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RESEARCH ESTABLISHMENT

LUCAS HEIGHTS

HIFAR REACTOR SEALED BUILDING

NORMAL VENTILATION SYSTEM

by

J.B. HOPKINSON

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ABSTRACT

This manual describes the Normal Ventilation System of the HIFAR reactor sealed building and gives operating procedures. The system is treated independently of the Reactor Active Ventilation System and the Air Cleansing and Recirculating System.

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CONTENTS (Continued)

1. INTRODUCTION

Three basic ventilation systems are associated with the HIFAR reactor and the Reactor Sealed Building (R.S.B.):

Normal Ventilation System comprising Normal Input and Normal Extract serving the R.S.B. generally and described in this manual.

Air Cleansing System incorporating a scrubber recirculating system for removal of relatively large quantities of fission products, if an accident were to occur within the R.S.B., and an evacuation facility to relieve any subsequent excess pressure within the R.S.B. This system is controlled entirely from within the Emergency Control Room (E.C.R.). It is connected to the Normal Ventilation System just before the extracts of both systems pass through the shell of the R.S.B. During normal operation the isolating damper contained within the ductwork connecting these systems is kept closed.

Active Ventilation System: This system is independent of the other two and extracts air and gases from particular experimental rigs, the Heavy Water Plant Room and any other source of contamination within the R.S.B. This obviates the reactor shutdown which might otherwise result from detection of these gases by the monitors on the Normal Extract System.

1.1 The Normal Ventilation System

With some differences the Normal Input and Extract Ventilation System for the R.S.B. is typical of the Lucas Heights active ventilation systems of the negative pressure category, to which the following general principles apply:

(a) They ensure containment of all airborne matter entering or released within the ventilated area in order to protect the external environment during both normal operation and abnormal or accident conditions.

(b) They facilitate control of contamination within a building by ensuring that air moves from areas of lower to areas of higher contamination potential. (This does not strictly apply within the R.S.B. because of the need for recirculation by space conditioners.)

(c) They produce sufficient rates of change of air in areas of potential contamination to prevent build-up of unacceptable airborne concentrations during normal operations.

(d) They provide acceptable air change rates for personal comfort and removal of heat, odours etc., and where applicable produce air conditions necessary for correct operation of equipment.

The maintenance of a negative pressure in such systems ensures balanced overall control by use of pressure controllers, establishment of a clearly defined air flow pattern, with air flow to the more highly contaminated areas, and a minimum of air leaks into the ventilated space.

The R.S.B. ventilation system differs from such a system in that the air flow pattern is not clearly defined because the entire volume is regarded as a more or less uniformly classified area and the leakage into the R.S.B. is negligible because of the shell integrity, except for personnel and vehicle air lock operation.

It also differs from the typical active ventilation system in numbers of air changes per hour. Experience has shown that in some areas the number can be reduced from 10 to 6. Because of the comparatively large volume of the reactor building (about 270,000 cubic feet) and the input fan capacity (4,500 cubic feet per minute) the normal rate of air change per hour is approximately one. This arises from the fact, among other things, that the number of air changes required can be inversely proportional to the volume of the space being ventilated, otherwise prohibitive costs will be incurred.

The Input Ventilation System can operate independently of the operating condition of the main Extract Ventilation System and vice versa. Neither part of the overall system contains an automatic differential pressure controller for regulation of ventilation air pressure. The nominal slightly negative pressure maintained within the R.S.B. is due to the overall effect of the physical characteristics of the parts of the system and particularly the slight difference in actual input and extract fan capacities.

Figure 1 illustrates diagrammatically the principles of the Normal Input and Normal Extract Systems.

2. AIR INTAKE

2.1 Ducting

An extension piece on the original 8 square feet inlet opening above the plant room roof faces east to avoid the prevailing westerly winds that would introduce dust etc., into the inlet filters and prematurely choke them. It is fitted with a wire grille of approximately $\frac{1}{2}$ inch mesh.

2.2 Inlet Filters

The 15 inlet filters are of the K600 Kompak type which consists of a unit that can be attached to others to form a bank of the required size. Each unit consists of a series of hinged frames, folded from either side and with an interleaved continuous length of replaceable filter medium. The loaded unit is approximately 23 in. x 11 in. x $15\frac{1}{2}$ in.

The filter medium is of 'Composite' material, a cellulose filter medium backed by a glass wool fabric. It has an initial pressure drop of 0.3 in. w.g. at 400 ft^3/min. Using the No. 2 dust test, BS 2831-1957, its efficiency is approximately 99.5 per cent for particles down to 5 microns.

Because this filter is in continuous use and its continued effectiveness is important it is subject to a programmed annual change.

2.3 <u>Carrier 43Q7 Weathermaker</u>

This component, located at the western end of the auxiliary plant room, conditions the inlet air to a nominal 65°F with an average dew point of 50°F. It consists of:

- Recirculating spray water system.
- 'Aerofin' H.P.H.W. preheating coil.
- 'Aerofin' chilled water cooling and dehumidifying coil.
- 'Aerofin' H.P.H.W. after-heating coil.
- Centrifugal fan assembly driven by a 5 hp motor to deliver 4500 ft^3/min.

A Honeywell T915B modulating dewpoint thermostat is set at 51°F and operates in sequence a modulating valve on the H.P.H.W. line to the preheater coil and a three-way valve on the chilled water line to the 'Aerofin' chilled water coil. A T915A thermostat located in the discharge ducting is set at 65°F and controls a modulating valve in the H.P.H.W. line to the 'Aerofin' H.P.H.W. after-heating coil.

The following dial thermometers are installed:

- Outside air temperature.
- Preheated air temperature.
- Dewpoint temperature.
- Supply air temperature.
- Supply air temperature (Rototherm).

Although this Weathermaker has a Carrier serial number it is not a standard Carrier unit, having been designed and fabricated for this installation.

3. REFRIGERATION PLANT

3.1 Description

The Refrigeration Plant for cooling the recirculated chilled water consists of three identical but separate Freon 22 systems, any two of which can be selected to hold the demanded load as required, leaving the remaining system on stand-by. Each system comprises:

(a) An Ajax CMH-2 chilled water circulating pump direct-coupled to a $7\frac{1}{2}$ hp motor, pumping from a common return header, through a non-return valve, through the tubes of its corresponding water cooler, and thence to a common supply header. A Honeywell P406B differential 'pressuretrol' connected across the inlet and outlet piping closes the compressor to run only when water flow through the cooler is adequate.

(b) A Carrier 10T3 shell and tube cooler, fitted with a liquid level sight glass on the side of the shell, and two antifreeze protective devices wired in series with the P406B differential 'pressuretrol', namely, a Ranco 010 pressurestat set at 60 p.s.i. (refrigerant pressure) and a Honeywell L426 thermostat with its bulb set in the entering refrigerant liquid line and set at 36°F. Two L426A thermostats on the chilled water line set at 48°F and 50°F operate the leading refrigeration system. Freon enters through a shut-off valve, filter, expansion valve and final shut-off valve. Liquid level control is via an electrically charged element partly submerged and cooled by liquid Freon. When the level drops, the element temperature rises and the thermostat opens the expansion valve. Any oil in the system floats to the top of the liquid refrigerant and is automatically floated off to the compressor suction line.

(c) A Carrier 5F60 six cylinder compressor direct coupled to a 25 hp motor. This compressor is fitted with renewable cylinder sleeves, forced-feed lubrication, and integral capacity control which unloads the four outer cylinders in sequence as suction pressure falls below the set pressure of 68 p.s.i. A solenoid valve, energised only during the motor accelerating step, by-passes the oil feed to the cylinder loading mechanisms so that only two cylinders are loaded until full motor speed is attained. A 'Control Oil' pressure gauge indicates the number of cylinders loaded. Compressor protection is provided by a Penn Oil Safety Switch which opens circuit on failure of lubricating oil pressure and a Ranco 012 dual pressurestat which stops the 25 hp motor if suction pressure falls below 56 p.s.i., or if discharge pressure exceeds 260 p.s.i. A Ranco 010 pressurestat starts the spray pump of the evaporative condenser [see 3.1 (e)] when discharge pressure reaches 200 p.s.i. During normal operation the compressor gauges indicate as follows:

Suction:	60-75 p.s.i. depending on chilled water return temperature.
Discharge:	160-200 p.s.i. depending on numbers of cylinders loaded and outdoor wet bulb temperature.
Lubricating Oil:	45-55 p.s.i. above simultaneous suction pressure.
Control Oil:	Varies from lubricating oil + 7 p.s.i. (4 cylinders unloaded) to lubricating oil + 30 p.s.i. (all cylinders loaded).

(d) An oil separator in the discharge line from the compressor with an oil return line back to the crankcase. A solenoid valve in the return line is energised with the 25 hp motor. A 100 watt heater in the separator pot and one in the crankcase are energised by contacts on the 25 hp starter so that condensation of Freon in the oil is minimised when the compressor is not in service.

(e) A Carrier 9Q7 evaporative condenser outside the Auxiliary Plant Room, housing 'Aerofin' coils for refrigerant condensing and sub-cooling, a recirculating spray water system with a vertical spindle pump directly connected to a $\frac{1}{4}$ hp motor, and a centrifugal fan Vee belt driven by a 3 hp motor. A liquid receiver separate from the unit but part of the system is piped externally. Eliminator plates are located above the spray heaters which remove entrained moisture from the discharge air. The condensing coil is six-row and the sub-cooling coil is single row. The liquid receiver is a certified pressure vessel with pressure release and liquid test cocks to indicate minimum operating level. The Freon condenses to liquid while passing through the primary cooling coil, to the receiver, then through the sub-cooling coil to remove the final gas traces. It then passes to its cooler where the chilled water temperature is controlled within the range 35°F to 49°F.

3.2 Normal Operation

The following is a summary of the Carrier operating and servicing manual for the refrigeration plant.

3.2.1 Daily

Compressor pressure gauge readings are given in Section 3.1.(c). The compressor oil level should be visible in its sight glass and the crankcase temperature should be neither extremely hot nor chilled.

The setting of any safety or operating control must not be altered without specific approval.

If a compressor fails to start when its corresponding chilled water pump is running and the water temperature is above 53°F, press the reset buttons for the Penn oil safety switch and the Ranco dual pressurestat, and check the thermal overload cut-outs and fuses for the 25 hp motor and corresponding 3 hp evaporative condenser fan motor. If repeated resetting of the Ranco dual pressurestat is necessary, check the evaporative condenser for normal flow of air and water; the fan belt may be broken, the water strainer may be clogged, or the pump thermal overload may be tripped. The Penn oil safety switch needs a couple of minutes to cool before reset can be made. If continuous operation of the compressor cannot be achieved after resetting three or four times, check that the solenoid valve at the corresponding oil separator and the solenoid valve beside the corresponding cooler are both energised when the compressor starts, and oil flow from both are visible in their adjacent flow indicators. Do not alter the setting of either hand valve in these two oil return lines as they have been set by the supplier to provide proper operation. If these oil returns are normal and if liquid level is visible in the sight glass on the side of the corresponding cooler shell when the compressor starts, and if the oil safety reset is still necessary, switch the selector switch to another pump. Ensure that the crankcase heater in the troublesome compressor and the heater in the corresponding oil separator are both energised with the compressor stopped and wait at least 4 hours before restarting.

3.2.2 Weekly (With plant stopped)

Select the duty plant in accordance with maintenance requirements. The level of water in the chilled water make-up tank should be checked.

3.2.3 General

Any fault in the system that cannot be easily rectified must be referred to the Maintenance Supervisor who will arrange for service to be provided by the contractor responsible for specialised maintenance.

4. CHILLED WATER CIRCUITS

The refrigeration circuits are separate from each other. Although there are two independent chilled water circuits, this system has a common supply header and a common return header with respect to the recirculating pumps and coolers.

A diagram of the system is shown in Figure 2. The two independent circuits are:

(a) To and from the Plant Room 43Q7 Weathermaker, whose flow is regulated by a dewpoint thermostat located in the 43Q7 unit which controls a modulating motor operating a 3-way valve in the return line. This chilled water circuit serves the cooling and dehumidifying coil in this Weathermaker.

(b) To and from the six 39S4 Weathermakers within the R.S.B. whose flow is regulated by two thermostats (acting on the averaging principle), one just outside the Control Room door on the left hand side when entering the Control Room, and one of a pair, both situated diametrically opposite the Control Room. These control a modulating motor operating a 3-way valve in the return line.

Of the 3 chilled water pumps, normally only 2 operate according to the chilled water pump sequence selector on the Normal Input Ventilation switchboard.

The make-up head tank for the system is located within the R.S.B. and supplied from the site water reticulation system.

5. HIGH PRESSURE HOT WATER CIRCUITS

The H.P.H.W. flow and return piping serving the six 39S4 Weathermakers within the R.S.B. runs parallel to the chilled water flow and return piping. It is regulated by two thermostats (acting on an averaging principle), one just outside the Control Room door (same unit as in 4(b) above) and one of a pair, both situated diametrically opposite the Control Room. These control a modulating motor operating a 2-way valve located on the return line above and behind switchboard No. 3 in the Auxiliary Plant Room.

The H.P.H.W. flow and return piping to the 43Q7 Weathermaker in the Auxiliary Plant Room serves the pre-heating coil, controlled by a dewpoint thermostat operating a modulating motor associated with a two-way control valve in the return line. It also serves the after-heater coil, controlled by a thermostat operating a modulating motor associated with a two-way control valve, also in the return line.

A diagram of the system is shown in Figure 3. For completeness the Auxiliary Plant Room H.P.H.W. and domestic hot water pipework is also shown.

Nominally each R.S.B. space conditioner (39S4 Weathermaker) is served with 15 gal/hour of H.P.H.W. and the 43Q7 Weathermaker with 70 gal/hour.

6. HONEYWELL CONTROL SYSTEM, MAIN COMPONENTS

6.1 Normal Input System

The following are the Honeywell components of the air conditioning part of the Normal Ventilation System:

1. T92B Thermostat: Location, inside R.S.B. mounted (with item 2, below) opposite item 3, below. Control for R.S.B. chilled water (averages with item 3 below) operates items 4 and 9 below.
2. T92B Thermostat: Inside R.S.B. mounted (with item 1, above) opposite item 3, below. Control for R.S.B. H.P.H.W. (averages with item 3 below). Operates items 5 and 10 below.
3. T92E Thermostat: Inside R.S.B. just outside Control Room. Associated with items 1 and 2 above.
4. M904E Modulating Motor: In Auxiliary Plant Room above 43Q7 Weathermaker. R.S.B. chilled water regulation. Associated with item 1 above and item 9 below.
5. M904E Modulating Motor: Auxiliary Plant Room, above and to the rear of the Ventilation Switchboard. R. S. B. H.P.H.W. regulation. Associated with item 2 above and item 10 below.
6. M904E Modulating Motor: 43Q7 Weathermaker. After-heater coil, H.P.H.W. regulation. Associated with items 11 and 16 below.
7. M904E Modulating Motor: 43Q7 Weathermaker. Preheater coil, H.P.H.W. regulation. Associated with items 12 and 17 below.
8. M904E Modulating Motor: 43Q7 Weathermaker. Chilled water regulation. Associated with items 13 and 17 below.

9. V5013A-3-way Control Valve: Associated with items 1 and 4 above. R.S.B. chilled water regulation.

10. V5011A-2-way Control Valve: Associated with items 2 and 5 above. R.S.B. H.P.H.W. regulation.

11. V5011A-2-way Control Valve: Associated with item 6 above and item 16 below. After heater coil 43Q7, H.P.H.W. regulation.

12. V5011A-2-way Control Valve: Associated with item 7 above and item 17 below. Preheater coil 43Q7, H.P.H.W. regulation.

13. V5013A-3-way Control Valve: Associated with item 8 above and item 17 below. Chilled water regulation 43Q7.

14. Q52F Auxiliary Switch: Attached to chilled water modulating motor (item 4 above) and controls chilled water pumps.

15. Q52F Auxiliary Switch: Attached to chilled water modulating motor (item 8 above) and controls chilled water pumps.

16. T915A Thermostat: Air discharge duct after 43Q7 Weathermaker. Operates items 6 and 11 above.

17. T915B Thermostat: On 43Q7 Weathermaker (dewpoint control) and operates items 7 and 12 above, also items 8 and 13 above.

18 and 19. L426A 2-position Thermostats: Location, chilled water return line from R.S.B. at header. Chilled water controls to operate leading compressor/condenser.

20-22. P406B Pressure Controllers: These are differential pressuretrols across the 10T3 coolers which permit the appropriate compressor to run only if cooler water flow is adequate.

NOTE: This list excludes some Honeywell thermostats intimately associated with the liquid refrigerant system.

6.2 Normal Extract System

A damper, electrically operated, is situated in the Main Extract ductwork within the R.S.B. and behind the helium gas holder. This damper, commonly referred to as the 'Branch Damper', is push button controlled from the E.C.R. with test buttons inside the R.S.B.

Its operation forms part of the air scrubber operation when the shell air is being recirculated for cleaning purposes, and is normally left in the fully open position.

For operation the damper is linked to a Honeywell M904E modulating motor.

7. BUILDING SEALS

Under certain reactor conditions, for example, COMPLETE TRIP, it is essential that both the Normal Ventilation Input and Extract Systems are effectively sealed from the shell. This is automatically effected by a water seal and an electro-pneumatically operated Ponsford isolating valve in each system.

7.1 Input Water Seal

This seal is located external to the R.S.B. and just before the Input Ventilation ducting enters the shell. Its head tank, of approximately 150 gallons, has both its make-up water supply and flooding line to the seal pneumatically controlled and interlocked so that while one is held open the other is held shut and vice versa to prevent overflowing the seal when flooded. A pressurestat is incorporated in the system which arranges for the flooding valve to fail safe, that is, flood the seal on failure of the HIFAR service air supply.

The seal is either completely empty or full. It is fitted with a Mobray Magnetic level switch which provides for indication on the 3 mimic control panels (Control Room, E.C.R. and Auxiliary Plant Room) of the condition of the seal. It drains to the North Delay Tanks via a manually operated valve and an electrically operated F.R. Sauter type of drain valve which also can be hand operated in the event of electrical failure. This drain valve is normally operated from the E.C.R. in sequence with the shell unsealing procedure (see Section 11.2).

Apart from the automatic flooding of the seals, provision exists for independently flooding them via the operation of a push button on the Control Room mimic diagram panel.

The solenoids associated with tank filling and seal flooding valves and also the Sauter drain valve are operated by a 240V d.c. supply from the No. 1 Sub-station batteries.

7.2 Ponsford Valves

The inlet and outlet Ponsford valves are similar in all respects. Each normally acts simultaneously with its associated water seal. The inlet Ponsford valve is located inside the R.S.B. immediately after the entry of the Main Input system into the R.S.B. and the outlet Ponsford valve is located immediately after the outlet from the shell of the Main Extract System.

The general arrangement of the Ponsford operating mechanism is shown in Figure 4. Its operation is as follows (the numbers relate to components in accordance with the manufacturer's drawings):

7.2.1 Pneumatic operation

(a) To Close: The air supply enters air filter (27) at 100 p.s.i. passes through lubricator (28) and into solenoid valve (23). From the solenoid valve it passes up through air connection (22) to the regulator (19). This is attached to the cylinder for piston (17) which pushes the main rack with piston (18), driving pinion (30) and its main shaft (7) to rotate through 90°. This in turn turns the damper shoes, and closes the damper. As ratchet (16) traverses with piston (18), ratchet lock (13) locks ratchet (16) at the end of the stroke. When the damper has been closed and the 'open' operation started, the air in the cylinder for piston (17) is exhausted by solenoid valve (23).

(b) To Open: The air passes through filtration unit (29) to solenoid valve (23), as for the closing operation. From the solenoid valve it passes through connection (21) to minor cylinder (14), compressing spring (32) thus releasing ratchet lock (13) and allowing air to pass through connection (20) into the cylinder for piston (18), thus forcing the main rack back into the cylinder for piston (17). This is the reverse of the operation 'To Close'.

7.2.2 Hand operation

Shut off the air supply (24). With the key provided, bleed off valves (26). Release lever (11) by cam (8). The ratchet lock (13) will thus disengage from ratchet (16). To operate the damper by hand, push the capstan wheel (10) forward to engage pinion (31) (on the capstan wheel shaft) with the main rack. Rotation of capstan wheel (10) anticlockwise will close the damper, and clockwise, will open the damper. Before returning the Ponsford valve to pneumatic operation ensure:

(1) that capstan wheel (10) is pulled back to the neutral position, and

(2) that bleed valves (26) are fully closed.

NOTE: For hand operation this procedure must be adhered to. If not strictly followed a hazardous situation can arise.

7.3 Extract Water Seal

The extract water seal is similar in virtually all respects to the inlet seal. It is located immediately after the extract Ponsford valve where the extract system leaves the shell.

The seal drain, however, is manually operated from within the E.C.R. in sequence with the shell unsealing procedure. The extract seal drains to the South Delay Tanks.

8. BUILDING INTERIOR

8.1 39S4 Weathermakers (Space Conditioners)

Provision exists for six of these units to be fitted around the interior of the building, each served with H.P.H.W. and recirculating chilled water. Each can be fitted with a viscous air filter removable for periodic cleaning if required. The basic components of each unit are:

- 'Aerofin' chilled water six row coil for air cooling and dehumidifying.
- An assembly of two centrifugal fan wheels driven by 2 hp motor.
- 'Aerofin' H.P.H.W. coil.

These Weathermakers continually recirculate the air within the R.S.B. to maintain nominal atmospheric conditions between a summer maximum of 70°F with 60 per cent relative humidity and a winter minimum of 65°F with 50 per cent relative humidity. The modulating thermostats and associated controls are described in Sections 4, 5 and 6.

Each unit has its own stop/start controls. Normally all units run continuously under all reactor conditions. Those units located within the reactor top gallery are fitted with input and output air flow deflectors to prevent their delivery air streams from impinging on personnel passing by.

The moisture drain from each unit runs into the normal R.S.B. effluent system.

These Weathermaker units were installed to facilitate reduction of atmospheric pressure within the R.S.B. should this pressure become excessive owing to any accident condition. However, because of their H.P.H.W. heating facility, they have been incorporated within the air conditioning part of the Main Ventilation System. Current locations are:

No. 1 is not in use.

No. 2 is approximately opposite face 5 of the reactor.

No. 3 is approximately opposite face 7 of the reactor.

No. 4 is approximately opposite face 10 of the reactor.

No. 5 is approximately opposite face 8 of the reactor.

No. 6 is approximately opposite face 4 of the reactor.)

8.2 Control Room Ventilation

A 19 inch Aerex axial flow fan is mounted on the spindle of a 1425 rev/min $\frac{1}{2}$ hp motor, all located within the exhaust ducting above and leading from the Control Room and exhausting into the R.S.B. atmosphere.

This fan normally runs continuously under all reactor conditions. Its nominal capacity is 1800 ft^3/min. This system extracts air from behind and above each of the nine instrument panels of the Control Room. The inlet grilles serving the rear of panels 1, 2, 8 and 9 are each of 150 ft^3/min nominal capacity and those of panels 3, 4, 5, 6 and 7 of 200 ft^3/min and all grille assemblies have a hand operated variable damper. The side external walls of the Control Room and the doors to the rear of the Control Room all have grilles to permit the inward flow of make-up cooling air.

The fan on/off control is within the Control Room and at the reactor top level. An isolating switch is mounted on the duct above the Control Room.

8.3 Input and Extract Ductwork

8.3.1 Input ductwork

All normal input air to the R.S.B. is introduced via two 36 in x 12 in Universal outlets. The cross section of the ductwork is 20 in x 21 in from the 43Q7 Weathermaker to the first outlet where a Pearson stream splitter is fitted and is 12 in x 21 in to where the second outlet terminates the inlet ducting. The approximate position of these outlets is shown in Figure 1.

The ductwork from the Weathermaker to the R.S.B. inlet is thermally insulated and the lagging is metal sheathed at the inlet water seal.

Each Universal outlet delivers a nominal 2250 ft^3/min into the R.S.B.

All ducting is of 16 s.w.g. with $\frac{1}{8}$ in thick rubber gaskets between flanged joints.

8.3.2 Extract ductwork

The main ductwork of the Extract System within the R.S.B. is shown in Figure 5. The main points of extract are:

- Centre top ceiling of R.S.B., triple 9 in x 5 in grille.
- Main 49 in x 23 in extract grille opposite face 4 of the reactor.
- Experimental Cooling Plant Room, 18 in x 3 in grille.
- B.O.E. unit.
- Irradiation Block area, ground floor, 14 in x 5 in grille.
- Above H_2O cooling pipework, ground floor. 14 in x 5 in grille.
- Connection for Porto-Vac, above helium pumps.
- Both recombiner units.
- Storage block and B.F.E. port vents. 2 in and 1 in dia. pipes.

Normally the total quantity of air extracted is 4500 ft^3/min of which 3500 ft^3/min is drawn through the main 49 in x 23 in grille opposite face 4 of the reactor. The so-called 'Branch Damper' is immediately down-stream of this main intake grille and is controllable from the E.C.R. but normally left in the fully open position.

All ductwork is constructed in 16 s.w.g. plate with $\frac{1}{8}$ in thick rubber gaskets between flanged joints.

9. AIR EXHAUST

The main components of the Normal Extract System, apart from the seal and Ponsford valve as described in Section 7, are filters and monitors as well as extract fans and stack dispersal.

9.1 Filters and Monitors

There are two separate filter and monitor assemblies, each consisting of 3 banks of 3 Vokes Multivee filters per bank and two monitors (see Figure 6).

The Multivee filters have a medium of cellulose material supported on insect screen wire. Their dimensions are $19\frac{3}{4}$ in x $19\frac{3}{4}$ in x 2 in. At an initial pressure drop of 0.30 in w.g. at 600 ft^3/min they have an efficiency up to 99.9 per cent for particles down to 5 microns.

Across each filter bank is fitted a Vokes manometer, range 0 - 3 in w.g. to indicate pressure drop across the assembly which normally should not be permitted to exceed 2.5 in w.g.

The filter housings have been modified from the original design which necessitated the use of the permanently installed gantry. Each bank of 3 filters can be separately withdrawn; the top and bottom banks, from one side, and the middle bank from the other.

When required, the filters are changed by the Works and Operations Section who, in conjunction with the Safety Section and after determination of the degree of activity (if any), on the filters, decide which technique of filter changing is to be adopted, that is, polythene sealed bag system or otherwise.

Downstream of each of the filter assemblies and contained within the filter housings are two gamma monitor heads associated with I.D.L. type 1529A logarithmic amplifiers located within the lower portion of Control Room panel No. 8. The amplifiers provide contacts for use in the reactor safety circuits. With respect to either pair, if one monitor detects a pre-set level of activity a warning is given. If both monitors simultaneously detect a dose rate above the high trip level setting then the reactor is automatically shut down to the COMPLETE SHUTDOWN state.

(The current settings for these operations are:

Low level warning	2.5 mR/hour
High level trip	1,000 mR/hour.)

It is possible to by-pass the SHUTDOWN condition should the filters ever be required to be changed while the reactor is operating.

For further information on these monitors see Manuals AAEC/M28 and AAEC/M29.

9.2 Fans and Dispersal

The two main extract fans are Richardson 4CL type each of 4,500 ft^3/min capacity and driven by a 5 hp motor. Normally only one fan and one filter/monitor assembly are in use although both fans and both filter/monitor assemblies may be utilised, for example, during reactor start-up or excessive release within the R.S.B.

The arrangement permits either filter/monitor assembly to be used with either fan via the interconnection of the fan suctions and the use of hand operated isolating dampers before and after each of the four main components.

Each of the eight hand-operated isolating dampers is fitted with micro-switches to facilitate indication of condition at the 3 mimic control panels.

The microswitches on the dampers associated with the fan form part of the d.c. control circuits of the motor starter contactors. Thus both inlet and outlet damper of either fan must be fully open before that fan can be started. Similarly the dampers on at least one filter assembly must be fully open.

Figure 6 shows a general arrangement of the Normal Extract plant layout.

Both fans discharge into a common 20 in x 21 in duct leading to the centre outside top of the R.S.B. for discharge and dispersal through a stack of at least twice the height of surrounding buildings. Considerable dilution occurs between the point of discharge and the ground. The exhaust velocity from the stack should be $1\frac{1}{2}$ times prevailing wind speeds to avoid down-wash effects.

10. ELECTRICAL

10.1 Input System (See Figure 8)

The Input Ventilation Switchboard is in the Auxiliary Plant Room office and is fed from the Standby Switchboard via a 150 amp fuse switch labelled P40.

Externally it contains compressor ammeters, chilled water pump ammeters, plant push buttons start/stop, control selector auto/manual/off, chilled water pumps sequence selector 1-3, 2-3, and 1-2. A voltmeter provides the technician with an indication of the Reactor Instrumentation bus-bar voltage.

Internally it contains all space conditioner motor fuses, stop/reset buttons, as well as contactors, time delays, fuses, auto/test switches, overloads, etc., for permitting normal complete automatic operation of the plant.

The time delay circuits form part of the starting-up sequence (see Section 11).

The auto/test switches allow various units to be switched out of the automatic operation to permit manual control for maintenance and testing.

10.2 Extract System

The main electrical aspect of the Extract system is the two 5 hp motors associated with the Extract fans.

These motors are supplied from the Standby Switchboard via a 60 amp fuse switch labelled P36. The fuses and main contactors with stop/start and reset buttons are located within Kiosk C immediately adjacent to the Extract fan assemblies. These contactors can be remotely operated from the E.C.R. and Auxiliary Plant Room via 240 volt d.c. solenoids.

10.3 D.C. Voltage System

There is no d.c. voltage control in the Input air conditioning system. 240 V d.c. comes from No. 1 Sub-station batteries, and as far as the main overall ventilation system is concerned, electrically serves the following:

(a) Ponsford valves, Inlet and Extract.

(b) Water Seals, Inlet and Extract.

(c) All push button controls associated with the 2 mimic panels (except those for stop/start 'Input fan'), E.C.R. and Auxiliary Plant Room.

(d) All controls associated with both Normal Extract fans at Kiosk C.

Note that this d.c. supply from No. 1 Sub-station also provides all control power for the main Auxiliary Plant Room switchboards and has no connection with the 'guaranteed supply' batteries in the Auxiliary Plant Room.

10.4 Mimics and Control

The 3 mimic control panels are located as follows:

(1) Control Room in R.S.B.

(ii) E.C.R.

(iii) Auxiliary Plant Room.

Each control panel indicates the operating condition of both the Normal Ventilation System and the Air Cleansing System, all air lock doors and two drain valves. The mimic arrangement is shown in Figure 9. However, it should be noted that the D_2O plant room and experimental facilities purge, as indicated on these panels are now connected to the Active Ventilation System. Each mimic panel has its own associated controls as follows (with respect to the Normal Ventilation System only):

LOCATION	CONTROLS
(i) Control Room in R.S.B.	Seal Building
(ii) E.C.R.	Normal Extract
	Start/Stop, No. 1 Extract Fan
	Start/Stop, No. 2 Extract Fan
	Start, Extract Water Seal
	Open/Close, Extract Damper (Ponsford)
	Open/Close, Branch Damper (in R.S.B.)
	Normal Input
	Open/Close, Input Damper (Ponsford)
	Open/Close, Input Water Seal Drain
	Start, Input Water Seal
	Start/Stop, Input Fan
	Seal
	Vent. Scram. Cancel. Reset.

LOCATION (Continued)	CONTROLS (Continued)
(iii) Auxiliary Plant Room	Normal Extract Start/Stop, No. 1 Extract Fan Start/Stop, No. 2 Extract Fan Start, Seal Flooding Open/Close Extract Damper (Ponsford) Normal Input Open/Close, Input Damper (Ponsford) Start, Seal Flooding Start/Stop, Input Fan

11. SYSTEM OPERATION

11.1 Normal Operation

11.1.1 Starting up

In most active ventilation systems the extract aspect of the system is always first to be started up. Normally electrical interlocks dictate this procedure although such facilities do not exist in this system. However, starting up should proceed as follows:

Extract System

(a) Ensure electrical supply is available, both a.c. and d.c.

(b) Ensure compressed air supply is available(General Service (G.S)).

(c) Ensure correct indicating lamps are showing on all mimic panels.

(d) Ensure gamma-health monitors are operative.

(e) Select extract fan and filter/monitor assembly for operation, and operate hand isolating dampers accordingly.

(f) Check that water seal is empty and that extract Ponsford damper is open.

(g) Check seal flooding tank water level and controls.

(h) Open branch damper inside R.S.B.

(i) Start selected extract fan, check fan for normal running.

(j) Check that filter pressure drop is not excessive, and that all mimic panels indicate correctly.

Input System

(a) As with the extract system, ensure electrical supply, compressed air supply, mimic lighting, water seal empty and Ponsford valve open.

(b) Check H.P.H.W. and chilled water circuits for normal operation.

(c) At switchboard:

Select for automatic operation, and required sequence for chilled water pumps.

Press START button and in sequence the following should start up.

- Chilled water pumps.
- Compressor and condenser fan.
- Space conditioners (inside R.S.B.)
- Input fan and 43Q7 Weathermaker pump.

(d) Check for normal current on chilled water pump motors (8 amps) and compressor motors (25 amps).

(e) Check for normal pressure/temperature readings, sight glasses etc., associated with the refrigeration plant.
Confirm correct operation of operating evaporative condenser, spray system, ball valve, fan, etc., (see Section 3).

(f) Check that no motors are overheating.

(g) Confirm that R.S.B. space conditioners are operating normally (heating, cooling, fans).

11.1.2 Normal running

Because the Input System is fully automatic no manual adjustment should be necessary. However at least every two hours the plant must be inspected and normal running confirmed. In particular the following should be checked.

- All compressor gauges
- All temperature indications
- Oil levels in sight glasses
- Chilled water pump gauges and temperatures
- Motor currents and motors not overheating

The Extract System also requires general inspection at least every two hours.

11.1.3 Shutting down

Complete shutting down of both systems is effected by pressing the respective STOP buttons. Complete shutting down of the R.S.B. Normal Ventilation System should, however, be a rare occurrence.

11.2 HIFAR Sealed Building Condition

An important aspect of operation of the Main Ventilation System is the procedure to be adopted after a HIFAR SEALED BUILDING condition which can be precipitated by:

(1) Pressing the SCRAM button.

(2) A complete reactor trip.

(3) Pressing the Seal Building button (Control Room mimic).

(4) Failure of the general service (G.S.) compressed air supply to the control circuits.

(5) Failure of d.c. supply from No. 1 Sub-station batteries.

Functions (1), (2), (3) and (5) above result in the interruption of the 240V d.c. power supply to the solenoid control valves associated with the Input and Extract seals as described in Section 7.1.

These are all open when energised, that is, the solenoid valve allows air to keep the flooding valve closed and the water solenoid valve allows water through to the head tank ball float control valve.

When de-energised these solenoid valves close, shutting off the air supply to the flooding valves which then open by spring actuation and flood the seals. Simultaneously the water supply to the head tanks is shut off allowing no more water than the capacity of the tanks to enter the seals.

In addition both Ponsford valves close and the duty Extract fan stops.

Function (4) above involves a Honeywell pressure switch in series with each pair of the above-mentioned solenoids arranged to disconnect the 240V d.c. power supply when the G.S. air pressure falls below 11 p.s.i. In this case the Ponsford valves and operation of the duty Extract fan is not affected. To permit re-setting the air pressure must return to at least 16 p.s.i.

After appropriate attention to the function which precipitated the SEALED BUILDING Condition the Normal Ventilation System is usually returned to normal operation immediately, by adoption of the following procedure within the E.C.R.:

(1) On the mimic control panel press the top Seal button.

(2) Press the bottom Seal button (after pause).

(3) Open the hand operated valve, Waste from Normal Extract Seal. (Ensure that it is fully open in order to operate the micro-switch on the valve spindle, which in turn energises the air and water solenoid valves

associated with the Main Extract seal, thus closing the flooding valve and allowing the head tank to refill).

(4) Press the Open button of Input Water Seal Drain.
Although the red lamp lights up immediately, it takes about one minute for the valve to open fully.
Wait until both Seal Flooded lamps show that both seals are empty, (that is, both green lamps are illuminated).

(5) Close the hand-operated valve Waste from Normal Extract Seal.

(6) Press the Close button on the Input Water Seal Drain. (Valve must be fully closed before the indicator light goes out).

(7) Press the Open button on Input Damper (Ponsford).

(8) Press the Open button on Extract Damper (Ponsford).

(9) Press the Start button on duty Extract Fan.

The system should now be normal but the following should be checked:

Normal input fan and refrigeration system although these do not cease operation on a Sealed Building Condition.
Both Ponsford valves open.
Both seals empty and drains shut.
Both head tanks filled (or filling).

Note: The Input seal drains to the North Delay Tanks and the Extract seal drains to the South Delay Tanks. (This water is classified as type B effluent (possibly active); its handling at the delay tanks is the responsibility of the Waste Operations Group.)

12. SAFETY FEATURES

Neither the CONTROL REVERSAL nor the RESTRICTED TRIP condition of the reactor will affect the operation of the Normal Ventilation System. However, the following contingencies apply:

1. Complete Reactor Trip

The Ponsford valves in the Normal Input and Extract ducts will close. at the same time the Extract fan will automatically stop but the Input fan and space conditioners within the R.S.B. will continue to operate. The Input fan cannot be stopped without stopping the space conditioners and these must be kept running to control the temperature within the R.S.B. Both Input and Extract water seals will flood. The Normal Input fan is not capable of blowing water from the seal during the flooding operation.

2. Failure of Supply from No. 1 Sub-station Batteries

The Ponsford valves in the Normal Input and Extract ducts will close. The pneumatic flooding valves will fail safe, flooding the Normal Input and Extract seals. The condition of normal mains supply will remain unchanged and any electrical switching will need to be done manually. The reactor operation is also affected. A COMPLETE TRIP will follow the loss of Instrumentation Voltage as the motor/alternator set runs down.

3. Failure of Supply from the Auxiliary Plant Room Batteries

This has no effect on the Normal Ventilation System

4. Failure of HIFAR General Service Air Supply

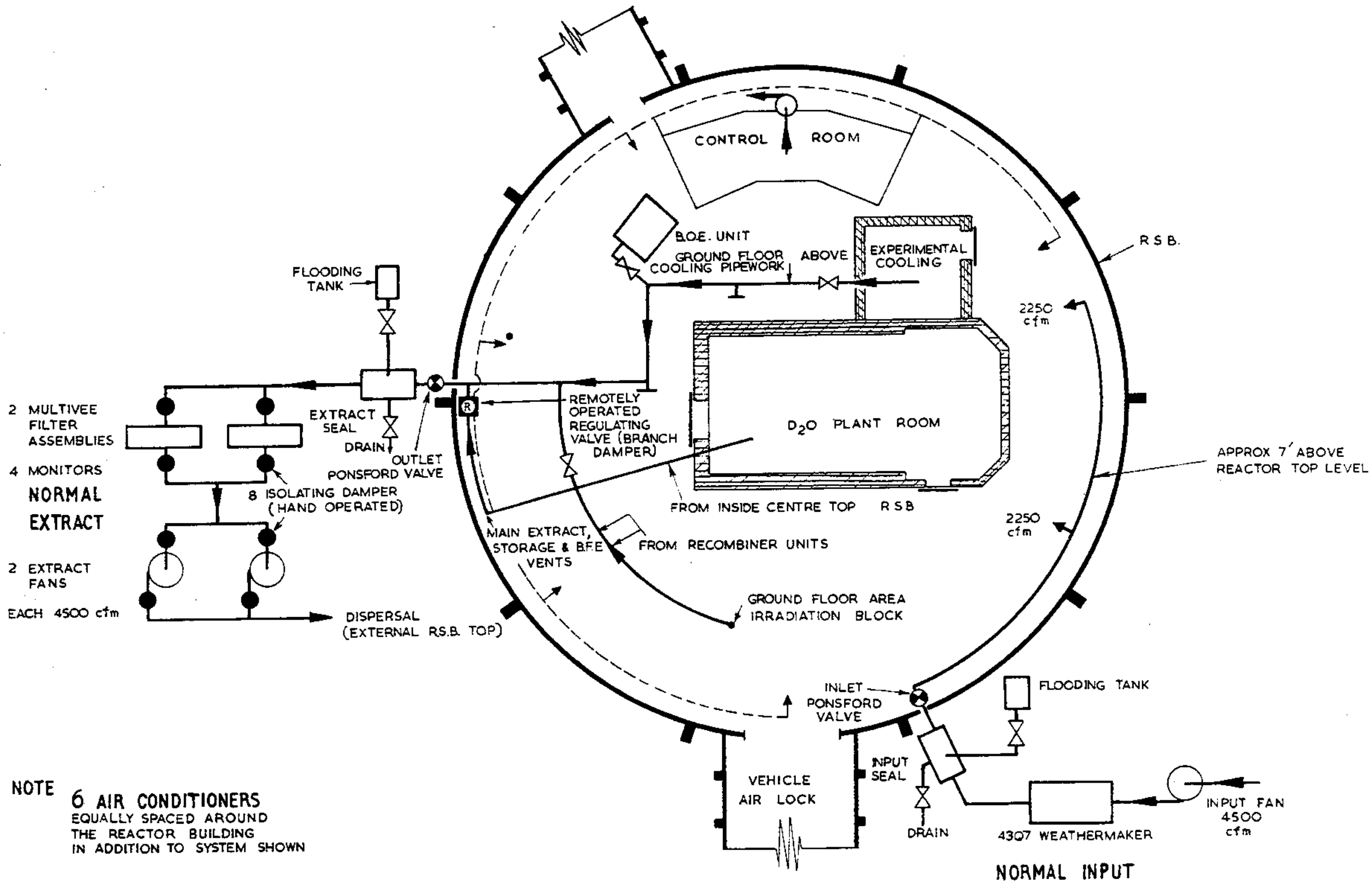
The Ponsford valves in the normal Input and Extract ducts will remain open. The pneumatic flooding valves will fail safe, flooding both seals.

5. Mains Failure

The reactor will shut down, as will all fans in the Normal Ventilation System, refrigeration plant, air compressors etc. The R.S.B. can be sealed by pushing either the SCRAM or SEAL BUILDING buttons.

13. ACKNOWLEDGEMENTS

A considerable portion of the Manual was derived from HIFAR files and records, the Carrier Air Conditioning operating and servicing manual for the refrigeration plant and the minutes of the Ventilation Safety Committee. Substantial assistance was also given by members of the HIFAR operating and maintenance staff in compiling the technical data.



NOTE 6 AIR CONDITIONERS EQUALLY SPACED AROUND THE REACTOR BUILDING IN ADDITION TO SYSTEM SHOWN

FIGURE 1. NORMAL VENTILATION OF HIFAR REACTOR SEALED BUILDING

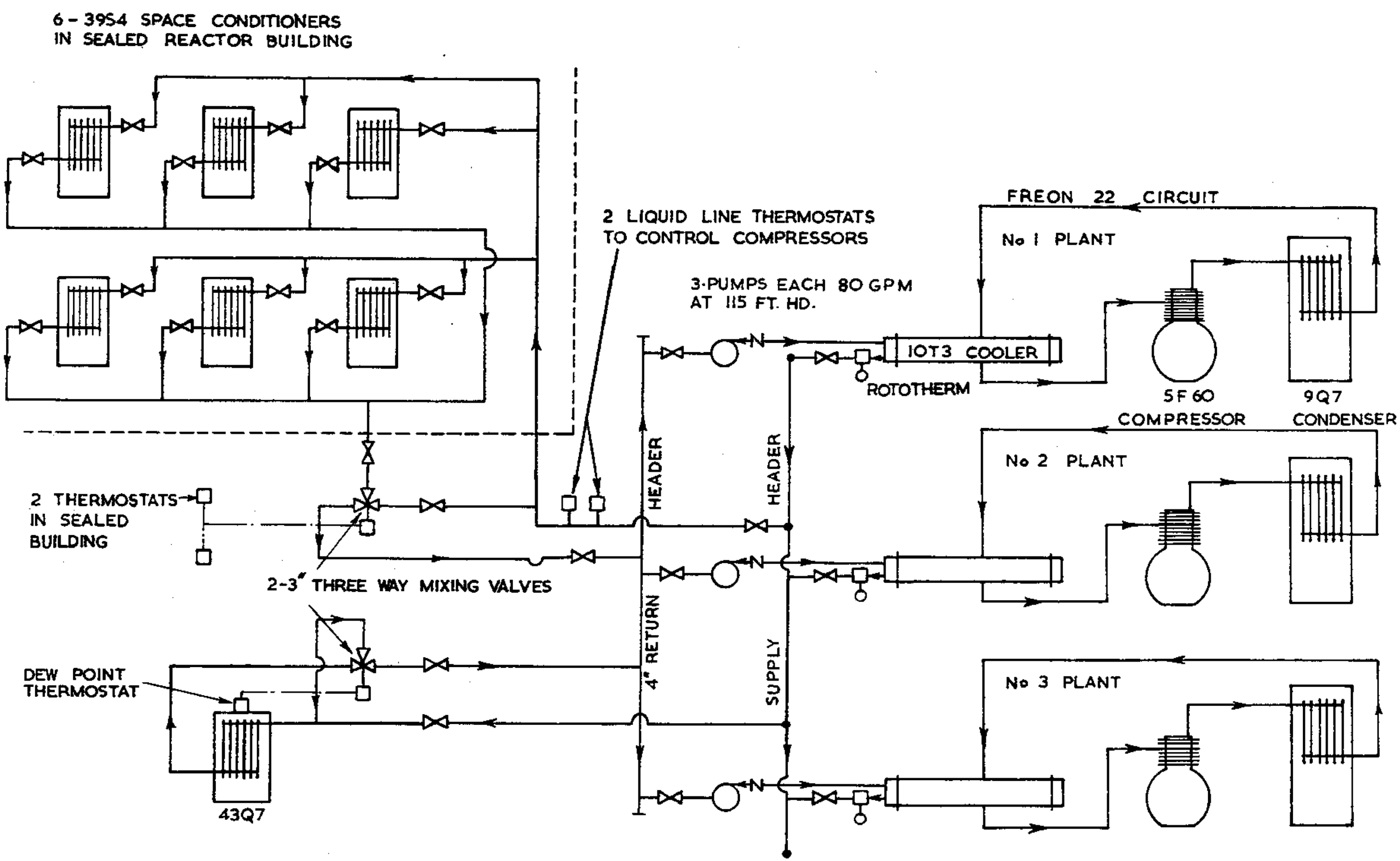


FIGURE 2. DIAGRAMMATIC ARRANGEMENT OF CHILLED WATER REFRIGERATION SYSTEM

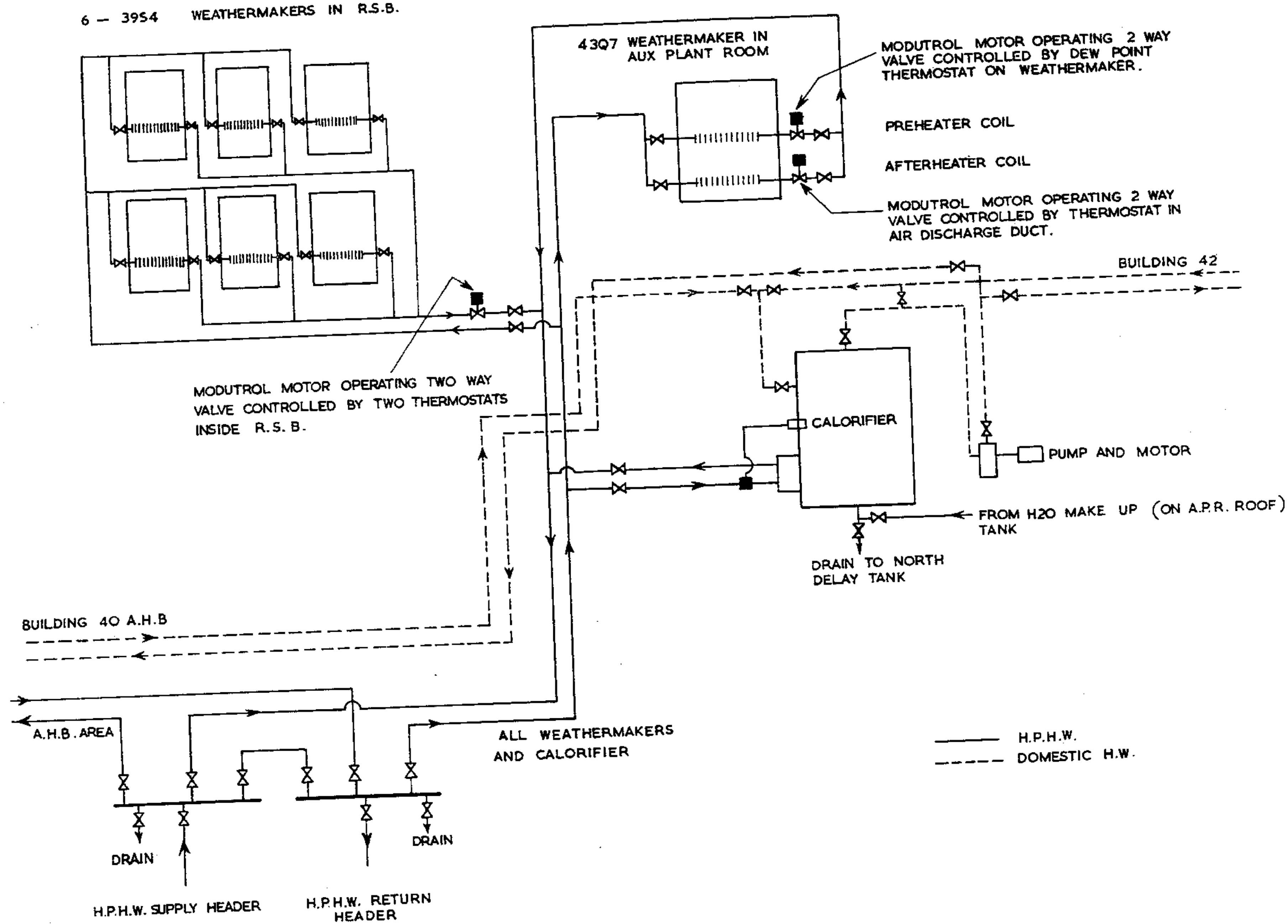
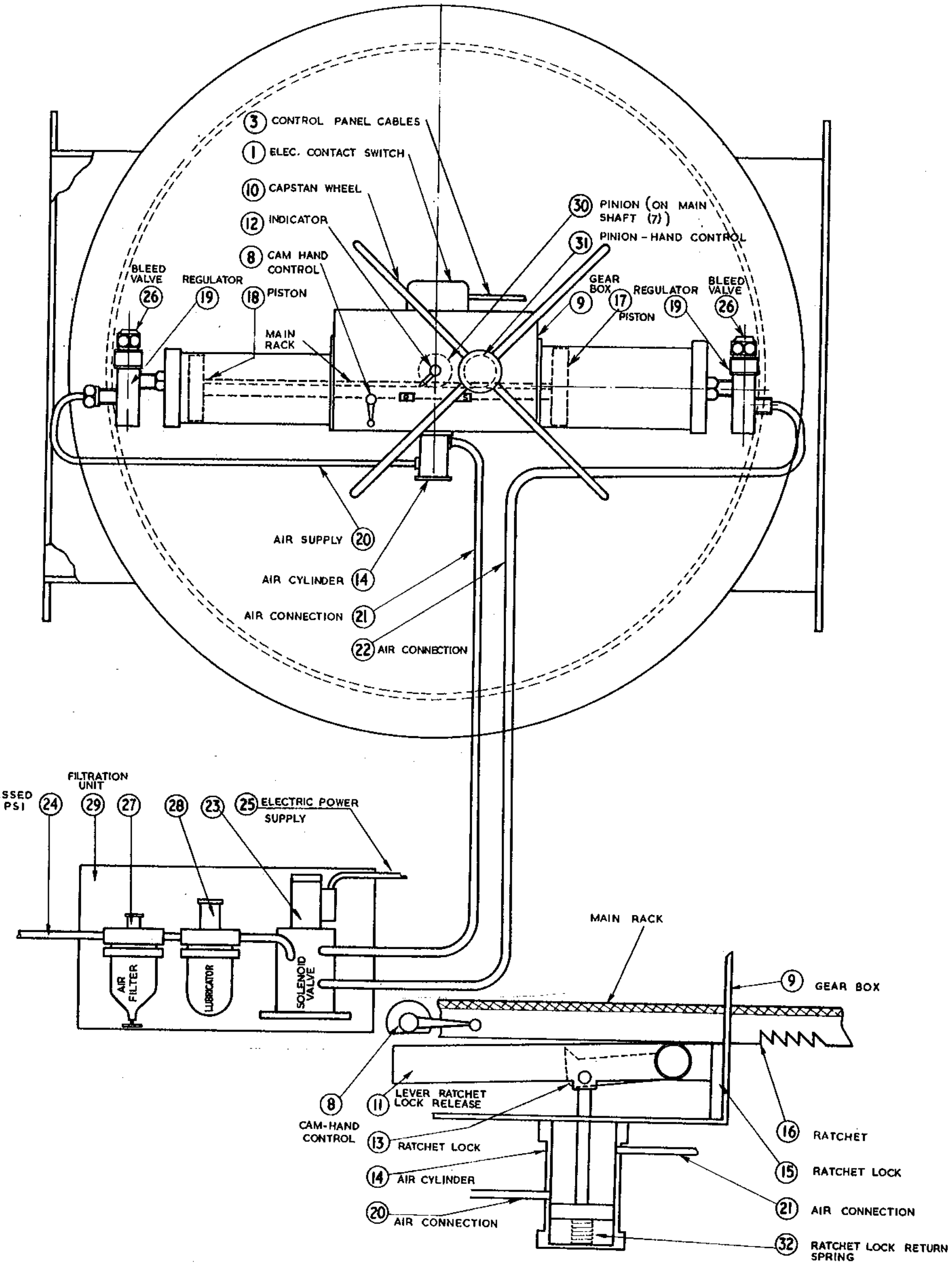


FIGURE 3. H.P.H.W. PIPEWORK AUXILIARY PLANT ROOM, NORMAL INPUT VENTILATION SYSTEM



SECTIONAL DETAIL OF RATCHET LOCKING MECHANISM IN DISENGAGED POSITION (DAMPER OPEN)

FIGURE 4. PONSFORD VALVE ARRANGEMENT

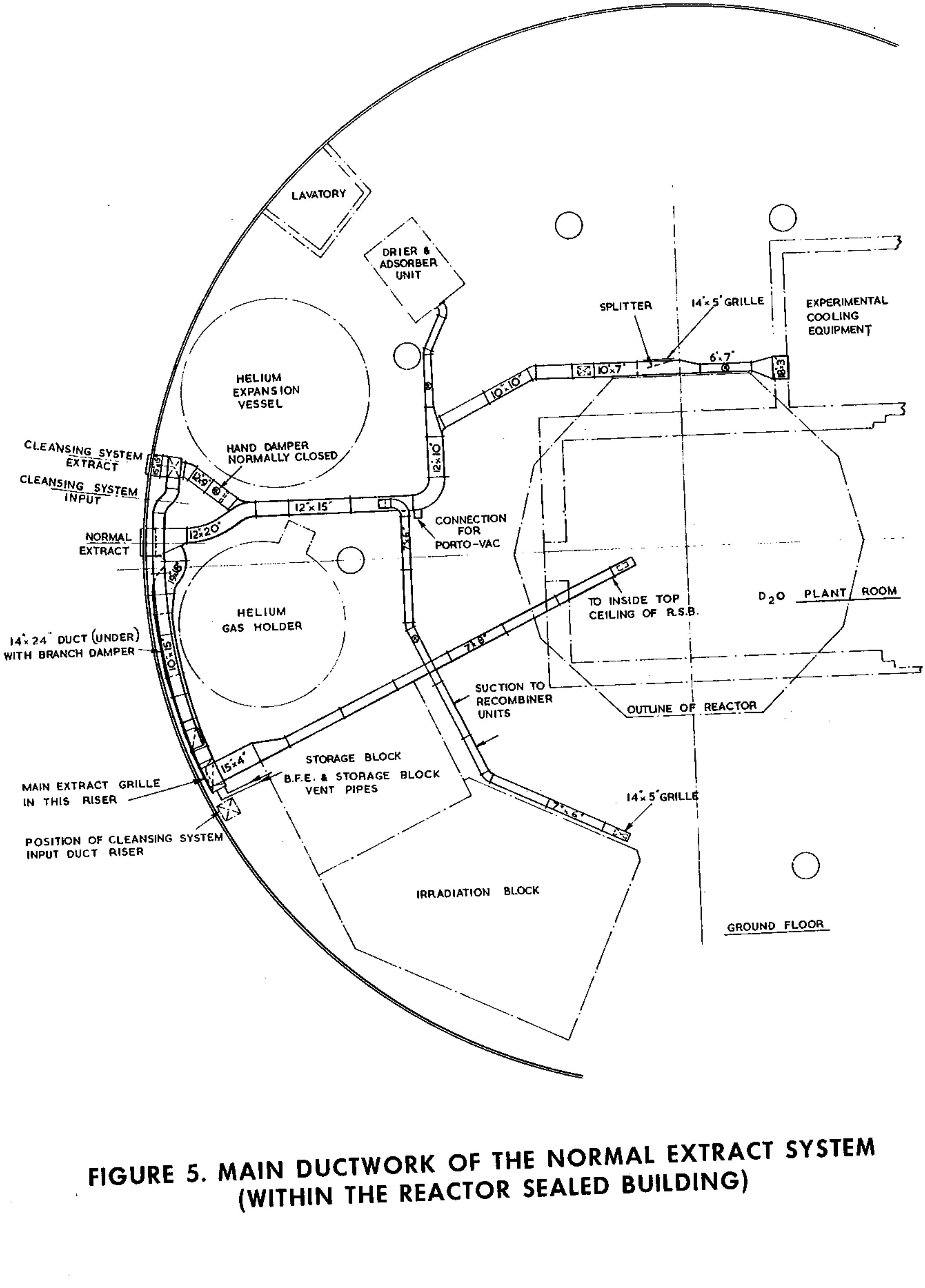


FIGURE 5. MAIN DUCTWORK OF THE NORMAL EXTRACT SYSTEM (WITHIN THE REACTOR SEALED BUILDING)

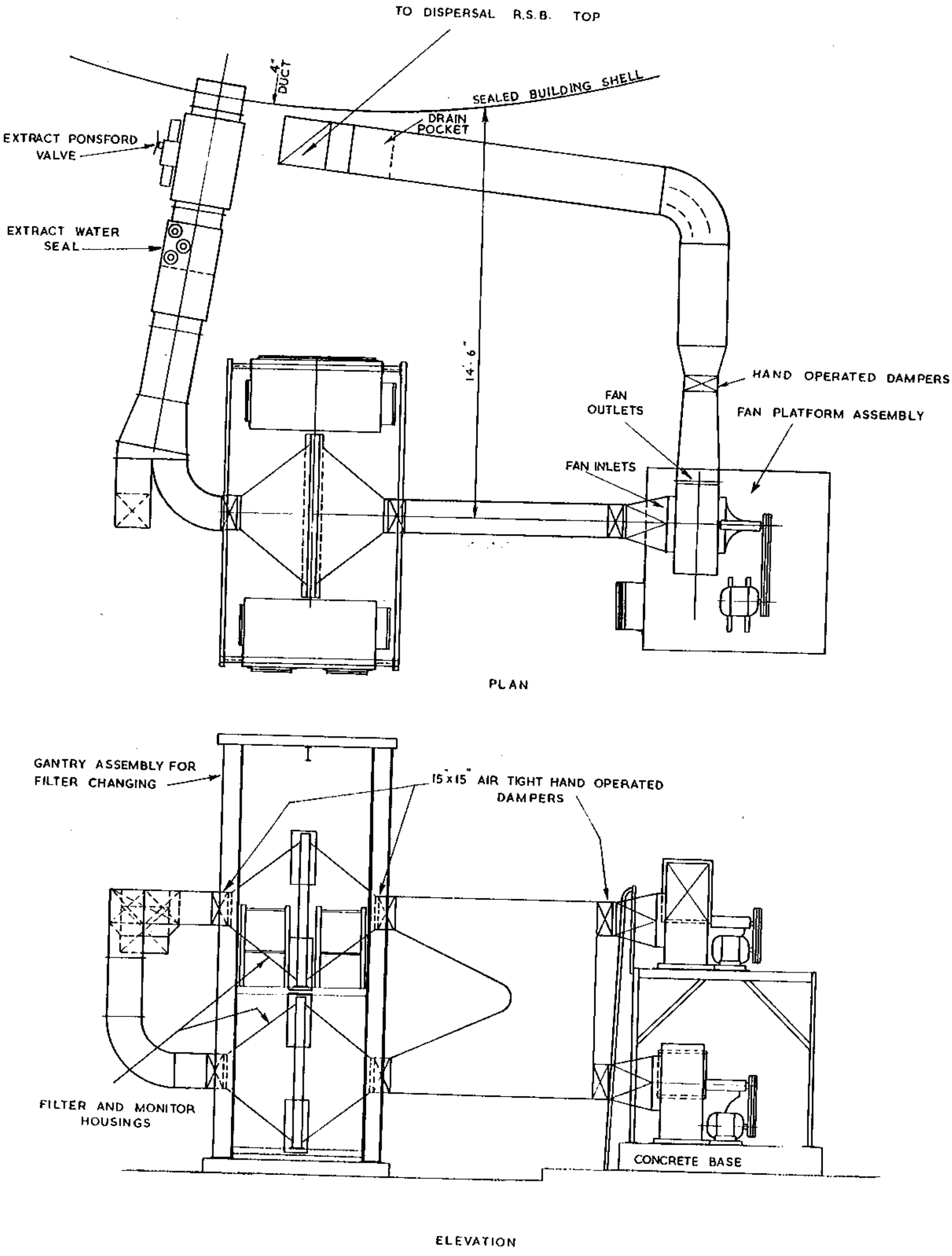


FIGURE 6. NORMAL EXTRACT PLANT LAYOUT

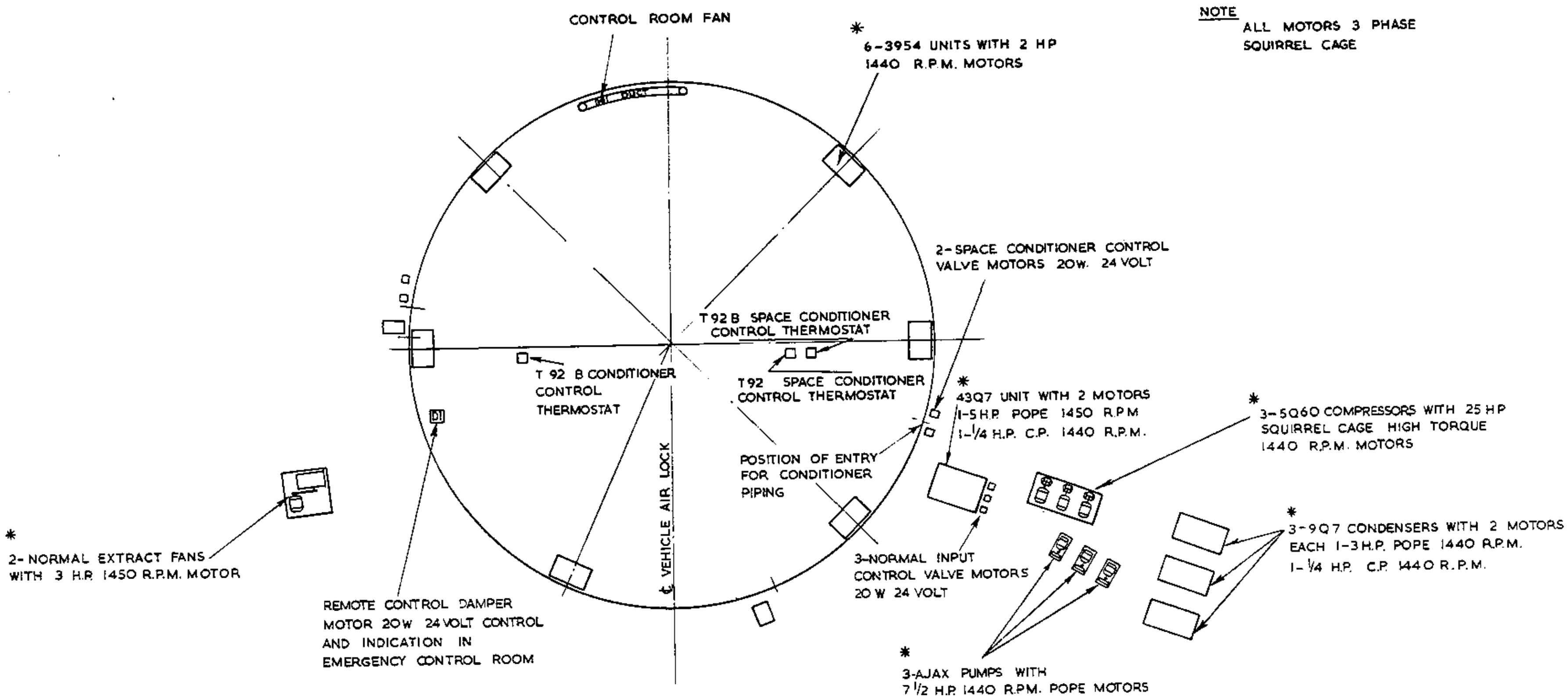
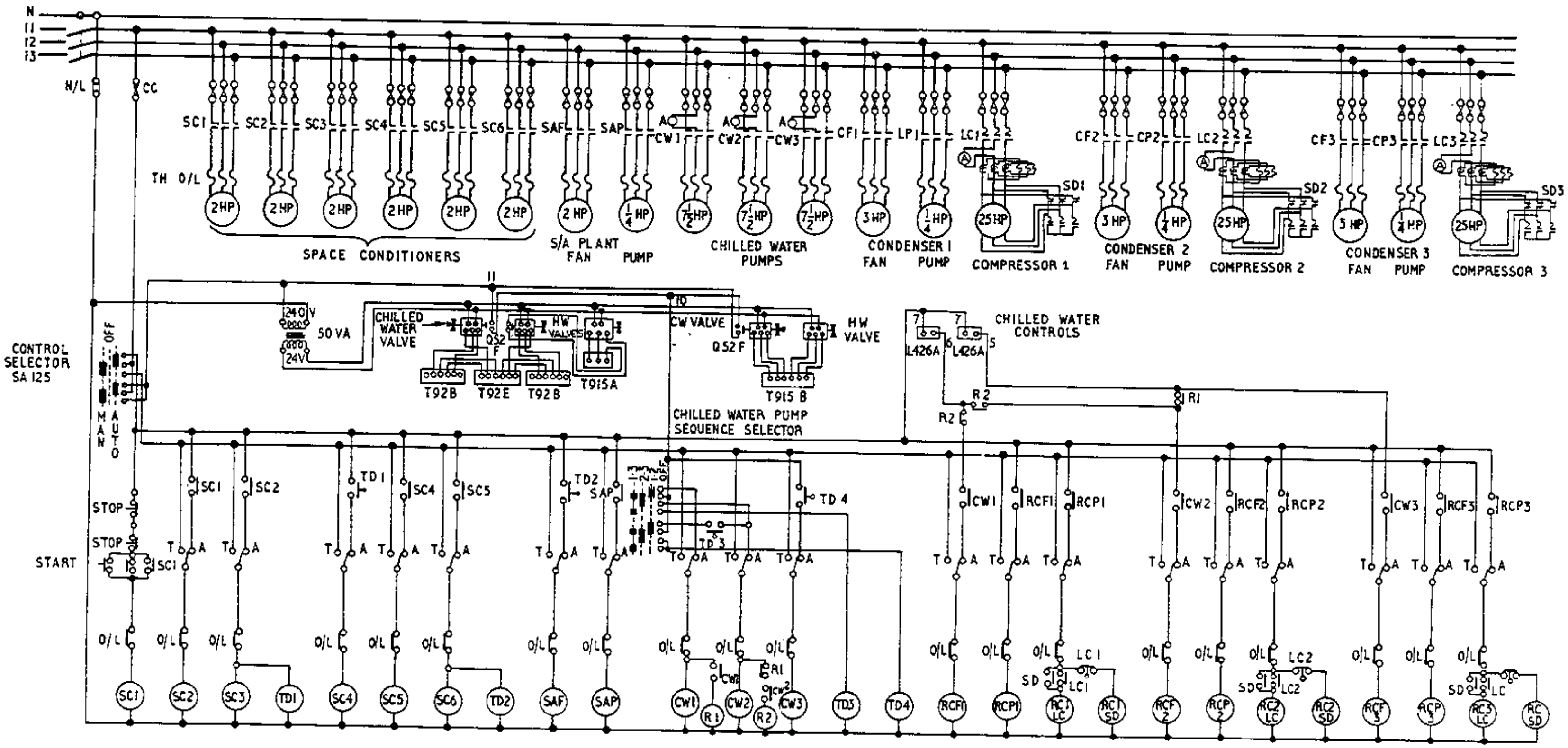


FIGURE 7. EQUIPMENT LAYOUT GIVING ELECTRICAL DATA



SC. SPACE CONDITIONER
SAF SUPPLY AIR FAN
SAP SUPPLY AIR PUMP
RCF. CONDENSER FAN
RCP. CONDENSER PUMP

RC-LC COMP LINE CONTACTORS
RC-SD COMP STAR-DELTA CONTACTORS
C.W CHILLED WATER PUMP
CRS. COOLER RETURN SOLENOID
ORS. OIL RETURN SOLENOID

U.S.V. UNLOADER SOLENOID VALVE
L.M.H LEVEL-MASTER HEATER
C.C.H. CRANKCASE HEATER
O.S.H OIL SEPARATOR HEATER
O.S.S. OIL SAFETY SWITCH

T.D. TIME DELAY RELAYS
R (1-5) RELAYS
O/L OVERLOAD
HP/LP HIGH PRESSURE LOW PRESSURE
CP CONDENSER PUMP PRESSURE STAT.

T 92 B, T 92 E, T 915A, L 426A } THERMOSTATS
Q 52 F. AUX SWITCH
P 406 B DIFF PRESSURE SWITCH

FIGURE 8. SCHEMATIC DIAGRAM OF AIR CONDITIONING CONTROL UNIT

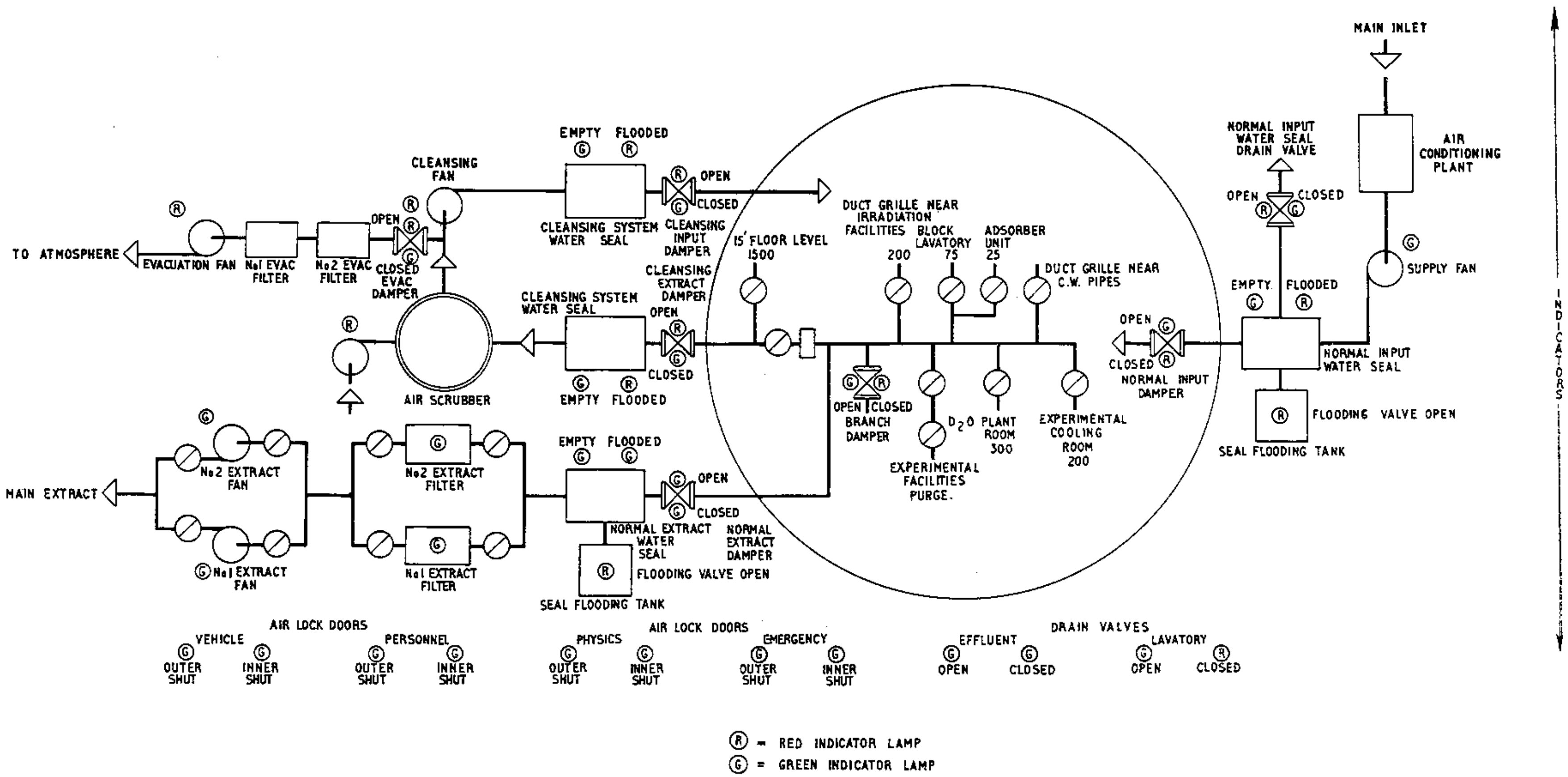


FIGURE 9. MIMIC INDICATION PANEL-CONTROL ROOM, EMERGENCY CONTROL ROOM AND AUXILIARY PLANT ROOM