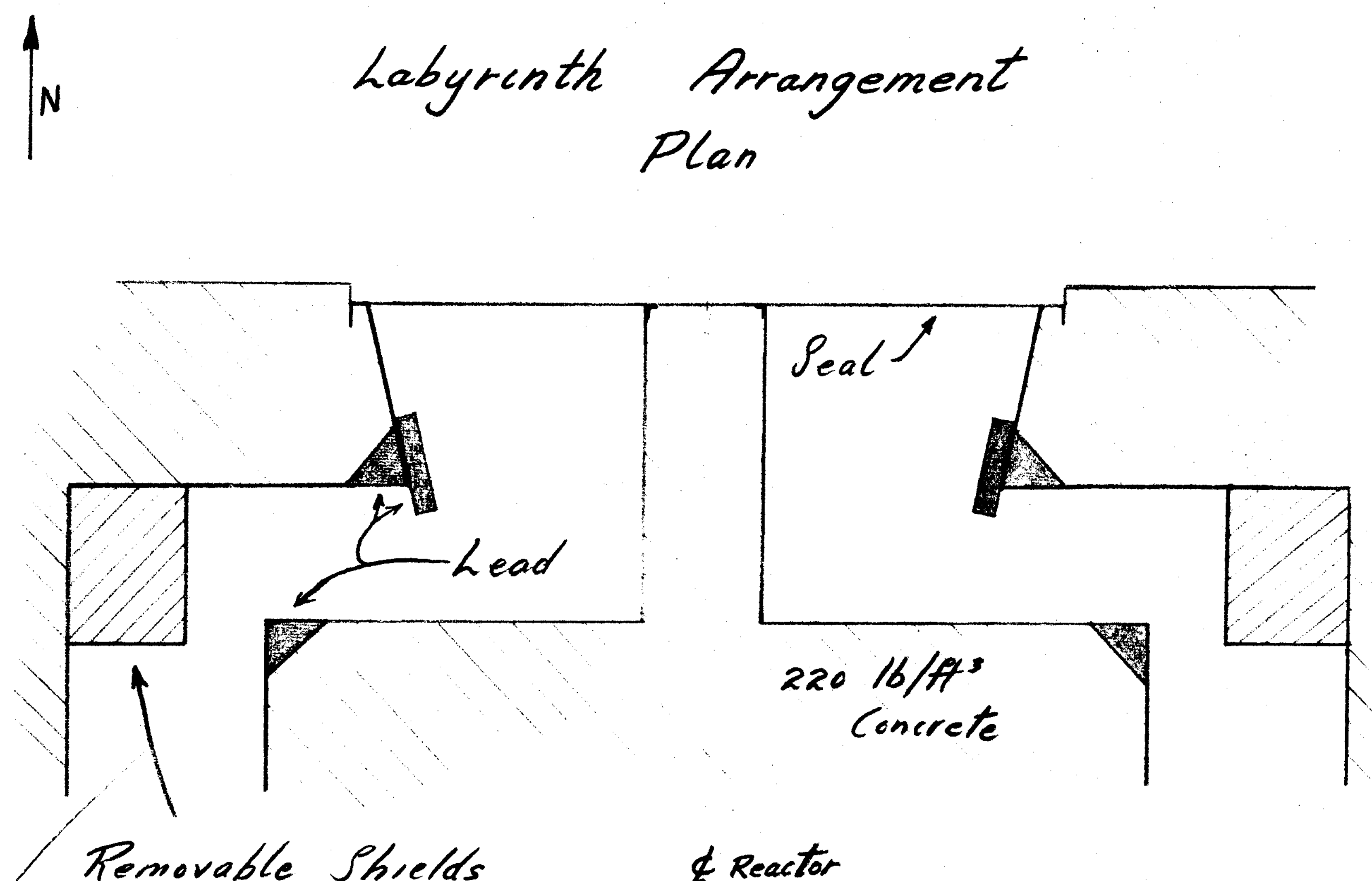


Fig. 6

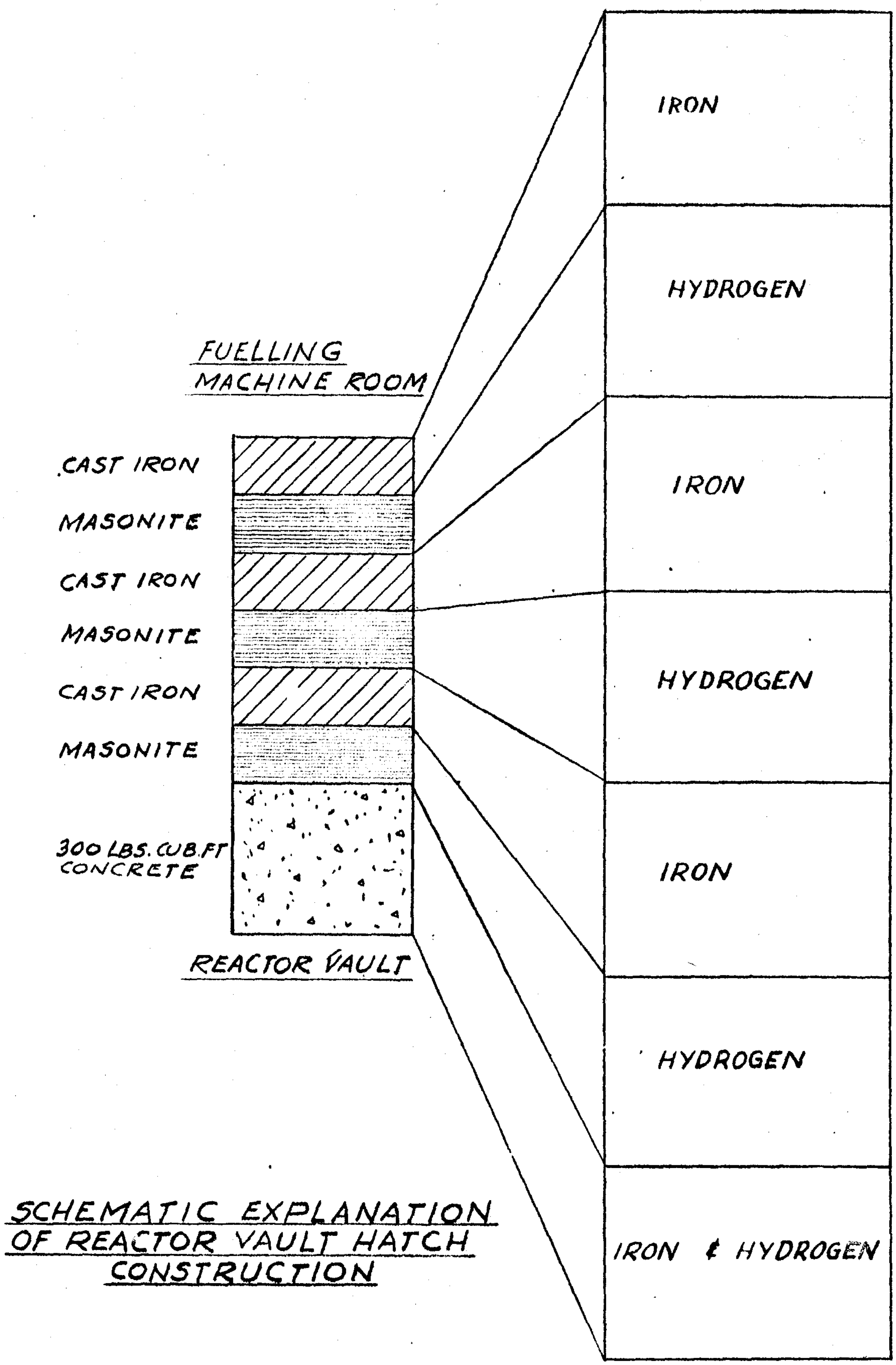

FUELLING MACHINE ROOM
CAST IRON
MASONITE
CAST IRON
MASONITE
CAST IRON
MASONITE
300 LBS. CUB. FT CONCRETE
REACTOR VAULT
IRON
HYDROGEN
IRON
HYDROGEN
IRON
HYDROGEN
IRON & HYDROGEN
SCHEMATIC EXPLANATION OF REACTOR VAULT HATCH CONSTRUCTION

FIG. 7

FUELLING MACHINE GATE ARRGT.

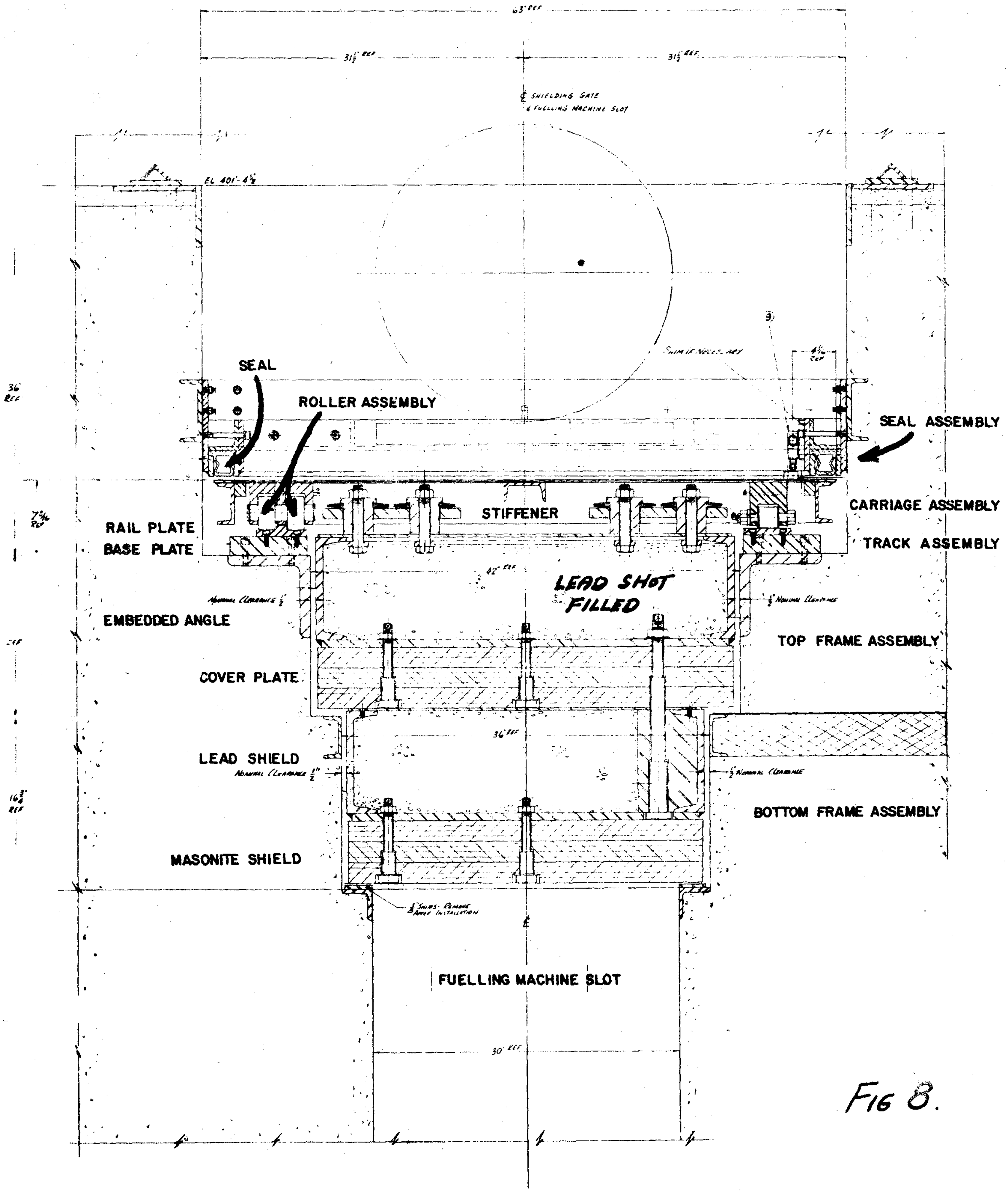


FIG 8.

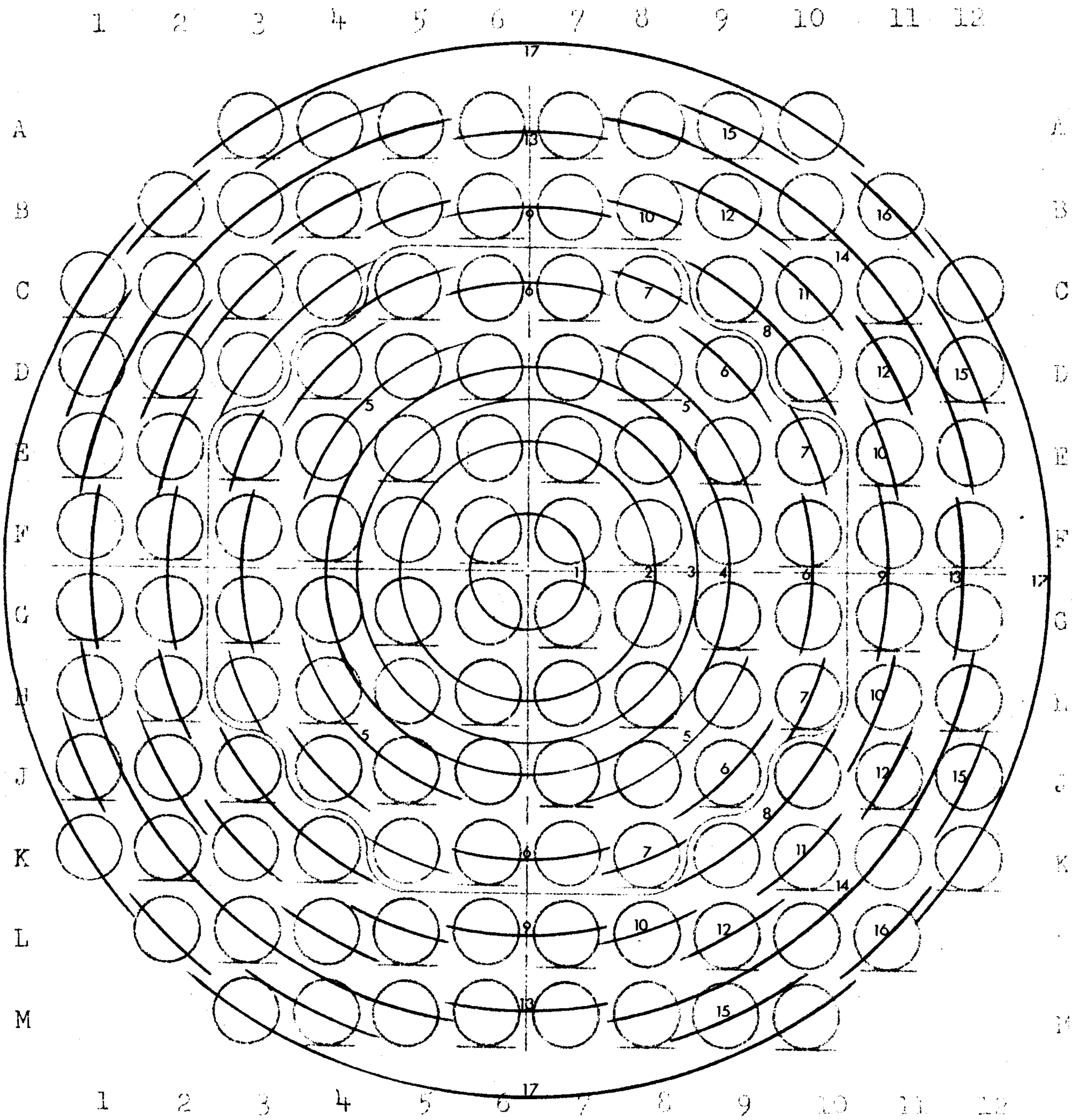
(1) WEST SLOT - OPPOSITE HAND

(2) EAST SLOT - AS SHOWN

Fig. 9

REACTOR CIRCLES SUPERIMPOSED ON

NPD G.C. LATTICE CODE LOOKING WEST



Fuel in at east end

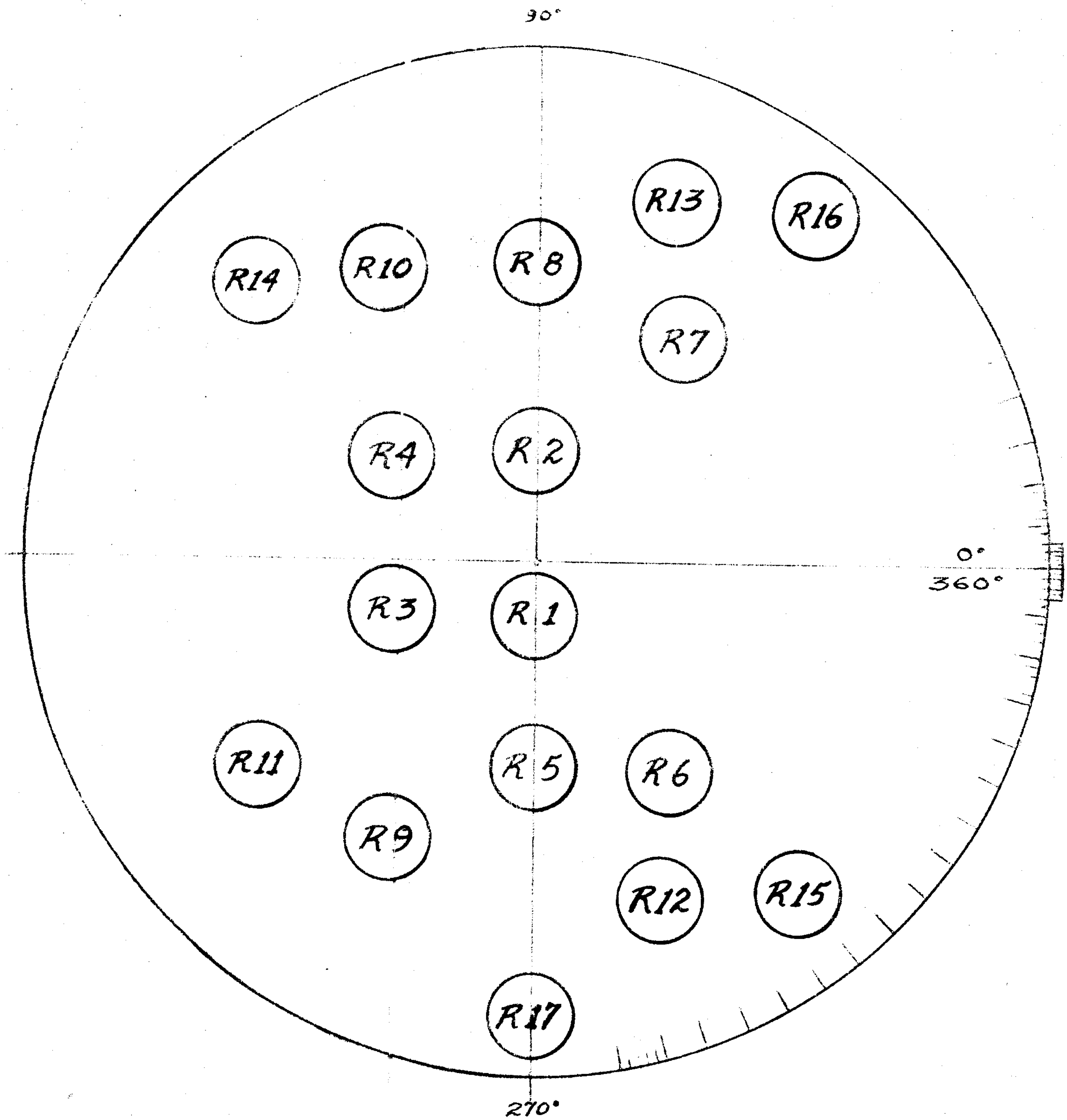


FIG 10

<u>End Shield Plugs</u>

The large end plugs are fitted with smaller stepped plugs.

	12	11	10	9	8	7	6	5	4	3	2	1	
A			R17 147¾	R15 197	R14 29¼	R13 333½	R13 344	R14 59¾	R15 246	R17 212½			A
B		R16 276	R14 6¾	R12 173¾	R10 6½	R9 147½	R9 160	R10 43½	R12 232	R14 82½	R16 6		B
C	R17 122½	R14 352½	R11 81	R8 324½	R7 305¼	R6 206¼	R6 222½	R7 351½	R8 35½	R11 171	R14 96¾	R17 237½	C
D	R15 156	R12 142	R8 305½	R6 169½	R5 149	R4 40¼	R4 63	R5 211	R6 259½	R8 54½	R12 263¾	R15 287	D
E	R14 329¾	R10 313½	R7 261½	R5 121	R3 64½	R2 341½	R2 18½	R3 154½	R5 239	R7 35¼	R10 96½	R14 119¼	E
F	R13 254	R9 70¼	R6 132½	R4 333	R2 288½	R1 135	R1 225	R2 71½	R4 130¼	R5 296½	R9 237½	R13 63½	F
G	R13 243½	R9 57½	R6 116¼	R4 310¼	R2 251½	R1 45	R1 315	R2 108½	R4 153	R6 312½	R9 250¼	R13 74	G
H	R14 299¼	R10 276½	R7 215¼	R5 59	R3 334½	R2 198½	R2 161½	R3 244½	R5 301	R7 81½	R10 133½	R14 149¾	H
J	R15 107	R12 83¾	R8 234½	R6 79½	R5 31	R4 243	R4 220¼	R5 329	R6 349½	R8 125½	R12 322	R15 336	J
K	R17 57½	R14 276¾	R11 351	R8 215½	R7 171½	R6 42½	R6 26¼	R7 125¼	R8 144½	R11 261	R14 172½	R17 302½	K
L		R16 186	R14 262½	R12 52	R10 233½	R9 340¼	R9 327½	R10 186½	R12 353¾	R14 186¾	R16 96		L
M			R17 32½	R15 66	R14 239¾	R13 164	R13 153½	R14 209¼	R15 17	R17 327½			M
	12	11	10	9	8	7	6	5	4	3	2	1	

SETTING ANGLES FOR <u>END ACCESS ROOM</u> ROTATING SHIELD LOOKING EAST.

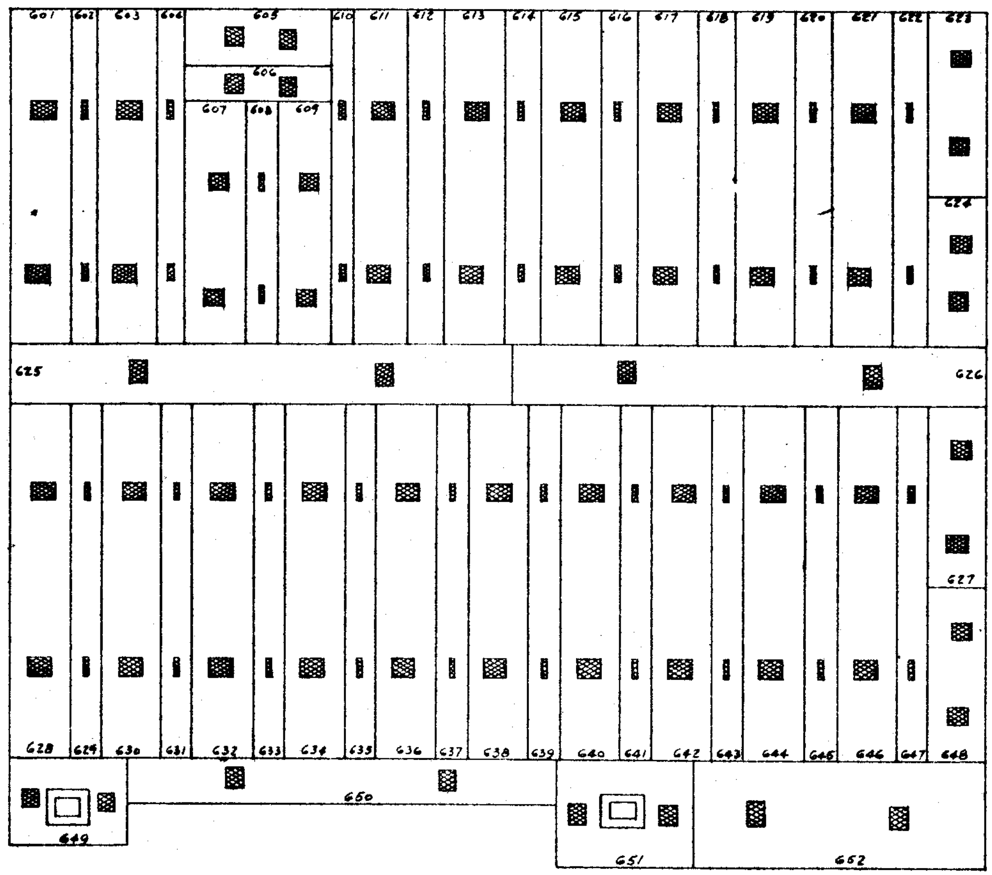
Fig 11

	1	2	3	4	5	6	7	8	9	10	11	12	
A			R17 147¾	R15 197	R14 29¼	R13 333½	R13 344	R14 59¾	R15 246	R17 212½			A
B		R16 276	R14 6¾	R12 173¾	R10 6½	R9 147½	R9 160	R10 43½	R12 232	R14 82½	R16 6		B
C	R17 122½	R14 352½	R11 81	R8 324½	R7 305¼	R6 206¼	R6 222½	R7 351½	R8 35½	R11 171	R14 96¾	R17 237½	C
D	R15 156	R12 142	R8 305½	R6 169½	R5 149	R4 40¼	R4 63	R5 211	R6 259	R8 54½	R12 263¾	R15 287	D
E	R14 329¾	R10 313½	R7 261½	R5 121	R3 64½	R2 341½	R2 18½	R3 154½	R5 239	R7 35¼	R10 96½	R14 119¼	E
F	R13 254	R9 70¼	R6 132½	R4 333	R2 288½	R1 135	R1 225	R2 71½	R4 130¼	R6 296½	R9 237½	R13 63½	F
G	R13 243½	R9 57½	R6 116¼	R4 310¼	R2 251½	R1 45	R1 315	R2 108½	R4 153	R6 312½	R9 250¼	R13 74	G
H	R14 299¼	R10 276½	R7 215¼	R5 59	R3 334½	R2 198½	R2 161½	R3 244½	R5 301	R7 81½	R10 133½	R14 149¾	H
J	R15 107	R12 83¾	R8 234½	R6 79½	R5 31	R4 243	R4 220¼	R5 329	R6 349½	R8 125	R12 322	R15 336	J
K	R17 57½	R14 276¾	R11 351	R8 215	R7 171½	R6 42½	R6 26¼	R7 125¼	R8 144½	R11 261	R14 172½	R17 302½	K
L		R16 186	R14 262½	R12 52	R10 223½	R9 340¼	R9 327½	R10 186½	R12 353¾	R14 186¾	R16 96		L
M			R17 32½	R15 66	R14 239¾	R13 164	R13 153½	R14 209¼	R15 17	R17 327½			M
	1	2	3	4	5	6	7	8	9	10	11	12	

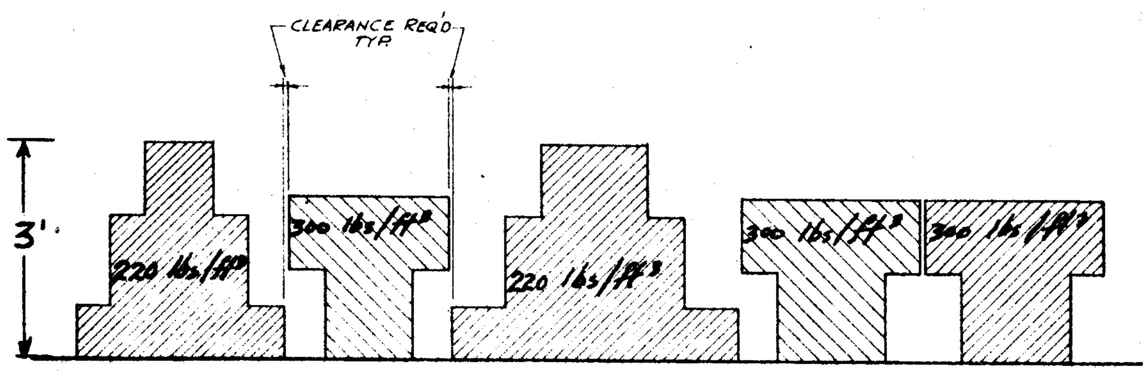
SETTING ANGLES FOR <u>TUBE WITHDRAWAL ROOM</u> ROTATING SHIELD LOOKING WEST.

FIG 12

Boiler Room Hatches FIG 13

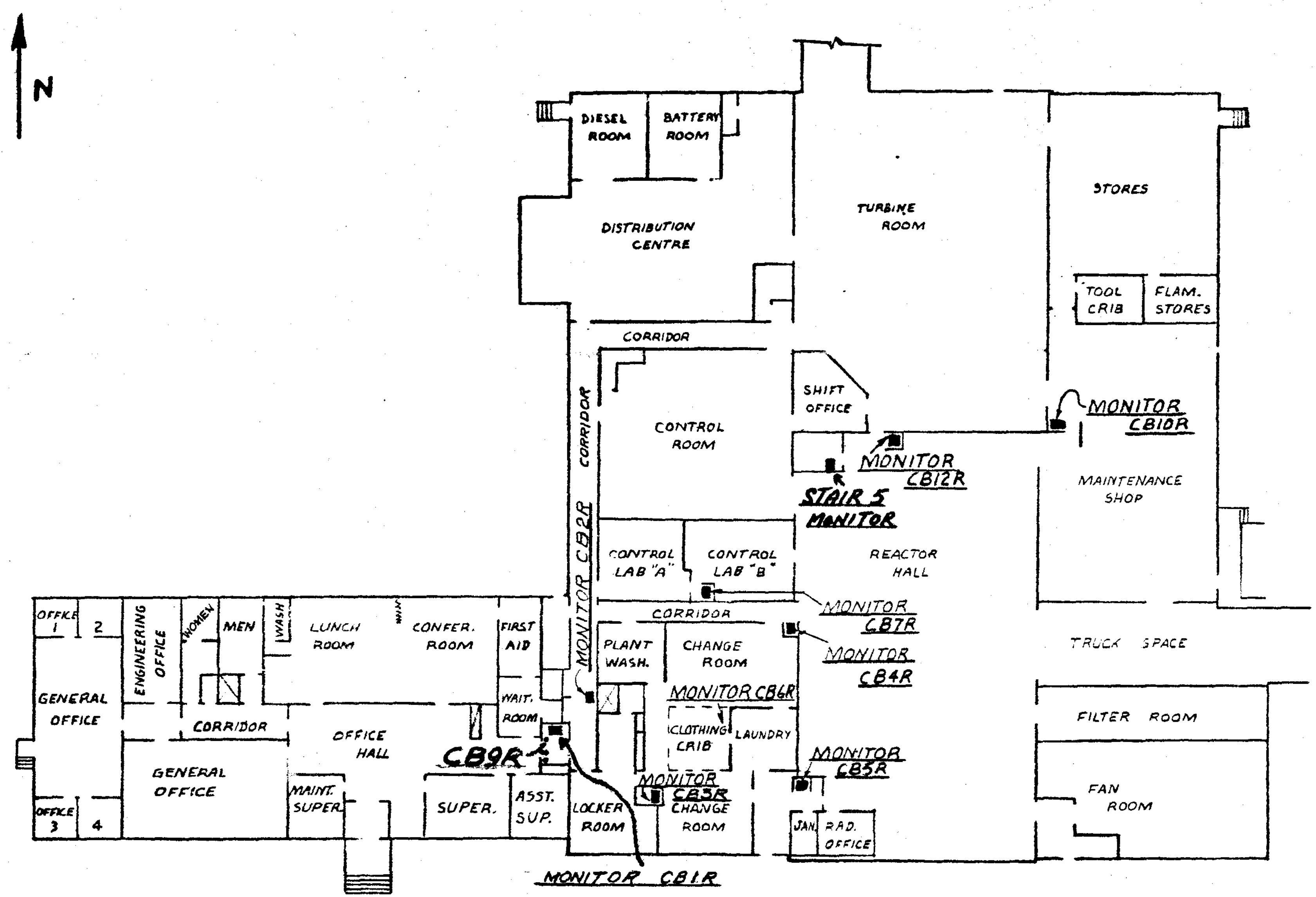


PLAN OF HATCH H-6



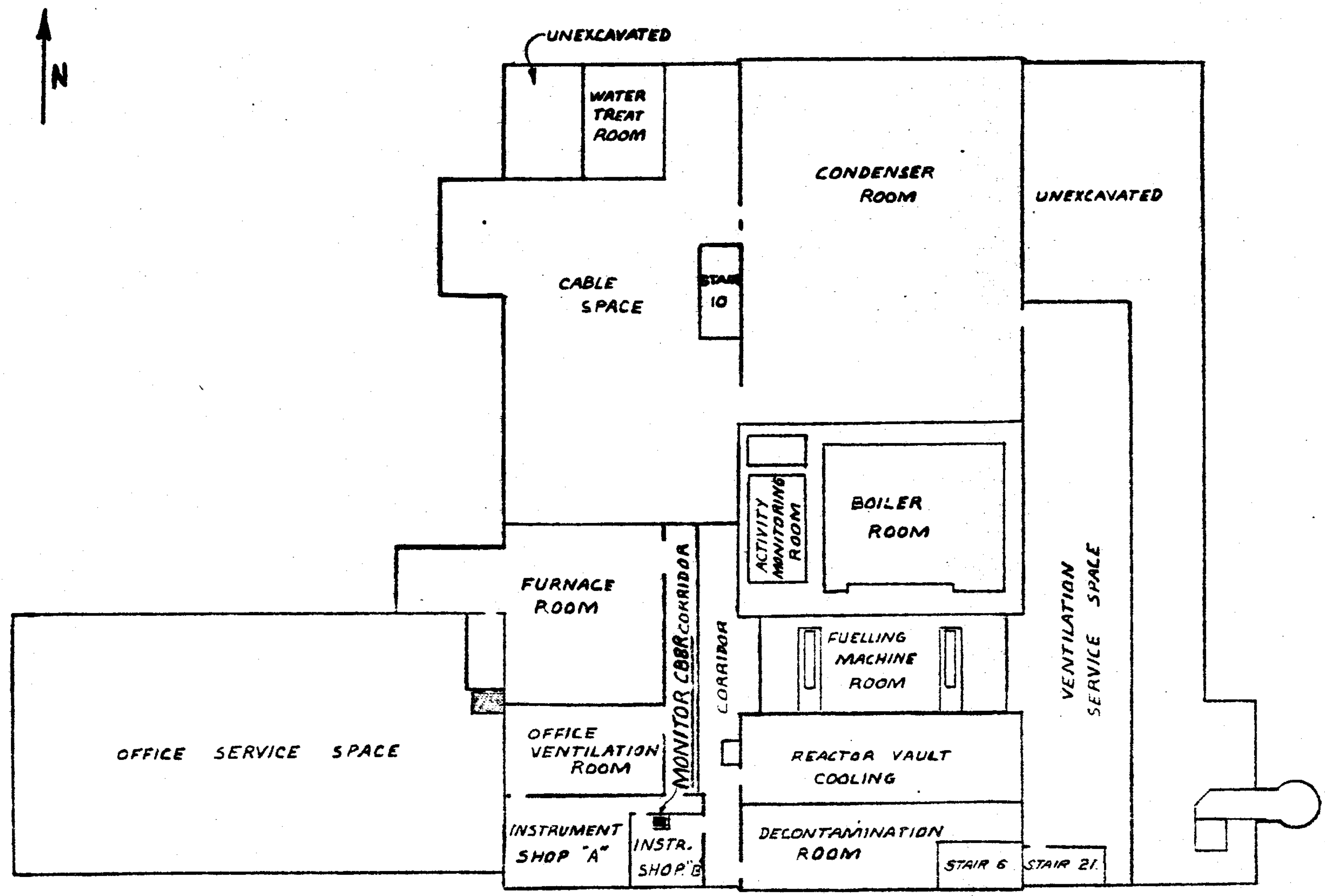
NOTE:

AFTER REMOVAL, HATCH SECTIONS TO BE LAID ON FLOOR IN SINGLE LAYER.
ON NO OCCASION SHALL THE HATCH SECTIONS BE STACKED ON TOP OF EACH OTHER.



LOCATION OF FIXED MONITORS AT ELEVATION 425'-0"

FIG 14



LOCATION OF FIXED MONITORS AT ELEVATION 406'-3"

FIG 15

Typical Shielding Door

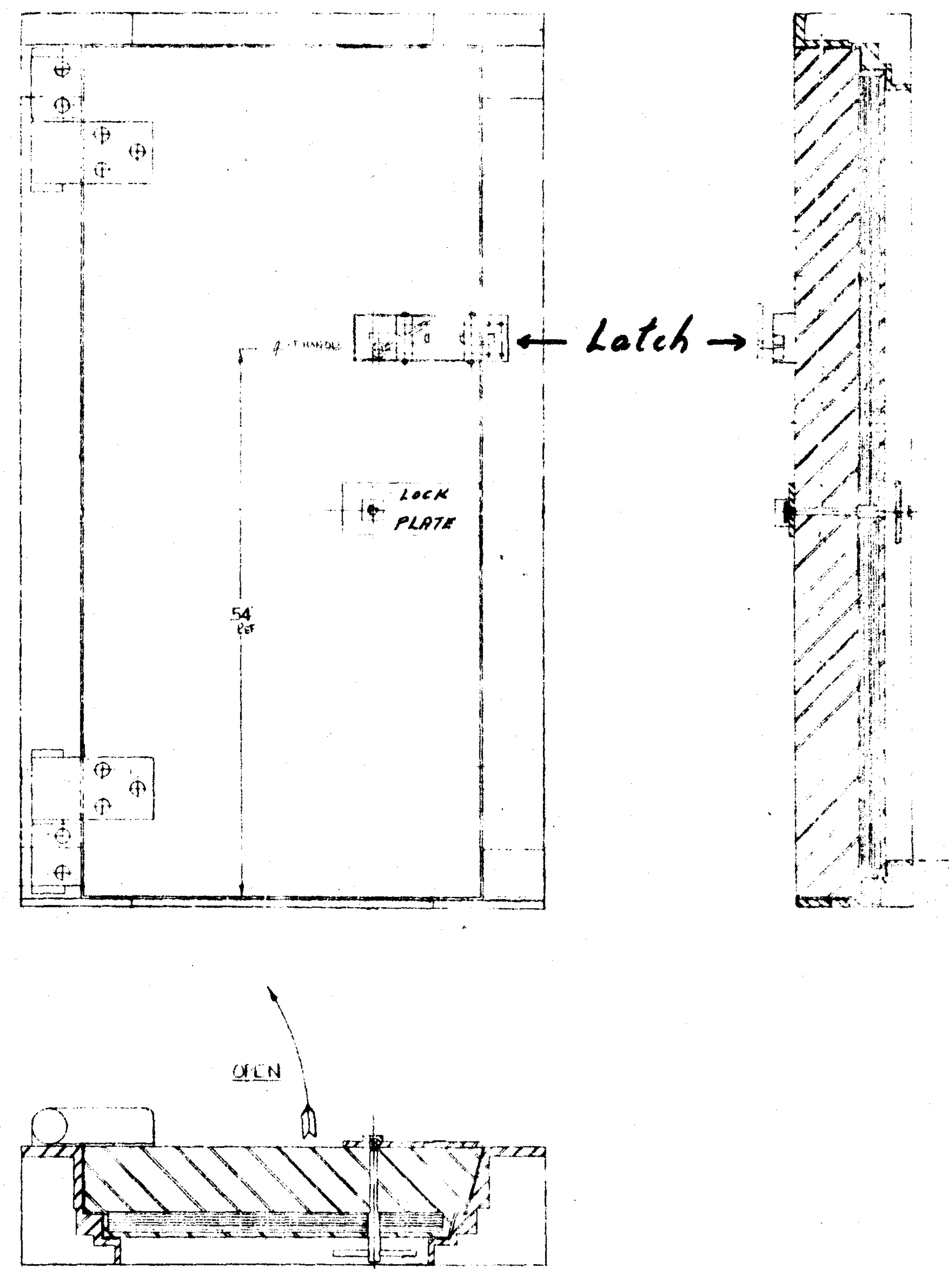


FIG 16

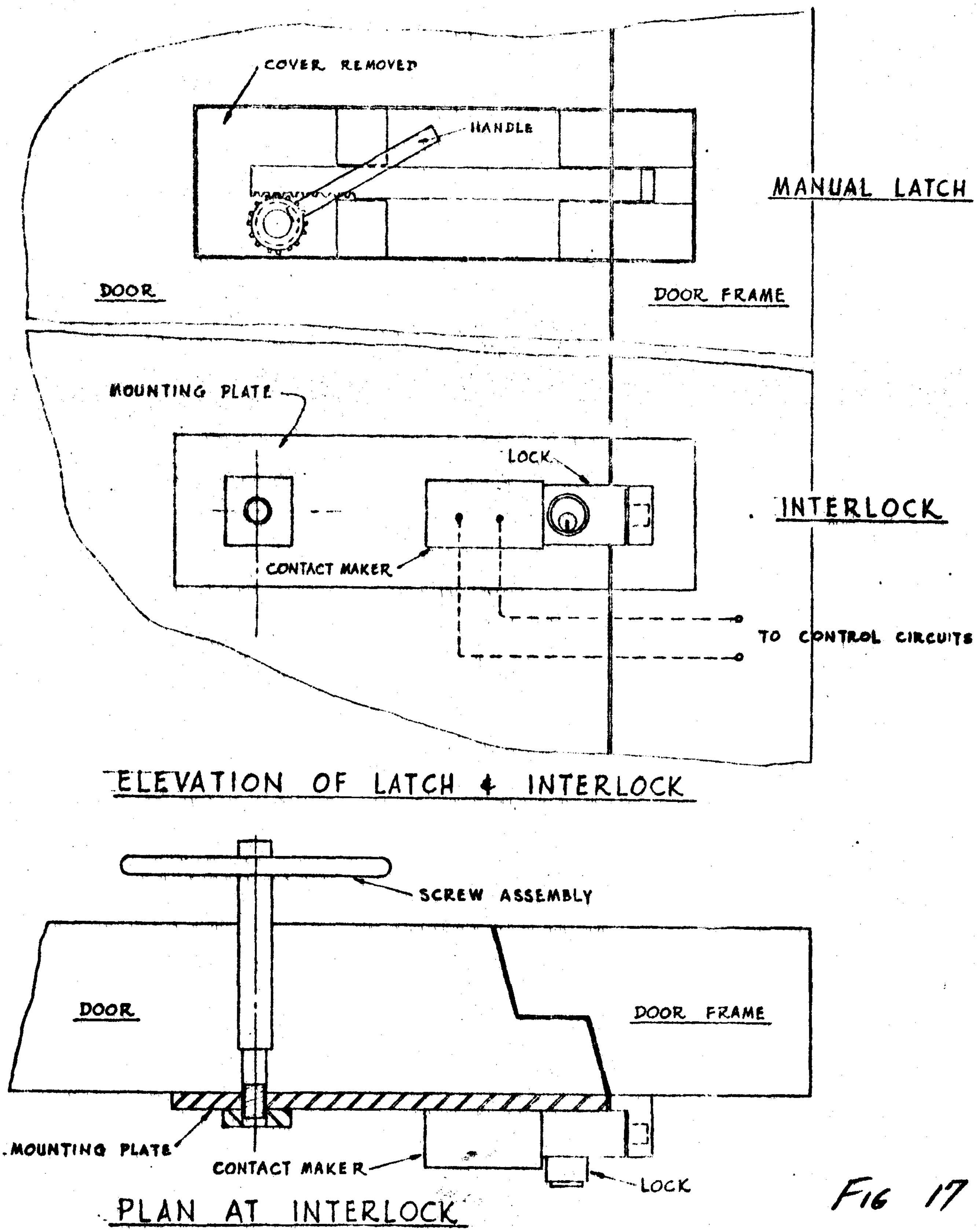
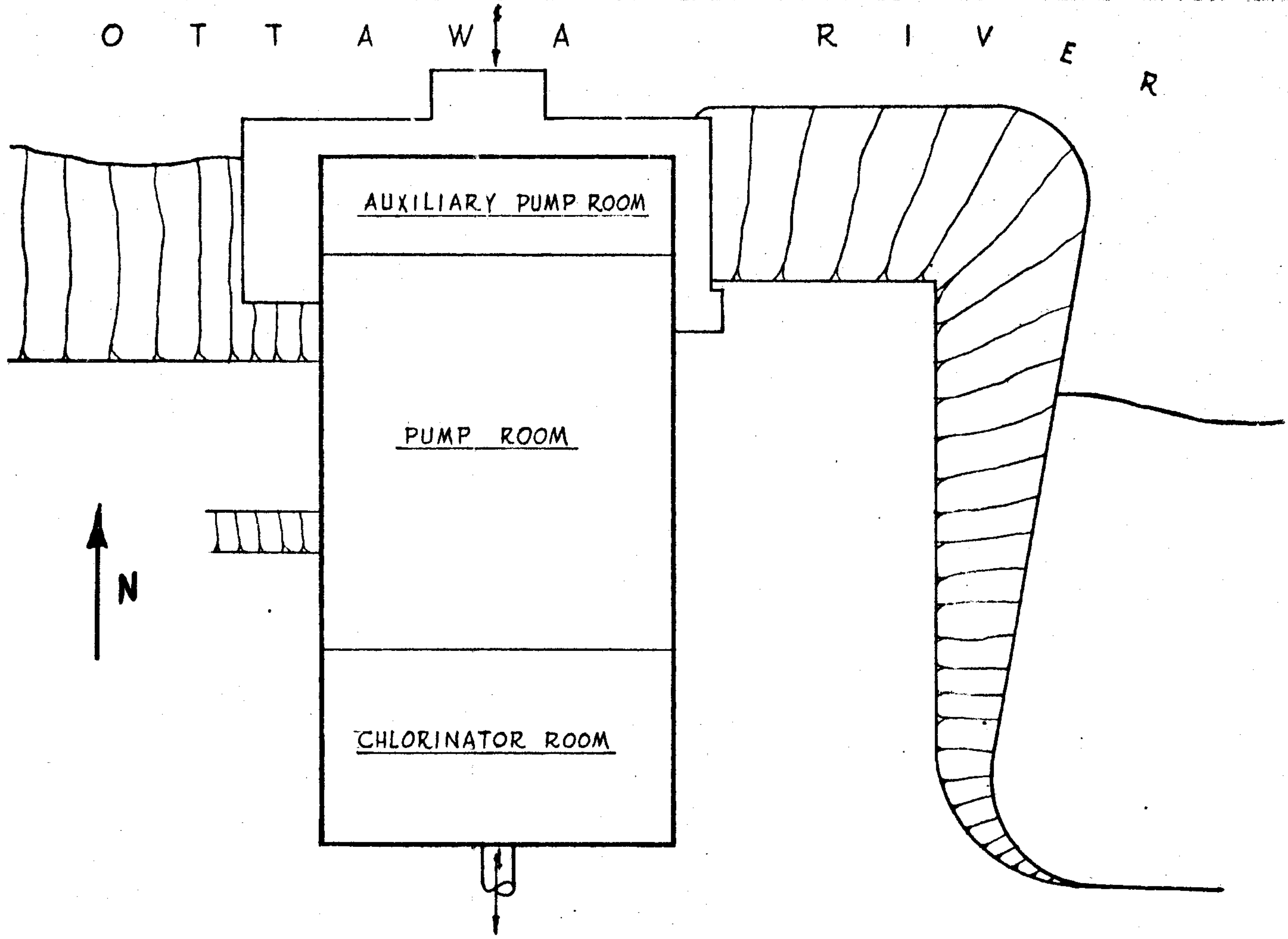
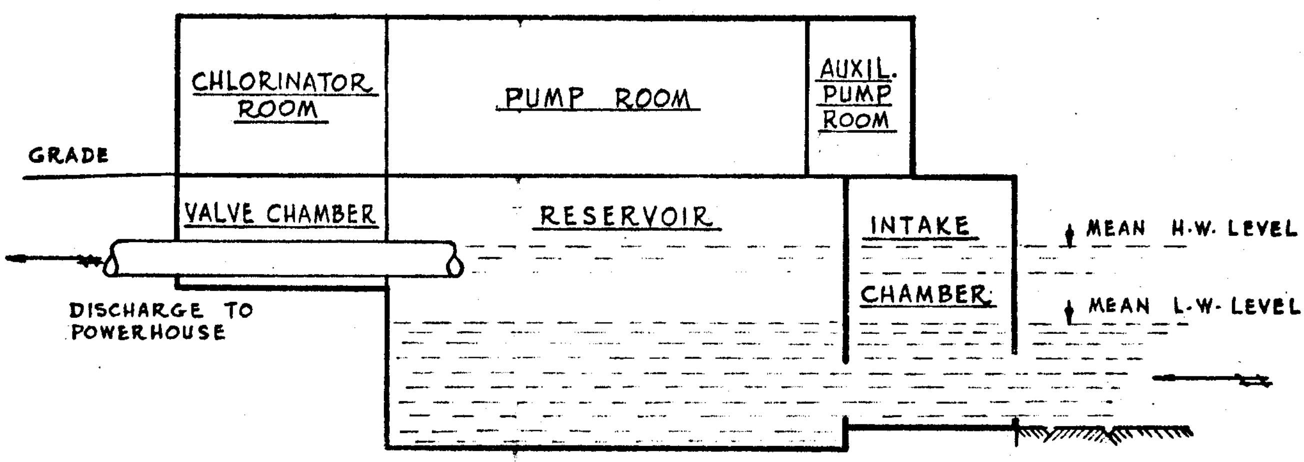


FIG 17

SHIELDING DOOR LATCH & LOCK



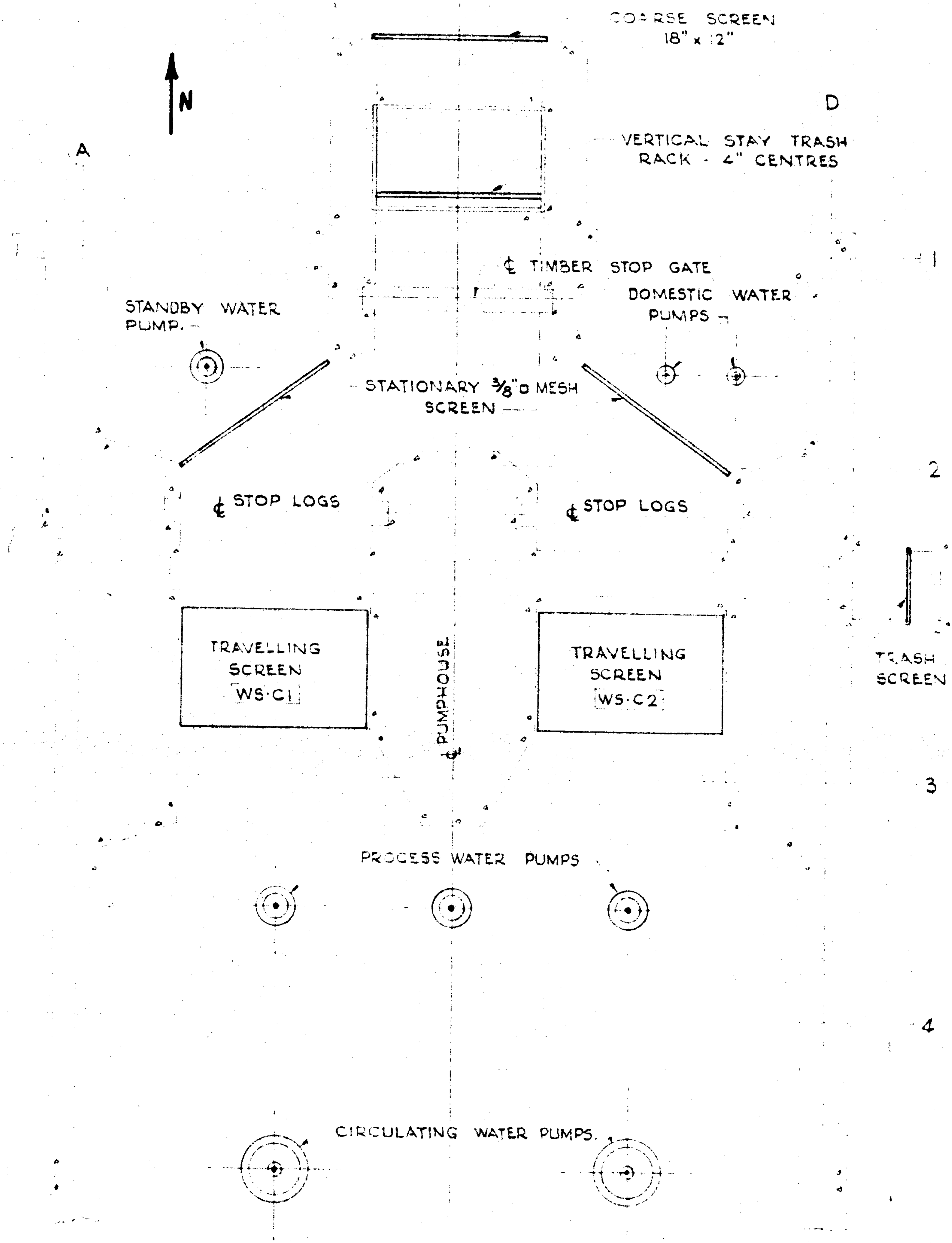
PLAN VIEW



LONGITUDINAL SECTION

PUMP HOUSE BLOCK DIAGRAM N.P.D.

FIG 18



N.P.D. —
INTAKE WATER SCREEN ARRANGEMENT
PLAN

Fig 19

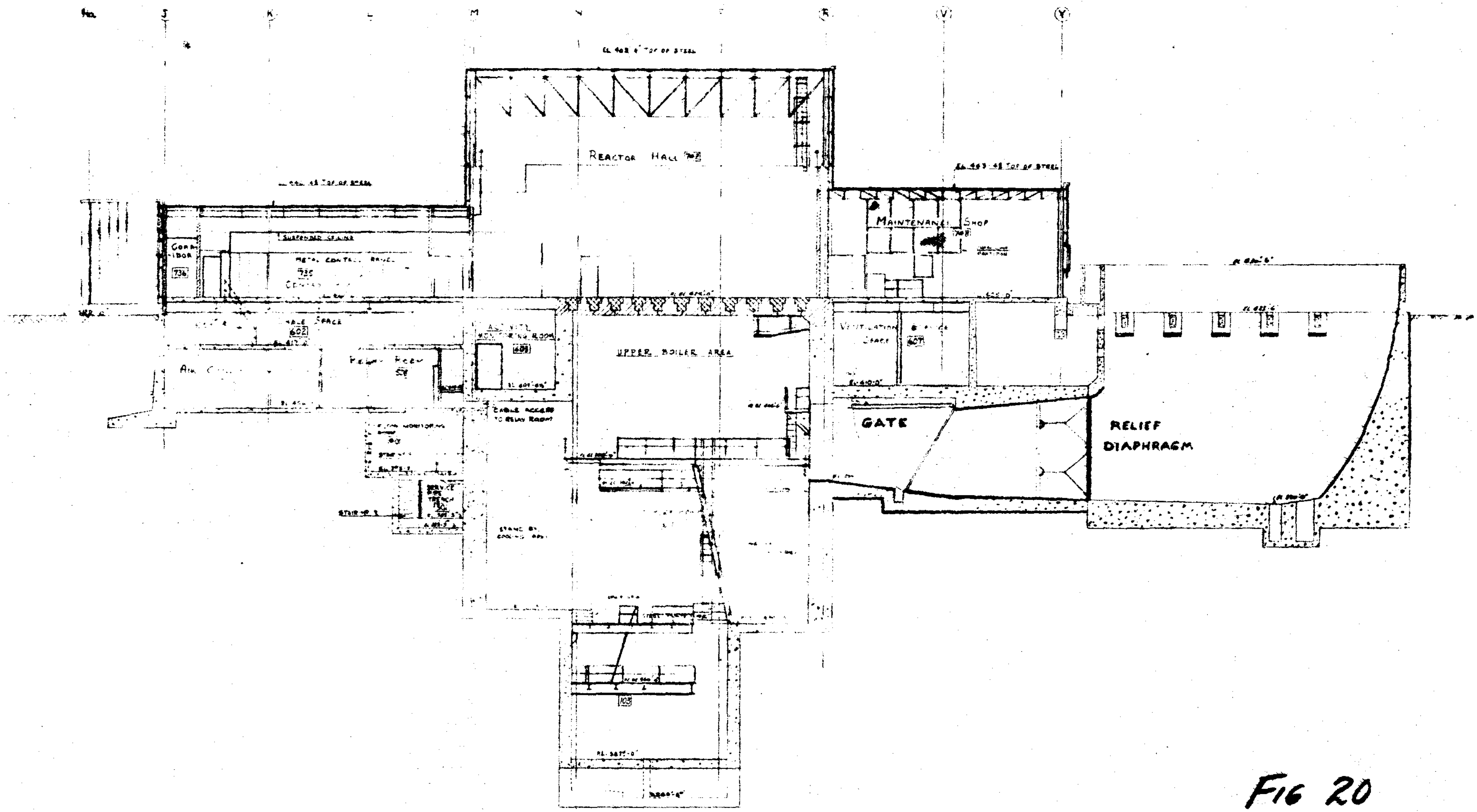
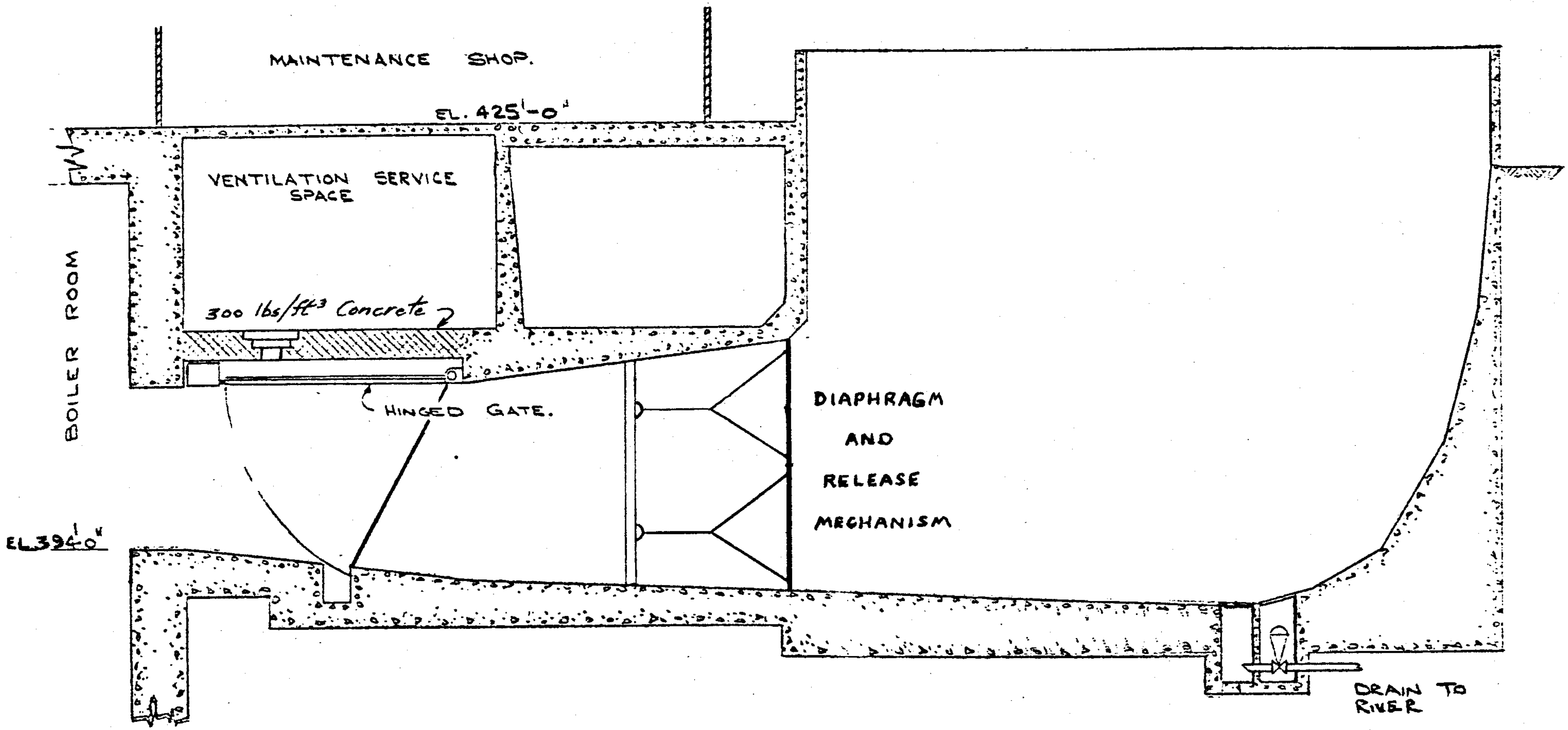
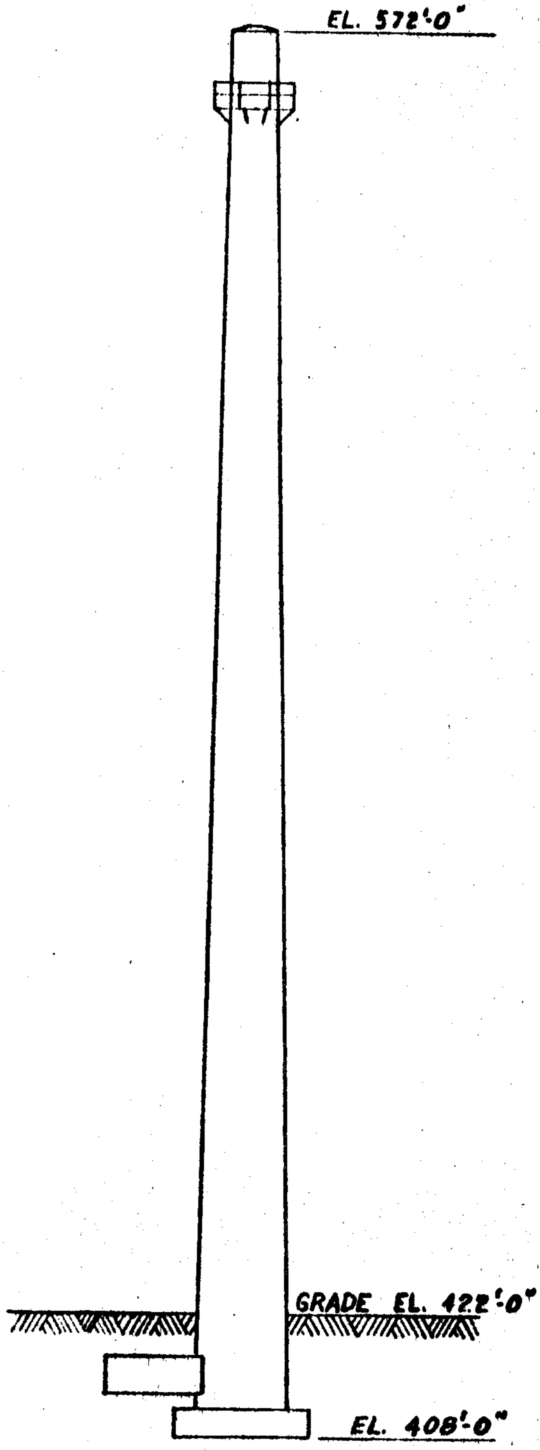

REACTOR HALL
MAINTENANCE SHOP
UPPER BOILER AREA
GATE
RELIEF
DIAPHRAGM

FIG 20



SECTION THRU' PRESSURE RELIEF DUCT FIG 21



STACK

FIG 22

Dousing Storage Tank – Plan

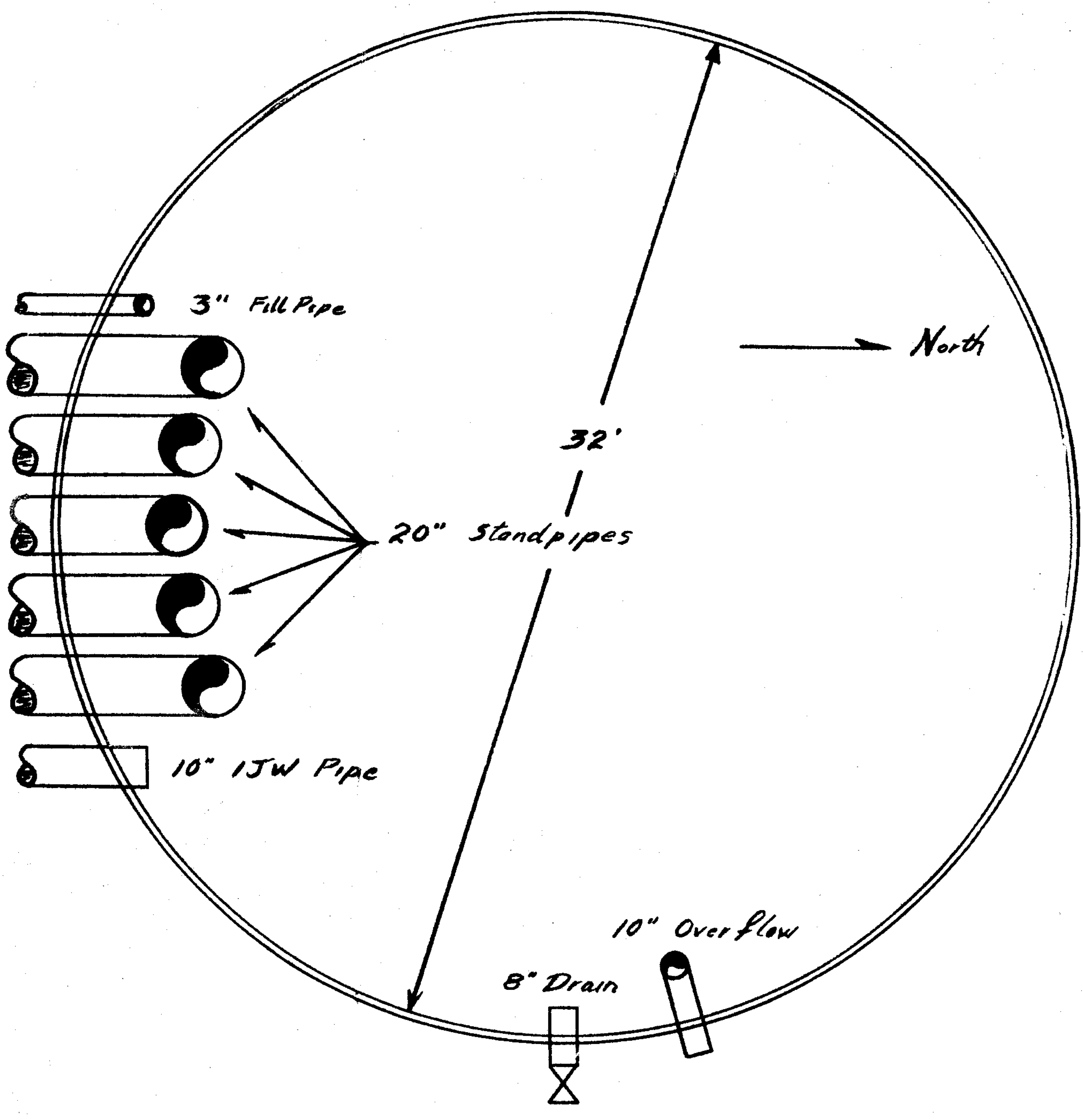


FIG 23

Dousing Storage Tank - Elevation

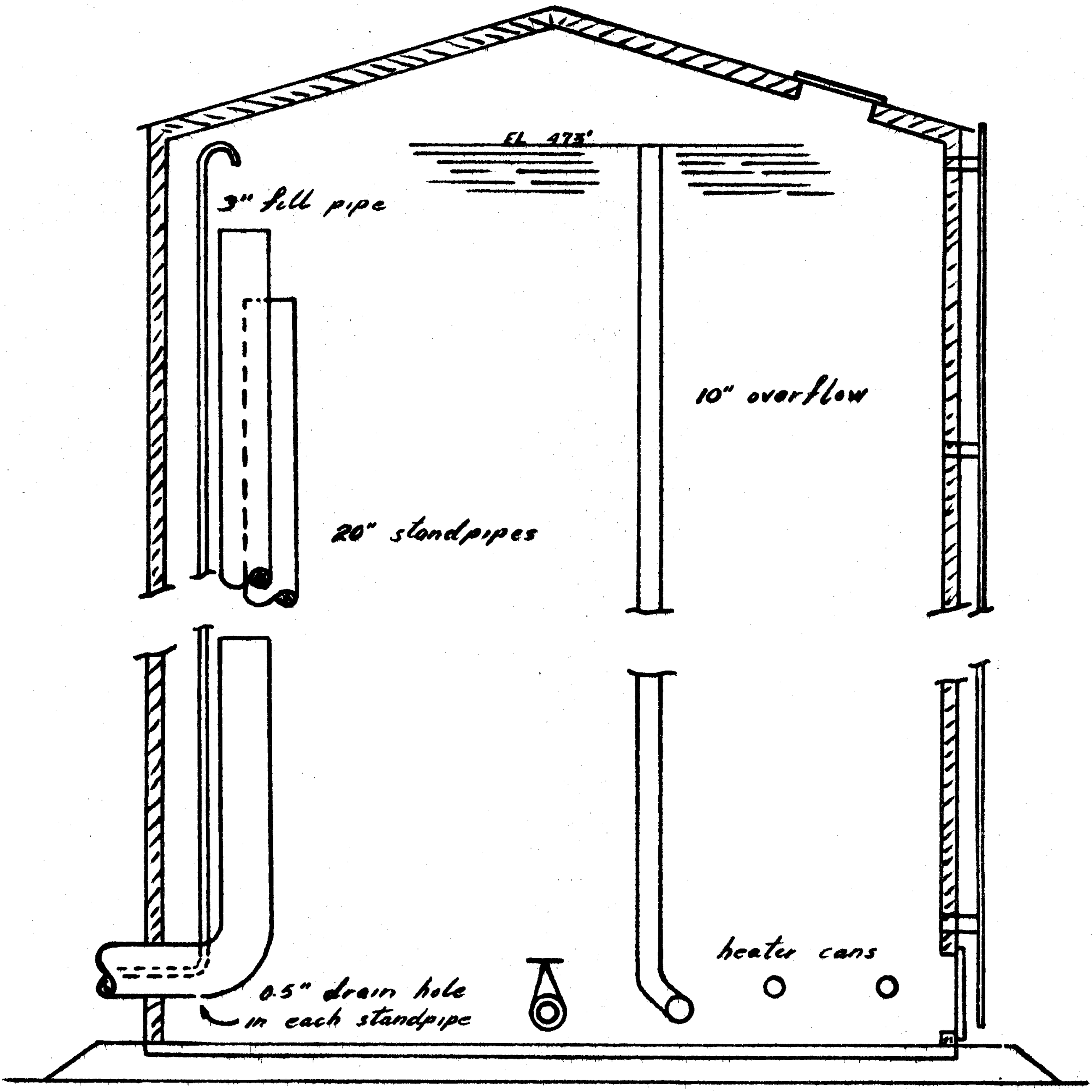


Fig 24

Dousing Tank

Pressure/Vacuum Relief Mechanism

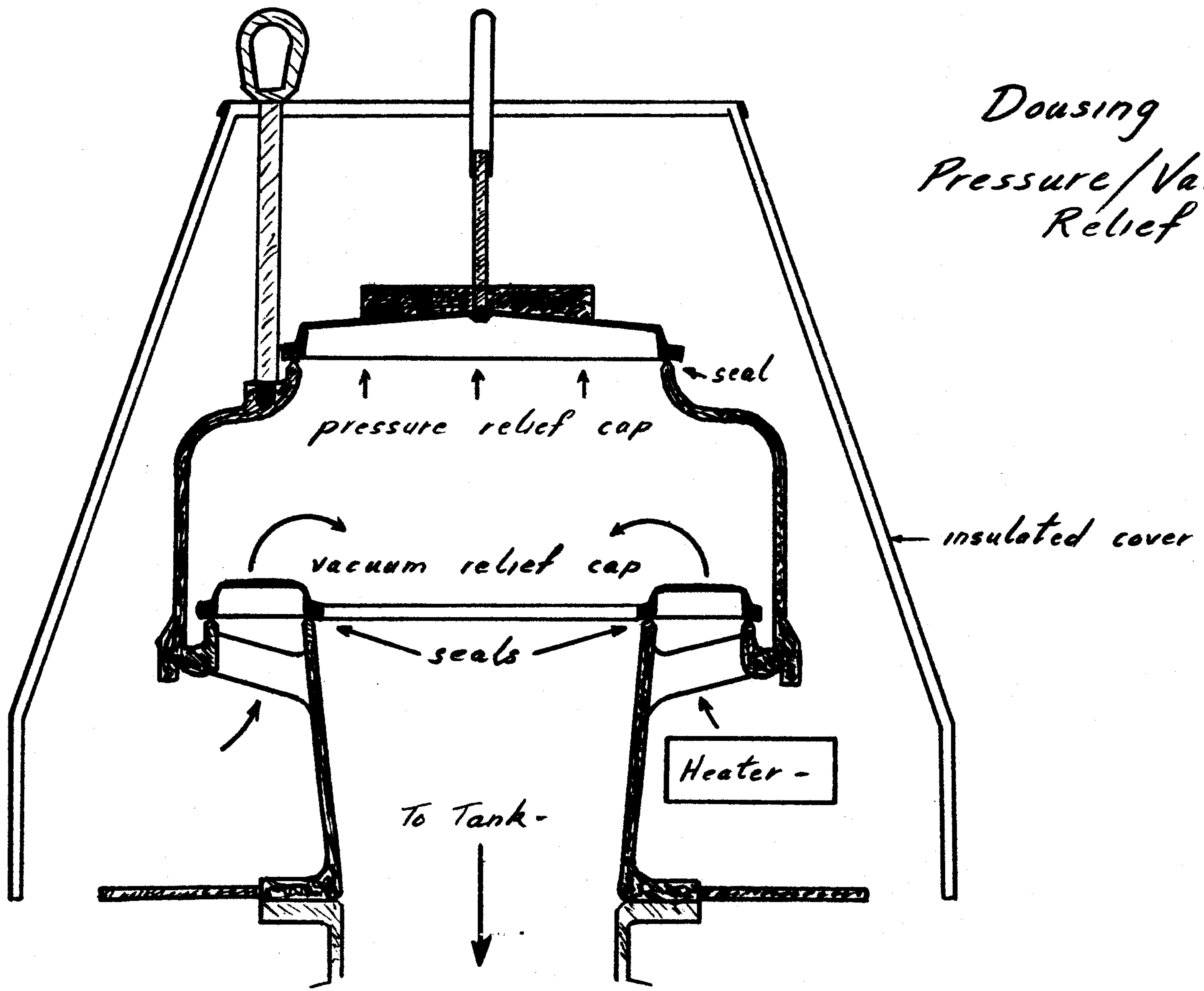


Fig 25

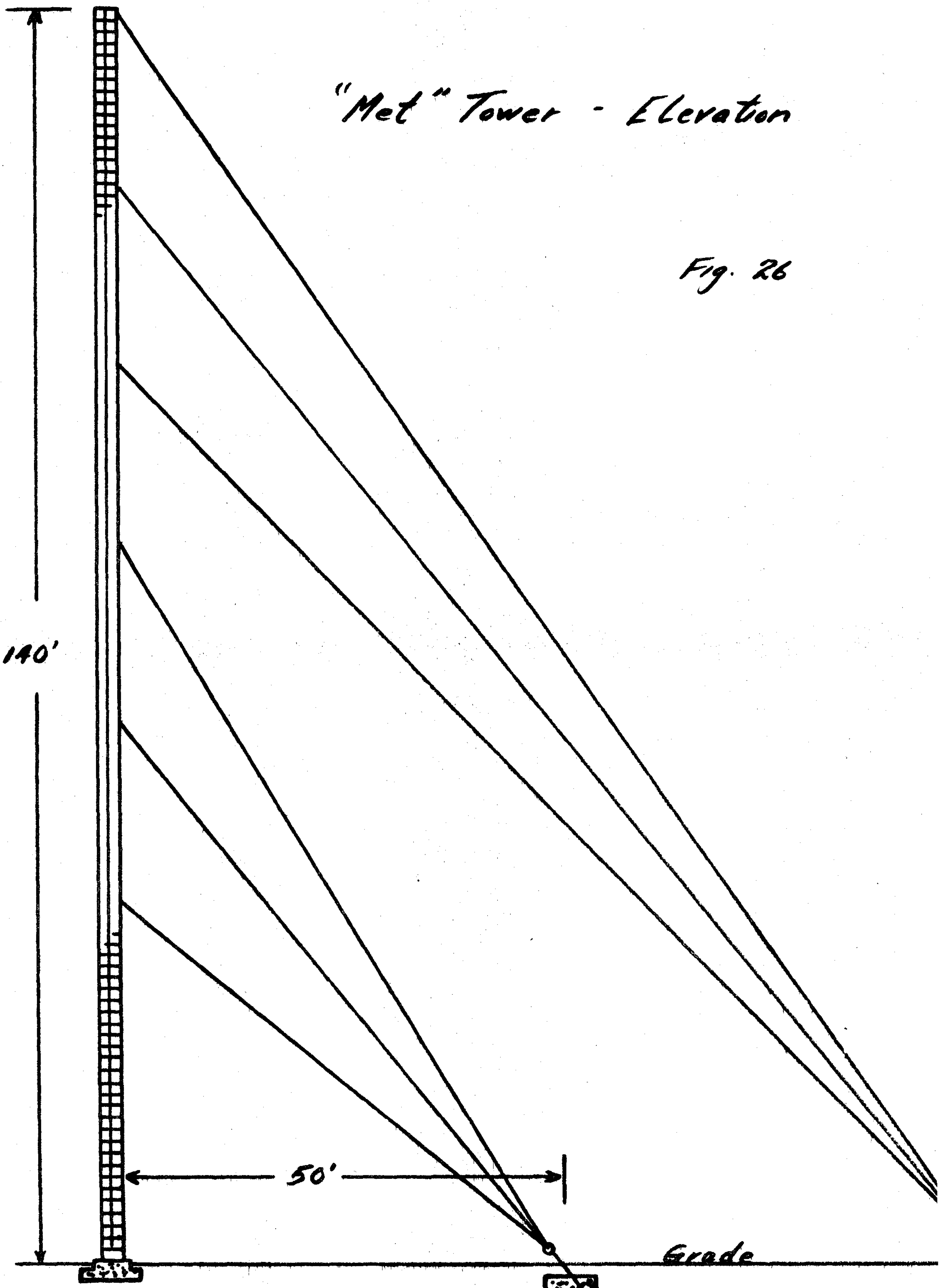


Fig. 26

BUILDINGS, STRUCTURES, AND SHIELDING, -

POWERHOUSE - GENERAL

APPENDIX A

ROOM LIST

Room No.		Room Name	
101		Wells Area Sump	
102		Heavy Water Collection Area	
103	Boiler Rm.	Dump Tank Room	
104		Dump Pipe Room	
201		Boiler Room	
202		End Access Room	
203		Reactor Vault	
204		Tube Withdrawal Room	
205		Spent Fuel Storage Bay	
206		Bay Area Sump	
207		Bay Clean-up Room	
301		Service Pipe Trench	
302		Service Pipe Trench Sump	
303		Condenser Room Pipe Trench	
304		Pressure Relief Duct	
306		Spent Fuel Storage Room	
307		Active Auxiliaries Room	
401		Flow Monitoring Room	
402		Water Treatment Room	
403		Condenser Room	
404		Escape Corridor	Upper Boiler Rm.
405		Fuelling Machine Room	
406		New Fuel Room West	
407		Corridor	
408		New Fuel Room East	
501		Instrument Shop "A"	
502		Instrument Shop "B"	
503		Office Ventilation Room	
504		Furnace Room	
505		Corridor	
506		Corridor	
507		Air Conditioning Room	
508		Relay Room	
601		Office Service Space	
602		Cable Space	
603		Activity Monitoring Room	
604		Reactor Vault Cooling Room	
605		Decontamination Room	
606		Corridor	
607		Ventilation Service Space	
701		Assistant Superintendent	
702		Superintendent	
703		Receptionist - Secretary	
704		Vestibule	
705		Maintenance Supervisor	
706		General Office	
707	Admin Wing	Engineering Office	
708		Women's Rest Room	
709		Women's Washroom	
710		Janitor's closet.	
711		Corridor	
712		Men's Office Washroom Lobby	
713		Men's Office Washroom	
714		Lunch Room Washroom Lobby	
715		Lunch Room Washroom	

Room No.		Room Name
716		Lunch Room
717		Conference Room
718		First Aid Room
719	Admin Wing	First Aid Closet
720		Waiting Room
721		Coat Closet
722		Office Hall
723		Airlock Lobby
724		Locker Room
725		Washroom
726		Zone 4 Change Room
727		Clothing Crib
728		Laundry Room
729		Zone 2 Change Room
730		Plant Washroom
731		Corridor
732		Control Laboratory A
733		Control Laboratory B
734		Control Panel Space
735		Control Room
736		Corridor
737		Distribution Center
738		Diesel Room
739		Battery Room
740		Turbine Hall
741		Shift Office
742		Reactor Hall
743		Janitor's Closet
744		Radiation Office
745		Fan Room
746		Filter Room
747		Truck Space
748		Maintenance Shop
749		Tool Crib
750	Service Wing	Flammable Stores
751		Stores
752		Corridor

BUILDINGS, STRUCTURES, AND SHIELDING, - POWERHOUSE - GENERAL

APPENDIX B

LIST OF ROOM ARRANGEMENT DRAWINGS FOR THE NUCLEAR AREA

	CGE Number	USI Number
Boiler Room Arrangement	201E344	300.C.1
Dump Tank Room Arrangement	201E496	320.C.5
Active Auxiliaries Room Arrangements	201E345	340.C.5
Demineralizer Cavities Arrangement	201E579	322.C.1
Activity Monitoring Room Arrangement	201E534	331.C.8
Heavy Water Collection Area Arrangement	551C709	335.C.5
Bay Clean-Up Room Arrangement	201E256	356.C.1
Reactor Area General Arrangement	201E314	310.C.1
Spent Fuel Room Arrangement	201E317	353.C.1
New Fuel Room Arrangement	201E377	351.C.6
Fuelling Machine Room Arrangement	201E270	352.C.7
Corridor 505 and 506	201E516	-
Ventilation Service Space (Ventilation)	201E358	730.C.4
Ventilation Service Spacing	201E545	713.C.4
Service Pipe Trench	201E303	713.C.5
Service Pipe Trench	201E309	713.C.6
Active Auxiliaries Room	201E397	2115.C.3
Water Treatment Room	491D360	716.C.1
Reactor Vault Cooling Room	201E316	734.C.2
Decontamination Room	201E285	781.CN.2
Fan and Filter Room	201E357	730.C.5
Maintenance Shop	491D353	770.C.1
Change Rooms	491D345	210.CN.12
Control Lab. A & B	551C296	782.C
Shift Office	551C285	-
Janitor Closet and Radiation Office	551C292	210.CN.14
Fan Room	491D661	713.C.8
Wells Area Sump	591D506	-

NPD G.S. - Systems

Building and Structures

Questions

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(1) What is the purpose of the Stack at NPD?

(2) What is the purpose of the Relief Duct?

(3) Why is the Pumphouse separate from and at a lower elevation than the Powerhouse?

(4) What is the purpose of the Meteorological Tower?

(5) What is the purpose of the Dousing Tank?

(6) What is the purpose of "zoning"?

(7) Why are some walls, hatch covers, etc., constructed from high density concrete and/or made thicker than would be required for purely structural reasons?

(8) Why are massive foundations used for the Turbo-Generator unit?

(9) Why is the Reactor Vault lined with steel plate?

(10) What function(s) do the Rotating End Shields serve?