B. Interrelationships between utilities and departments

Utilities spaces will be provided in each of the diagnosis and therapy departments as shown in Figures 2-10 and 2-11. The advantages of this arrangement are:

(a) Space flexibility: easy to plan future extensions and renovations;

(b) Easy control: possible to zone out the mechanical and electrical systems in accordance with various departmental functions;

(c) Easy maintenance: possible to concentrate various equipment and devices;

(d) Lower costs: simpler routing of piping, wiring and ductworks.

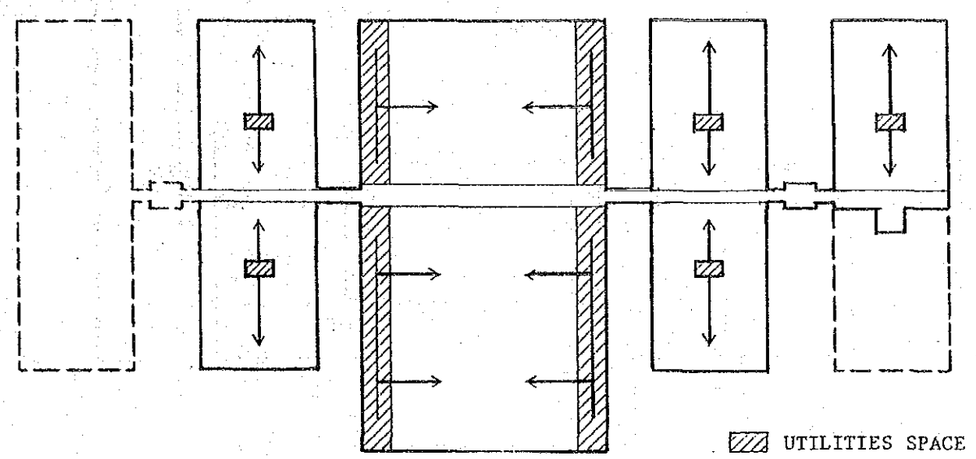


Figure 2-10 Horizontal View of Utilities Space

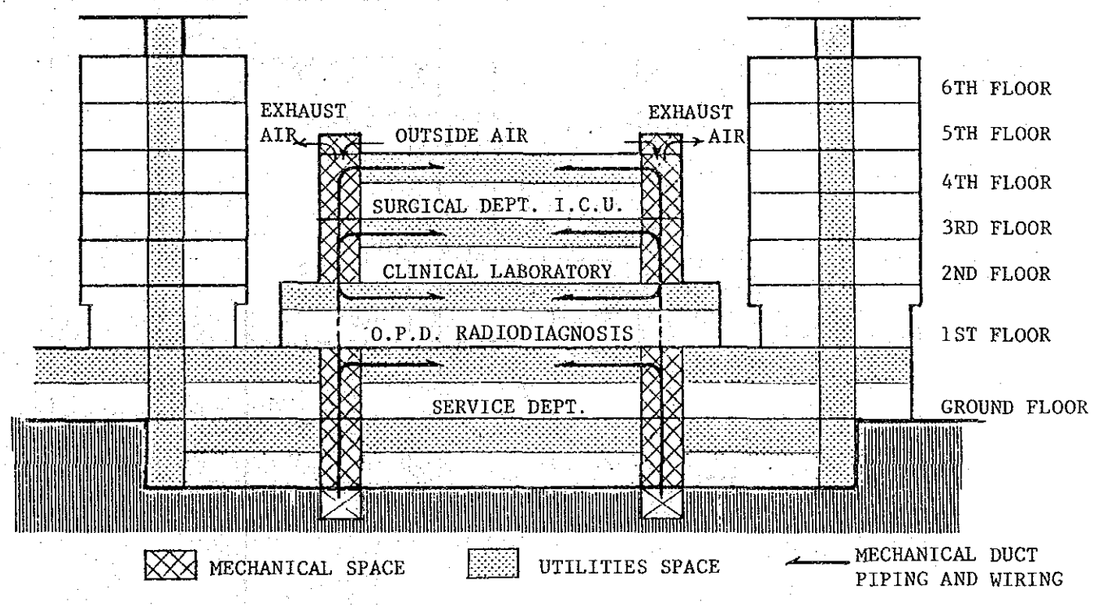


Figure 2-11 Vertical View of Utilities Space

2.3.4 Floor planning

A. Basement floor (Figure 2-12)

(a) The bodies of the deceased will be taken out of the morgue via the underground trench to the utilities center for later interment.

(b) Sewage from the animal laboratory in the basement will be carried via the underground trench to the treatment facilities in the utilities center.

(c) The transformer room and the air-conditining equipment room will be located on the basement floor.

(d) The basement floor space will be used as parking space for staff.

(e) Distribution of departments

Cancer Center	Research (animal)
Joint-use Section	Autopsy Locker rooms Morgue Utilities
General Hospital	Nil

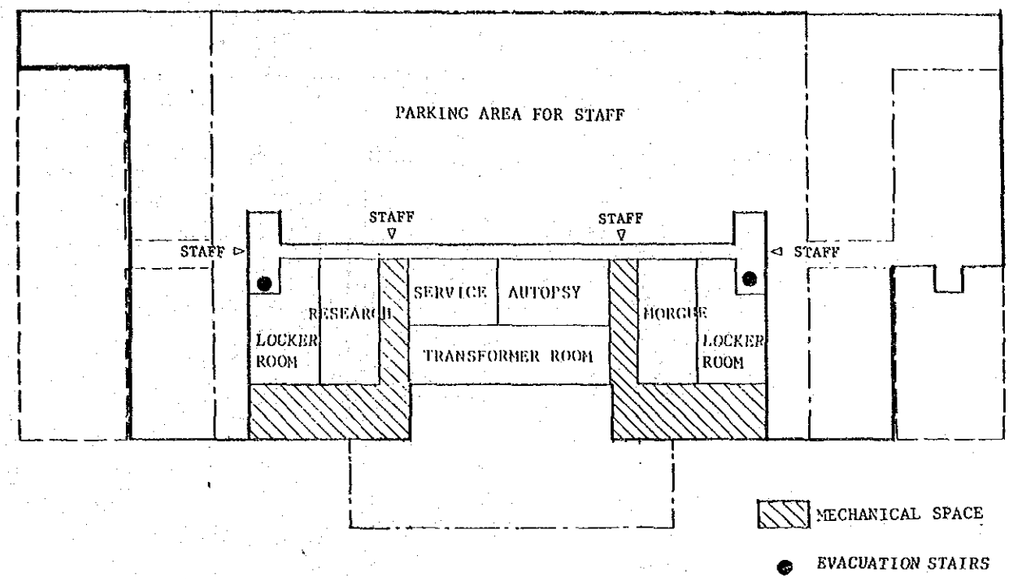


Figure 2-12 Basement Floor Plan

B. Ground floor (Figure 2-13)

(a) The central corridor will be divided into two lanes, one for personnel traffic and the other for goods traffic.

(b) The entrance for emergency casualty will be provided on the northeast side of the hospital buildings.

(c) The central sterilized supplies department (CSSD) will be positioned so as to be connected by a elevator and dumbwaiters to the Surgical Department.

(d) Entrances will be separately provided for the kitchen, the central storage and the pharmacy.

(e) The Radiotherapy Department will be located on the ground floor, because it requires thick concrete structures to prevent radiation leakage. A single entrance-exit routing will be provided for easier management.

(f) Distribution of departments:

Cancer Center	Research Radiotherapy
Joint-use Section	CSSD & Laundry, Hyperbaric Kitchen & dining hall Pharmacy & Storage Bed center Recreation facilities Utilities
General Hospital	Casualty

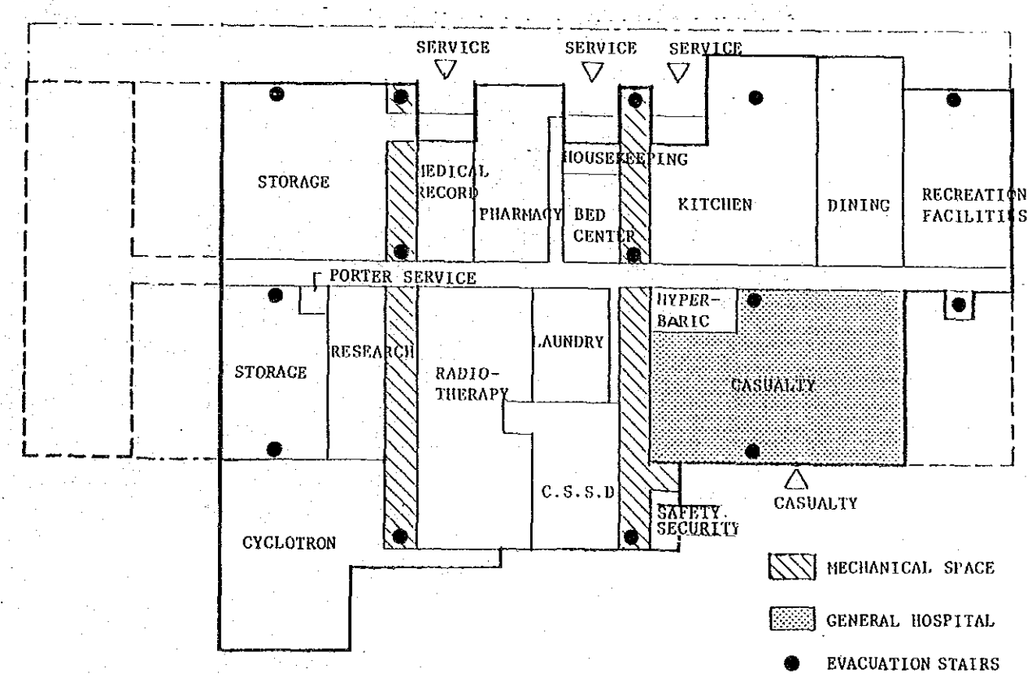


Figure 2-13 Ground Floor Plan

C. First floor (Figure 2-14)

(a) Entrance halls for patients will be separately provided for the Cancer Center and the General Hospital, each with one entrance for out-patients and another for in-patients and visitors.

(b) The Cancer Center and the General Hospital will both be provided with a sub-axis corridor starting from their entrance hall to meet the central north-south corridor.

(c) The Radiodiagnosis, Physiology, Endoscopy and Rehabilitation Departments, which are frequented by out-patients, will be located on the first floor, with circulating passageways connected to the main access route.

(d) The administration's office for the entire complex will be located on the first floor of the North Wings (1) and (2).

(e) A single entrance-exit routing will be provided for radioisotope rooms for easier management.

(f) Distribution of departments:

Cancer Center	Out-patient department Radioisotope Chemotherapy
Joint-use Section	Radiodiagnosis Administration Physiology Endoscopy Rehabilitation Pharmacy General clinic (separate bldg.)
General Hospital	Out-patient department

D. Second floor (Figure 2-15)

(a) The Clinical Laboratory, the Blood Bank and the Hemodialysis Departments will be located in the joint-use facilities building.

(b) The Delivery and Baby Nursery will be located on the west side of the central north-south corridor.

(c) The Wards and the joint-use departments will be located on both sides of the central north-south corridor. The Wards on this floor of the Cancer Center will be for infectious diseases.

(d) Distribution of departments:

Cancer Center	Infectious disease wards (12 beds) Administration
Joint-use Section	Clinical laboratory Blood bank Adminstration
General Hospital	Delivery Baby Nursery Hemodialysis Wards

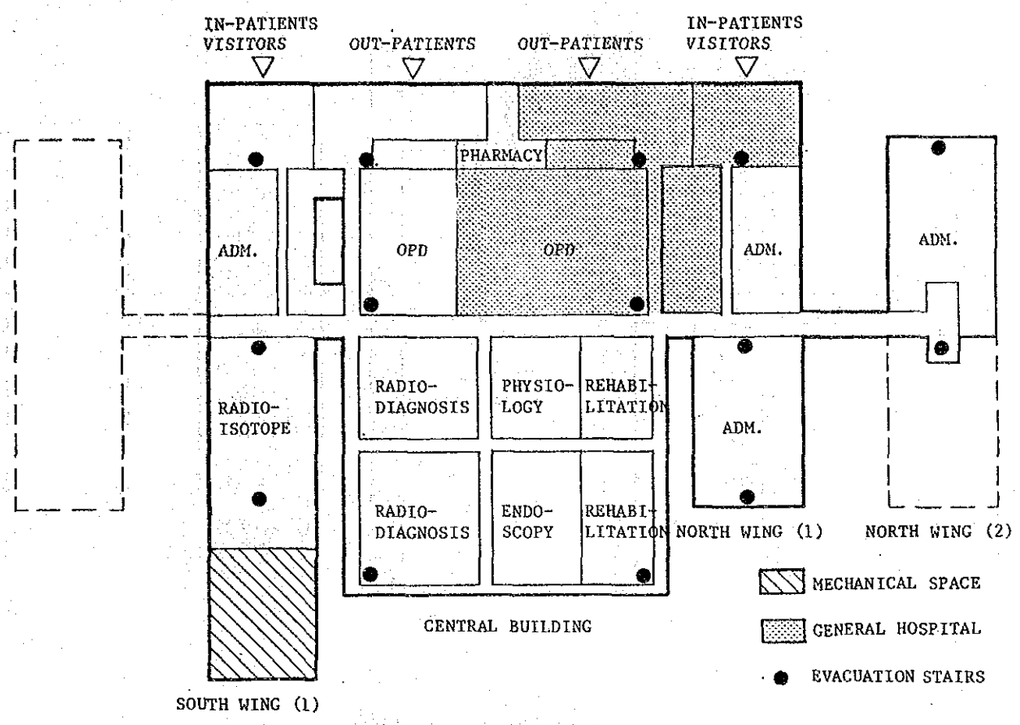


Figure 2-14 1st Floor Plan

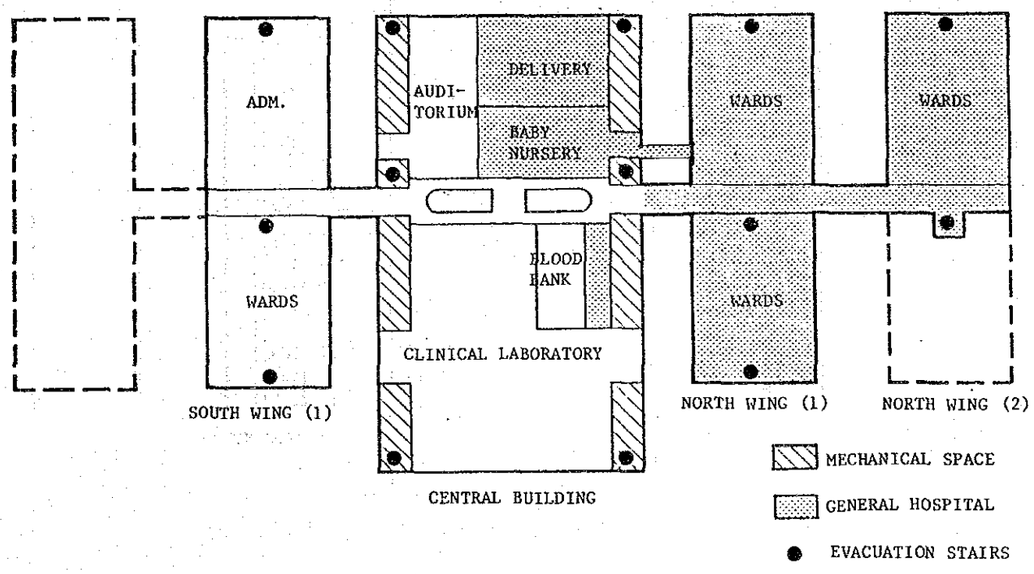


Figure 2-15 2nd Floor Plan

E. Third floor (Figure 2-16)

(a) The Surgical Department, ICU and several others will be located on both sides of the central north-south corridor.

(b) The Surgical Department is located above the CSSD on the ground floor and the clinical laboratory on the second floor, with inter-floor connection by dumbwaiters to carry supplies and specimens for laboratory examination.

(c) The wards and joint-use departments will be connected by the central north-south corridor.

(d) Distribution of departments

Cancer Center	Wards (48 beds) ICU
Joint-use Section	Surgical department CCRU
General Hospital	ICU CCU Wards

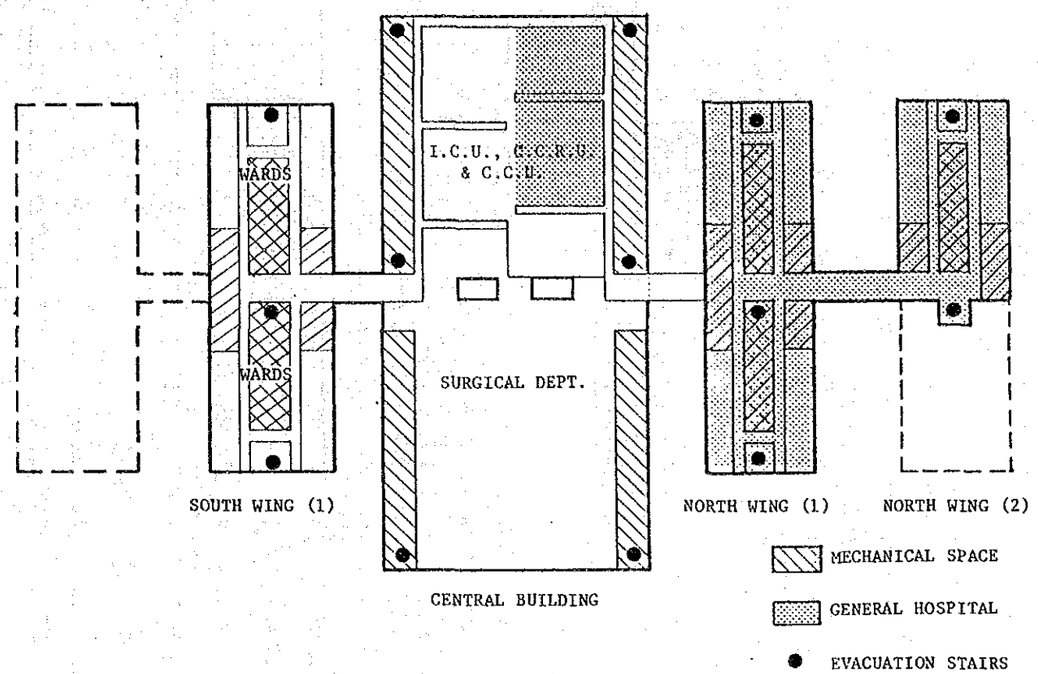


Figure 2-16 3rd Floor Plan

F. Fourth to sixth floors (Figure 2-17)

(a) The wards will be provided with a double corridor with a service core in the center.

(b) The staff area (doctors' offices, conference rooms, classrooms, etc.) will be located in the central part of the wards.

(c) The sixth floor of the Cancer Center will have germ-free (20 beds) and general wards.

(d) An exclusive elevator will be provided for meal services and collection of soiled dishes and garbage.

(e) Medicines, other medical supplies and linens will be carried by the service elevator located in the central part of the buildings.

(f) Germ-free wards (and infectious disease wards on the 2nd floor) will be prefabricated bioclean rooms with pressure balance control.

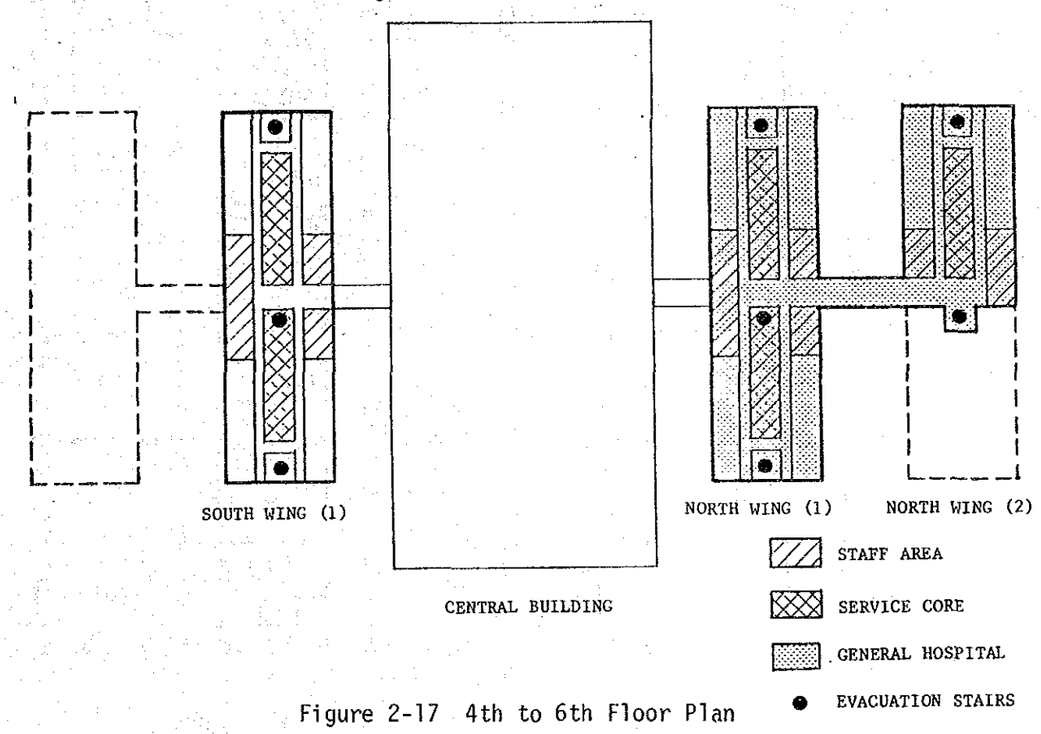


Figure 2-17 4th to 6th Floor Plan

2.3.5 Department planning

A. Cancer Center block

1) Wards (Figures 2-18 and 2-19)

(a) The basic nursing unit will consist of 24 beds; there will be two nursing units on the same floor.

(b) The floor plan will be double-corridored.

(c) Composition of wards will be as shown in Table 2-2, with the basic floor space requirement of 50 m^2/bed

(d) Ward allocation by sex will be done by nursing unit. Three units (72 beds) will be allocated to female in-patients.

(e) Doctor's offices, staff rooms and classrooms will be provided for each nursing unit, and each floor will have two prayer rooms.

Table 2-2

Floor	Ward Names	Kinds of In-patients		Single-bed Wards	Two-bed Wards	Four-bed Wards	VIP Wards	Total	
6th fl.	Western Wards	Female, Internal	No. of Wards No. of Beds	3 3	2 4	4 16	1 1	10 24	30 Wards 44 Beds
	Eastern Wards	Germ-Free	No. of Wards No. of Beds	20 20	- -	- -	- -	20 20	
5th fl.	Western Wards	Female Surgical	No. of Wards No. of Beds	3 3	2 4	4 16	1 1	10 24	20 Wards 48 beds
	Eastern Wards	Female GY and Mixed	No. of Wards No. of Beds	3 3	2 4	4 16	1 1	10 24	
4th fl.	Western Wards	Male Surgical	No. of Wards No. of Beds	3 3	2 4	4 16	1 1	10 24	20 Wards 48 Beds
	Eastern Wards	Male Surgical	No. of Wards No. of Beds	3 3	2 4	4 16	1 1	10 24	
3rd Fl.	Western Wards	Pediatrics	No. of Wards No. of Beds	4 4	2 4	4 16	- -	10 24	20 Wards 48 Beds
	Eastern Wards	Male Internal	No. of Wards No. of Beds	3 3	2 4	4 16	1 1	10 24	
2nd fl.	Eastern Wards	Infectious Disease	No. of Wards No. of Beds	12 12	- -	- -	- -	12 12	12 Wards 12 Beds
Total			No. of Wards No. of Beds	53 53	14 28	28 112	7 7	102 200	
			Distribution of beds*	12.5%	16.7%	66.7%	4.1%	100%	

* Except infectious disease and germ-free wards.

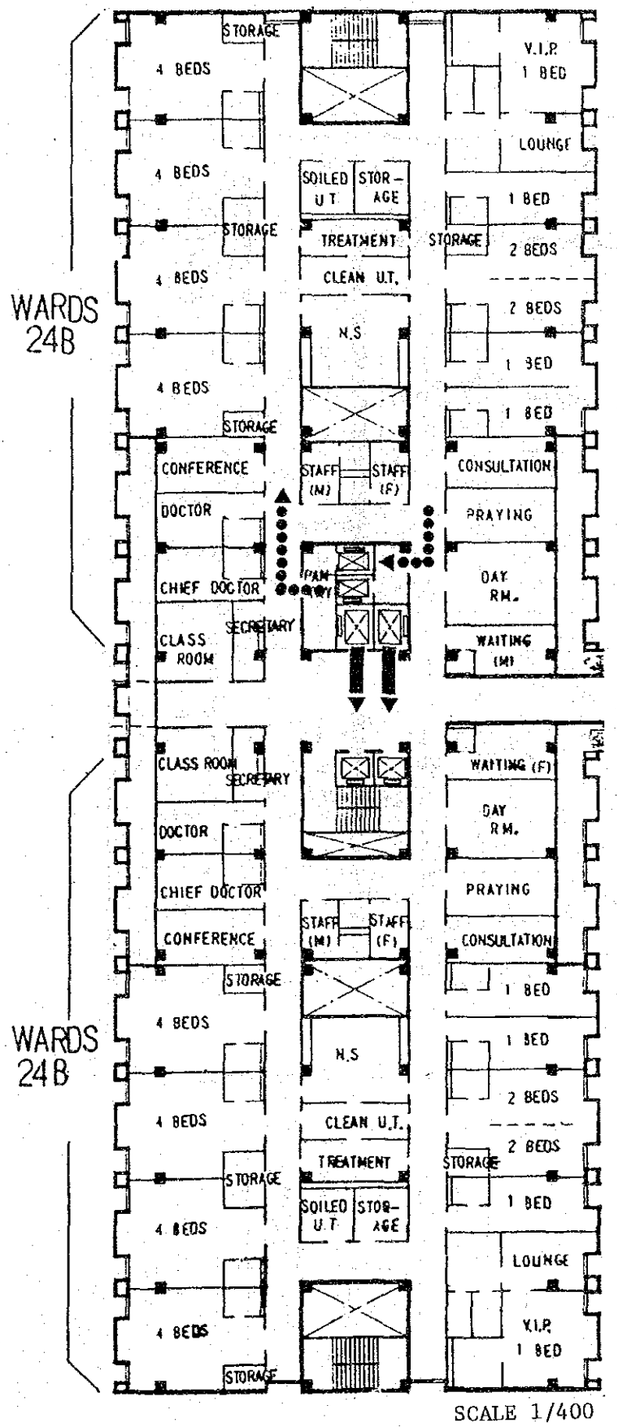


Figure 2-18 Wards

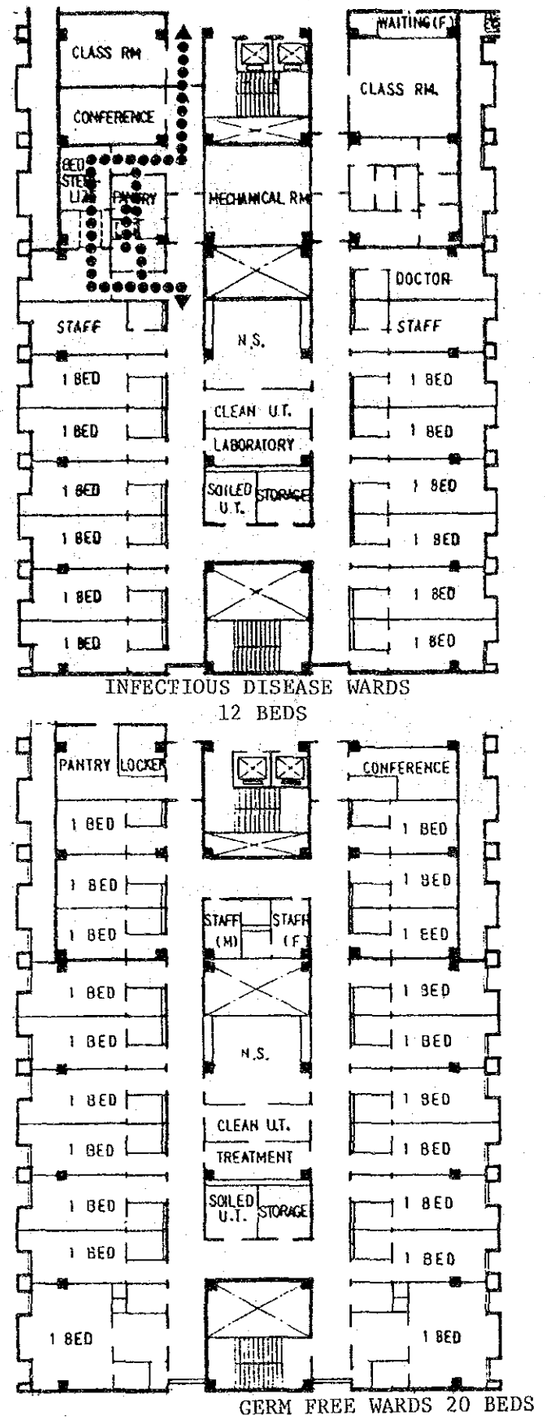


Figure 2-19 Special wards Scale 1/400

2) Out-patient department (Figure 2-20)

(a) The number of out-patients is assumed to be 450 persons per day.

(b) The departments will consist of 20 divisions as shown below:

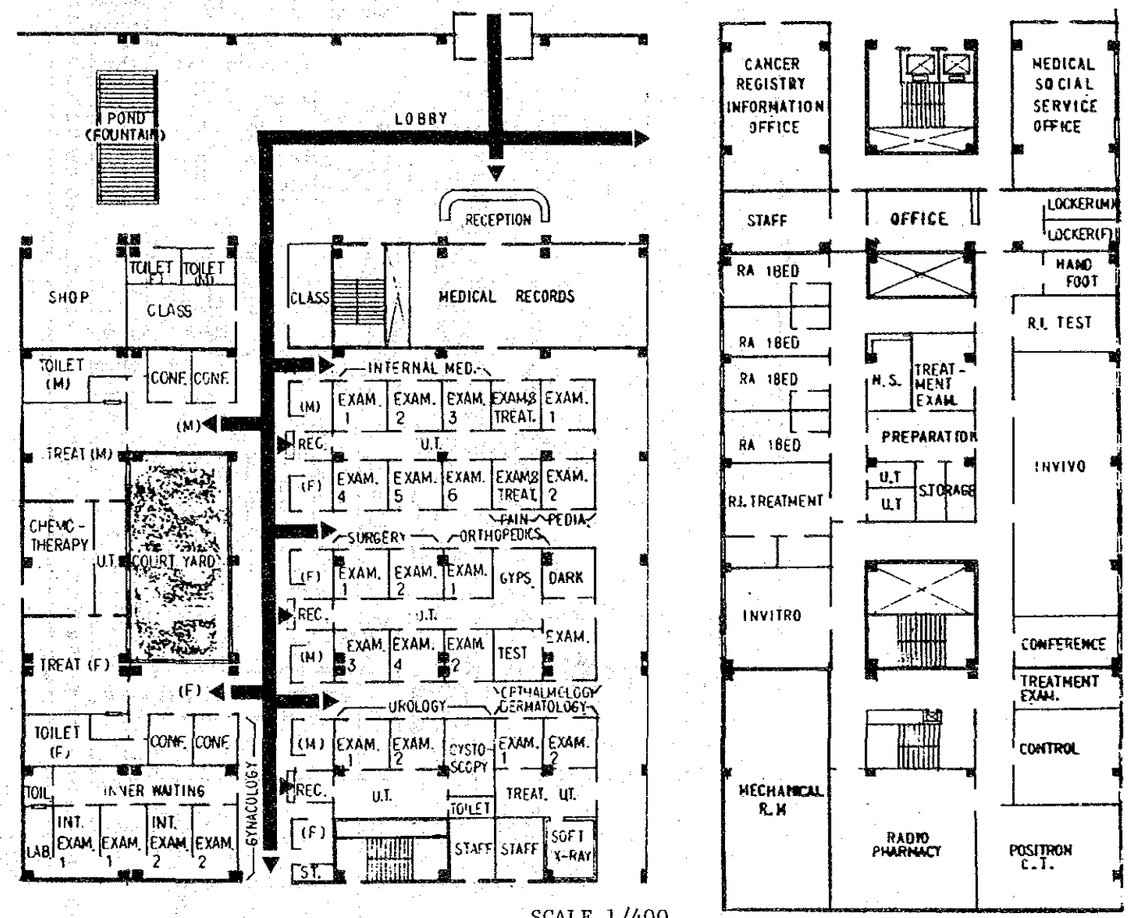
o general medicine	o head & neck	o radiology
o gastroenterology	o thorax	o endoscopy
o hepatology	o abdomen	o rehabilitation
o pulmonary medicine	o orthopedics	
o hematology	o neurosurgery	
o endocrinology	o urology	
o gynecology	o ophthalmology	
o pediatrics	o dermatology	
o pain clinic		

(c) Treatment rooms will be provided in one area.

(d) Clinical charts will be centrally managed and kept in the filing cabinets in the medical records room.

(e) Two separate waiting lobbies with benches will be provided for male and female out-patients.

(f) A small shop for the convenience of patients and visitors and an aesthetically pleasing fountain-waterfall will separate the lobby of the out-patients from that of the in-patients and visitors.



SCALE 1/400

SCALE 1/400

PATIENT

3) Radioisotope (Figure 2-21)

(a) The department will consist of the radiodiagnosis section and the radiotherapy section (four bedrooms).

(b) The RI area will be provided with a single entrance-exit access routing, and in-coming/out-going persons and goods will be checked at the office located at the entrance.

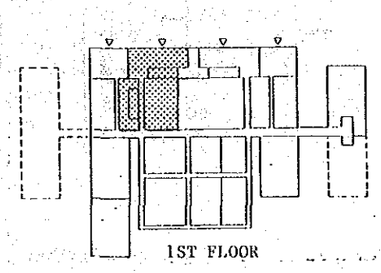


Figure 2-20 Out-Patient Department

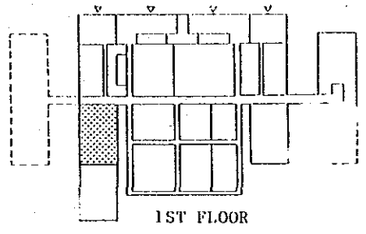


Figure 2-21 Radioisotope

(c) The office will be equipped with a control panel, which will monitor the radioactive pollution of air and waste water at discharge outlets.

(d) The leakage of radioactive rays through the interior and exterior walls of rooms using RI and/or Ra will be below 10 mili-rem/week.

(e) The positron C.T. room, using short life radioisotope, will be located on the first floor of the cyclotron building.

4) ICU and CCRU (Figure 2-22)

(a) Number of beds*

ICU: 20 beds

CCRU: 6 beds

(b) Air cleanliness level

Class 100,000 will be maintained for the wards and the passageway to the operating rooms. (See Section 4.1.2.)

The ICU and the CCRU wards will be connected to the outside corridors via hatched passages.

(c) Supplies

Medical implements and materials will be carted from the clean storage room in the operating department.

Medicine supplies will be carried by dumbwaiters.

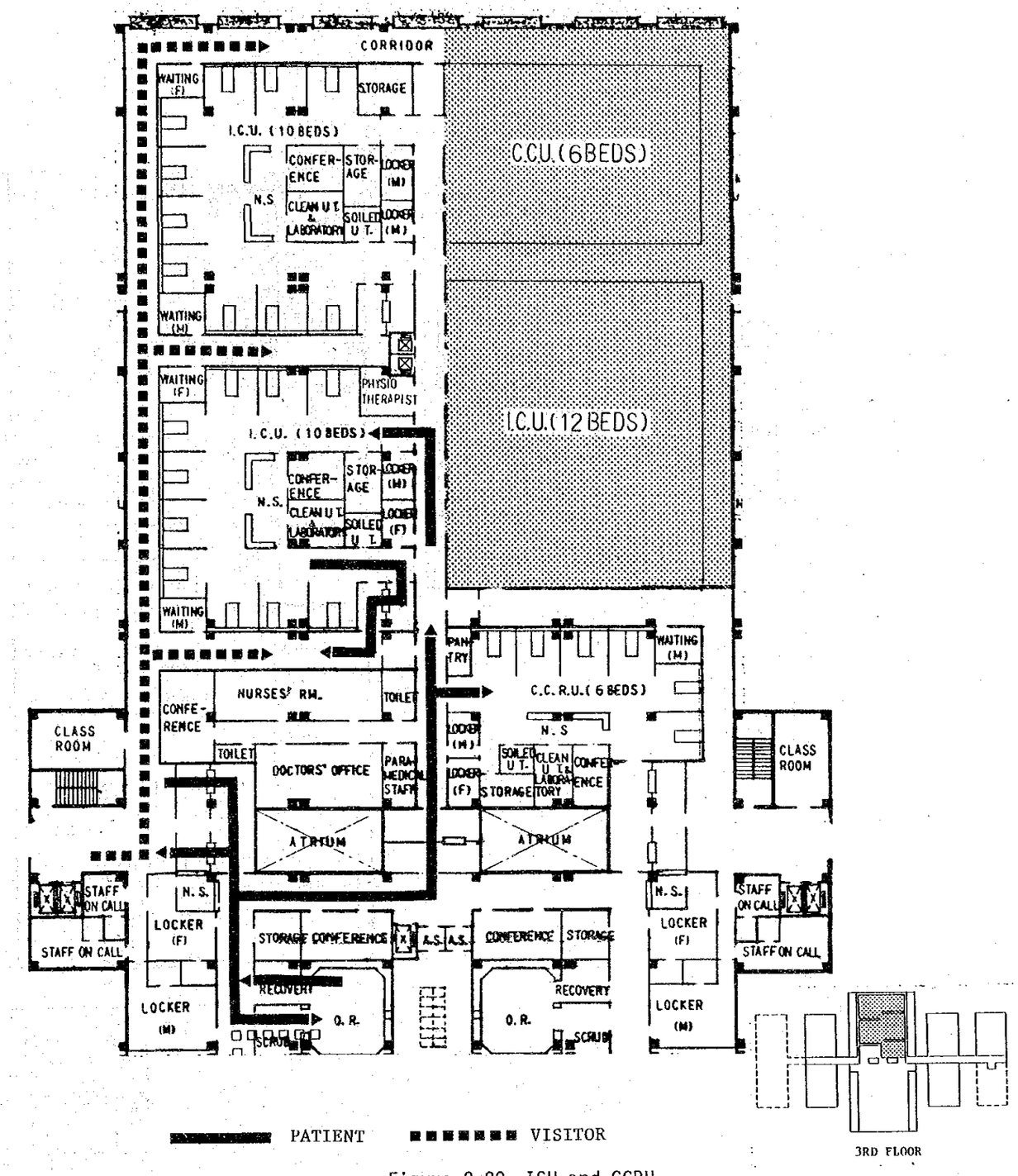


Figure 2-22 ICU and CCRU

* The General Hospital wards have 12 ICU beds and 6 CCU beds.

5) Radiotherapy (Figure 2-23)

(a) The space for the cyclotron rooms will be provided in space adjacent to the Radiotherapy rooms and will be connected to it by a corridor.

(b) The outer and inner walls of the Radiotherapy rooms will have a leakage rate of less than 10 mili-rem/week.

(c) An operating room will be provided for making incisions necessary for internal irradiation. The room will be connected to the operating rooms of the surgical department by an exclusive elevator.

6) Research (Figure 2-24)

(a) Space for a planned research center for future extension will be provided in the south wing (2).

(b) The general experimental laboratory will be provided on the ground floor and connected to the animal laboratory in the basement by an exclusive elevator.

(c) Research animals consist of dogs, monkeys, rats and mice. Measures will be taken to prevent contact among research animals and other house animals.

(d) Sewage from the laboratory animals will be transported via the underground trench to the treatment facilities in the utilities center.

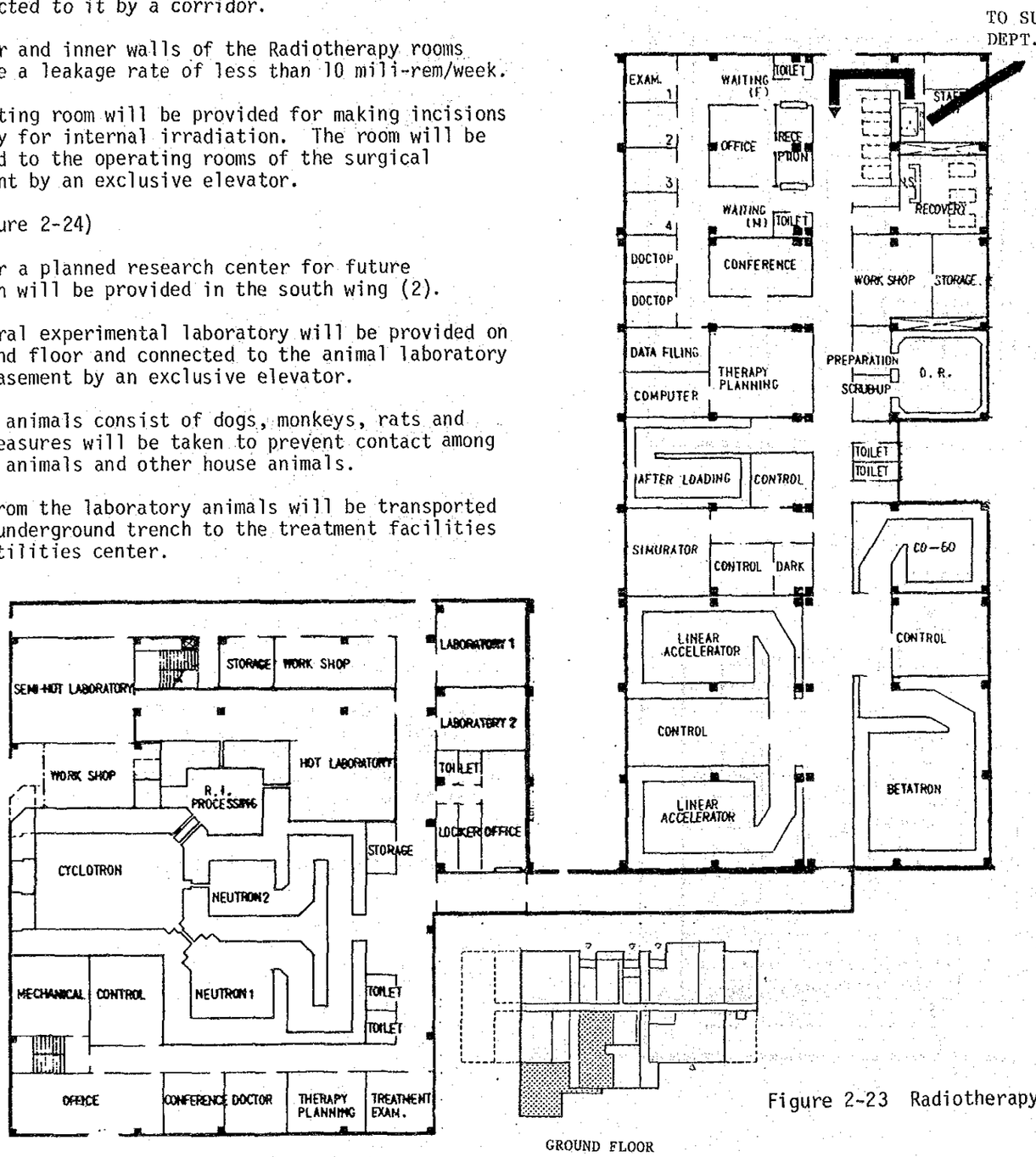


Figure 2-23 Radiotherapy

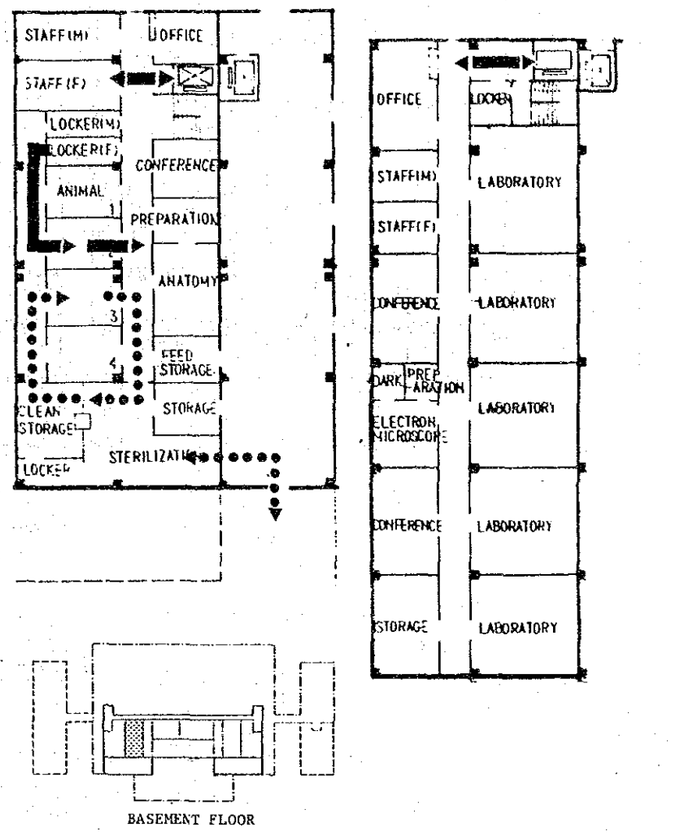


Figure 2-24 Research

B. Joint-use facilities

1) General clinic (Figure 2-25 and 2-26)

(a) The number of out-patients is assumed to be 1,550 persons per day.

(b) The clinical departments will consist of 9 divisions as shown below:

- o Internal Medicine
- o Surgery
- o Orthopedics
- o Eye surgery
- o E.N.T.
- o Obstetrics
- o Gynecology
- o Pediatrics
- o Dentistry

(c) The clinic will accept new out-patients and screen them for referral to the out-patient departments of the Cancer Center or the General Hospital.

(d) The clinic will be housed in a separate building but connected to the main hospital building by the passage-way on the second floor level for staff and by the passageway under the first floor for patients.

(e) The clinic will have its own clinical laboratory, radiodiagnosis department, pharmacy and administration office to support examination and treatment functions.

(f) With the common facilities of item (d), above, located in the central part of the General Clinic Building, separate entrance halls, waiting lobbies, examination rooms, treatment rooms and classrooms will be provided for male and female patients on opposite ends of the building.

(g) A snack room will be located in a corner of each waiting hall.

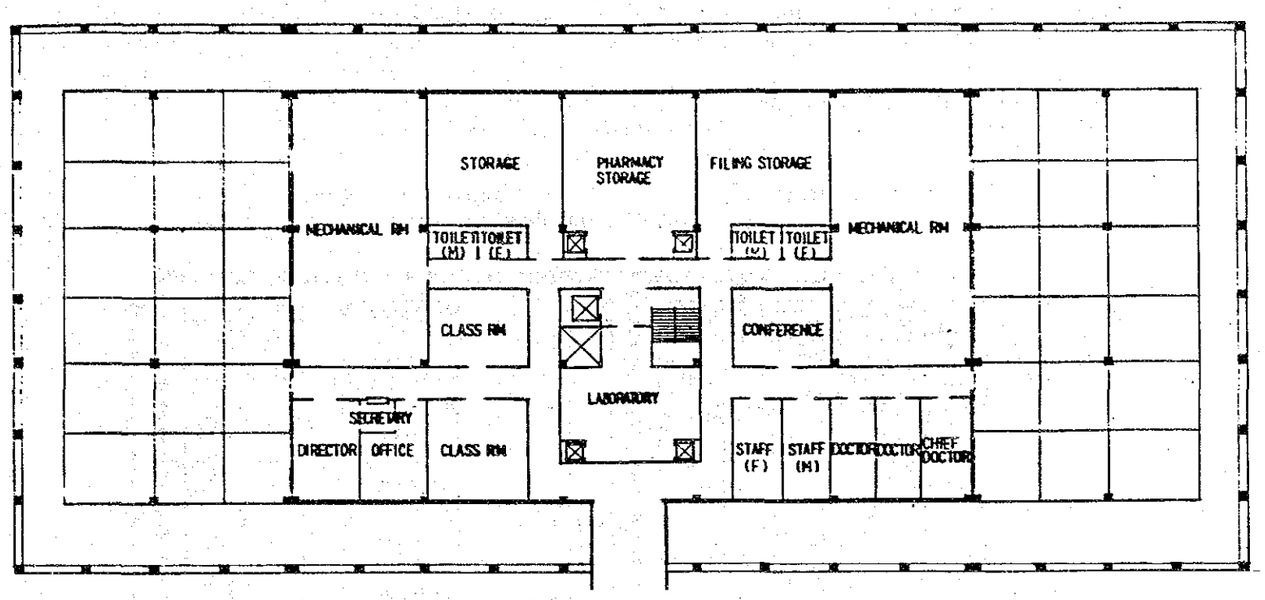


Figure 2-25 Second Floor

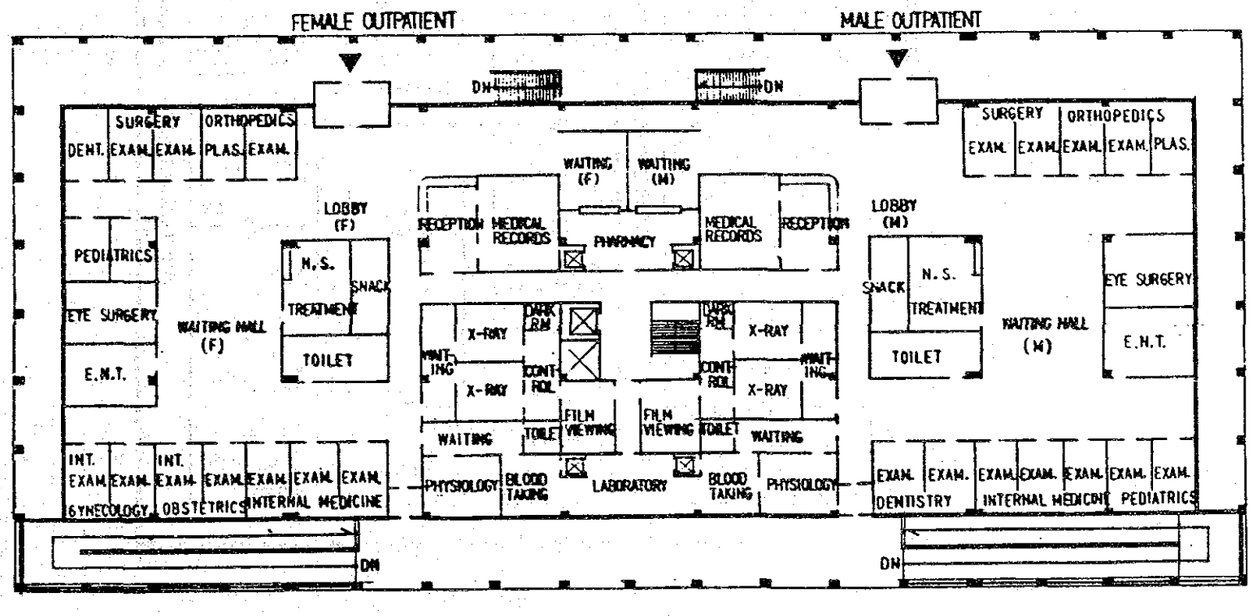


Figure 2-26 First Floor

2) Radiodiagnosis (Figure 2-27)

(a) The department will be located along the central north-south corridor because of its frequent use by out-patients.

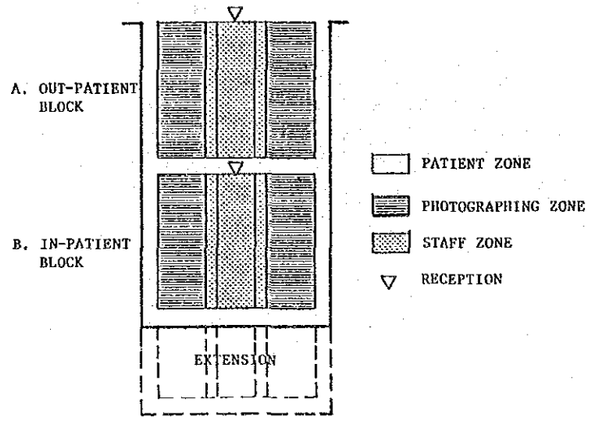
(b) The equipment will be controlled from the staff corridor.

(c) The X-ray rooms under frequent use will be provided with two separate dressing rooms for male and female patients.

(d) The department will be divided into two blocks, one for out-patients (A) and the other for in-patients (B), as shown below.

(e) The planned extension will be on the eastern side.

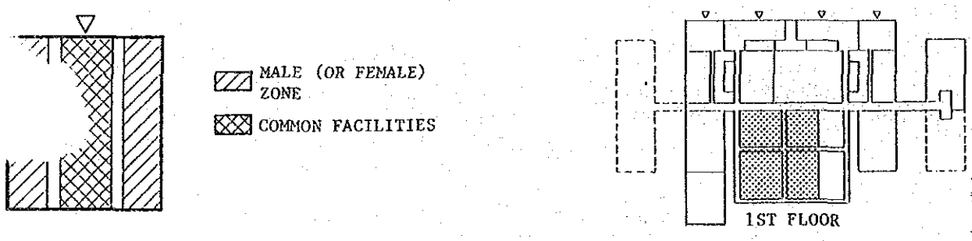
(f) The shielding of the X-ray rooms will be such as to keep radioactive ray leakage within the safety standard of 10 mili-rem/week.



3) Endoscopy (Figure 2-27)

(a) The department will be located next to the radio-diagnosis department because it will use X-ray apparatuses.

(b) Common facilities will be located in the center, with two separate endoscopy rooms, one for male patients and the other for female patients.



4) Physiology (Figure 2-27)

(a) The physiology department will be located on the opposite side of the out-patient department across from the central north-south corridor, because more tests will be required for out-patients.

(b) Noises, vibrations, electromagnetic waves and other emittances from the apparatuses will be effectively controlled so as not to disturb patients.

(c) The layout for male and female patients will be the same as in the endoscopy department.

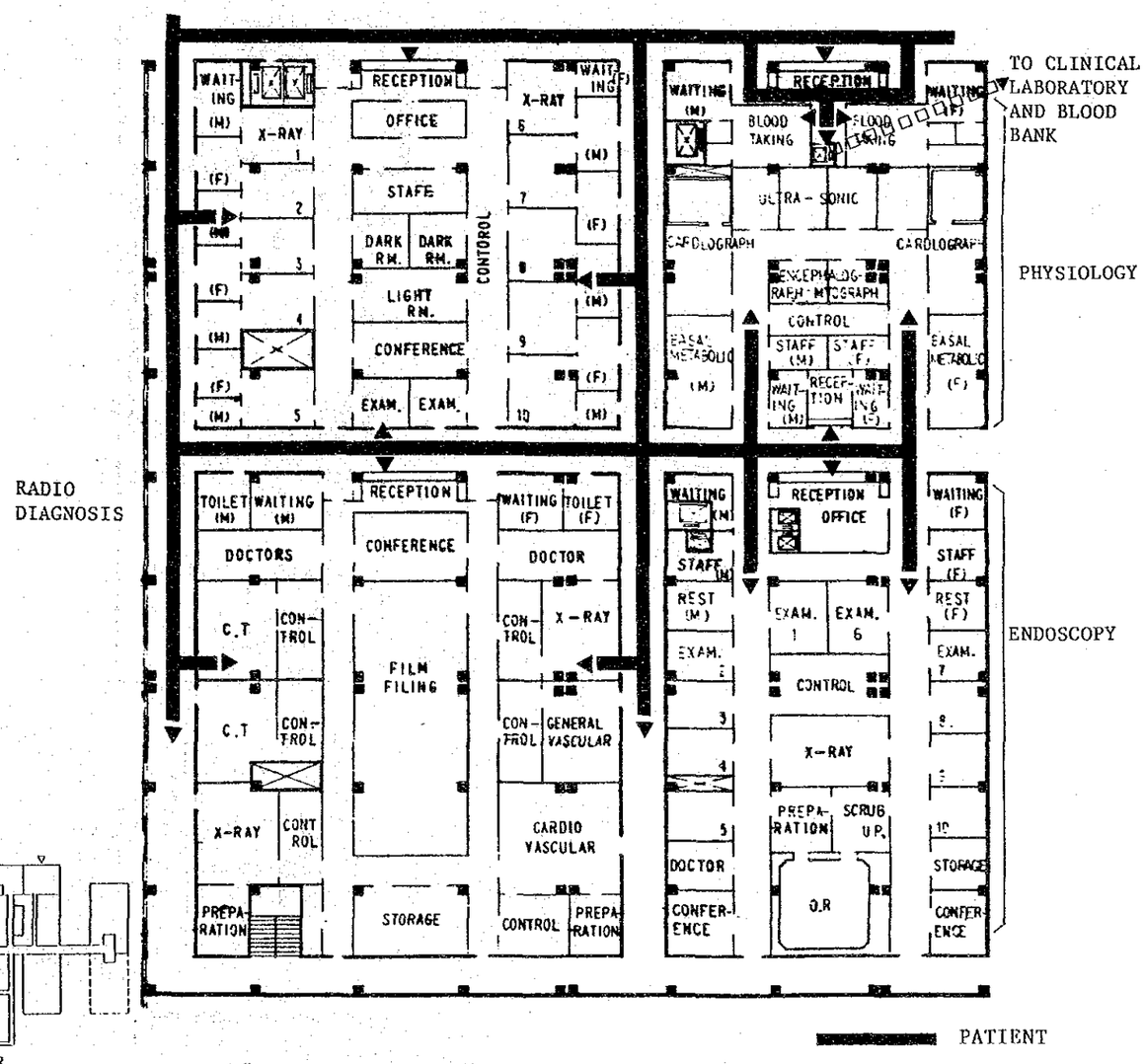


Figure 2-27 Radiodiagnosis, Physiology and Endoscopy

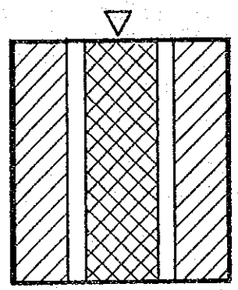
5) Rehabilitation (Figure 2-28)

(a) The rehabilitation department will be located close to the wards along the central north-south corridor because of its frequent use by in-patients.

(b) The department is for physical therapies: kinesi-therapy, hydrotherapy, thermotherapy and beam and electric therapy.

(c) The department will be divided into two blocks, one for static therapies and the other for kinesitherapy and hydrotherapy involving physical movement.

(d) Common facilities will be located in the center, with two separate sets of therapy rooms for male and female patients.



MALE (OR FEMALE) ZONE

COMMON FACILITIES

6) Pharmacy (Figure 2-29)

(a) The pharmacy will be located between the two front entrances of the hospital building.

(b) The compounding, dispensing and manufacturing of medicines will be done at the pharmacy.

(c) The check-in counter and medicine storeroom for out-patients will be located on the first floor, and the sample-testing room and medicine storeroom on the ground floor.

(d) Special dumbwaiters will be installed to carry medicines to the out-patient and surgical departments and ICU. Medicines will be carted via elevators to the other wards and departments. A satellite pharmacy will be located on every floor of the wards.

(e) Two separate waiting rooms will be provided for male and female patients.

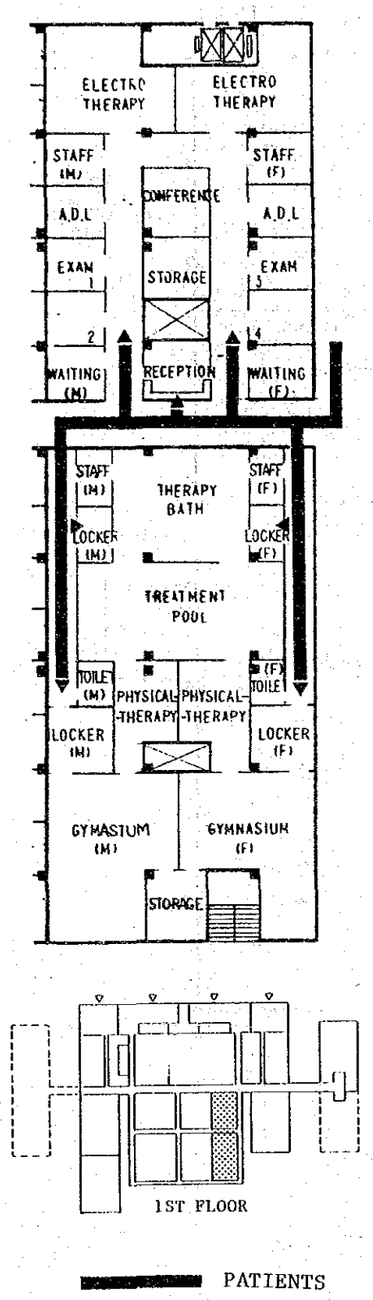


Figure 2-28 Rehabilitation

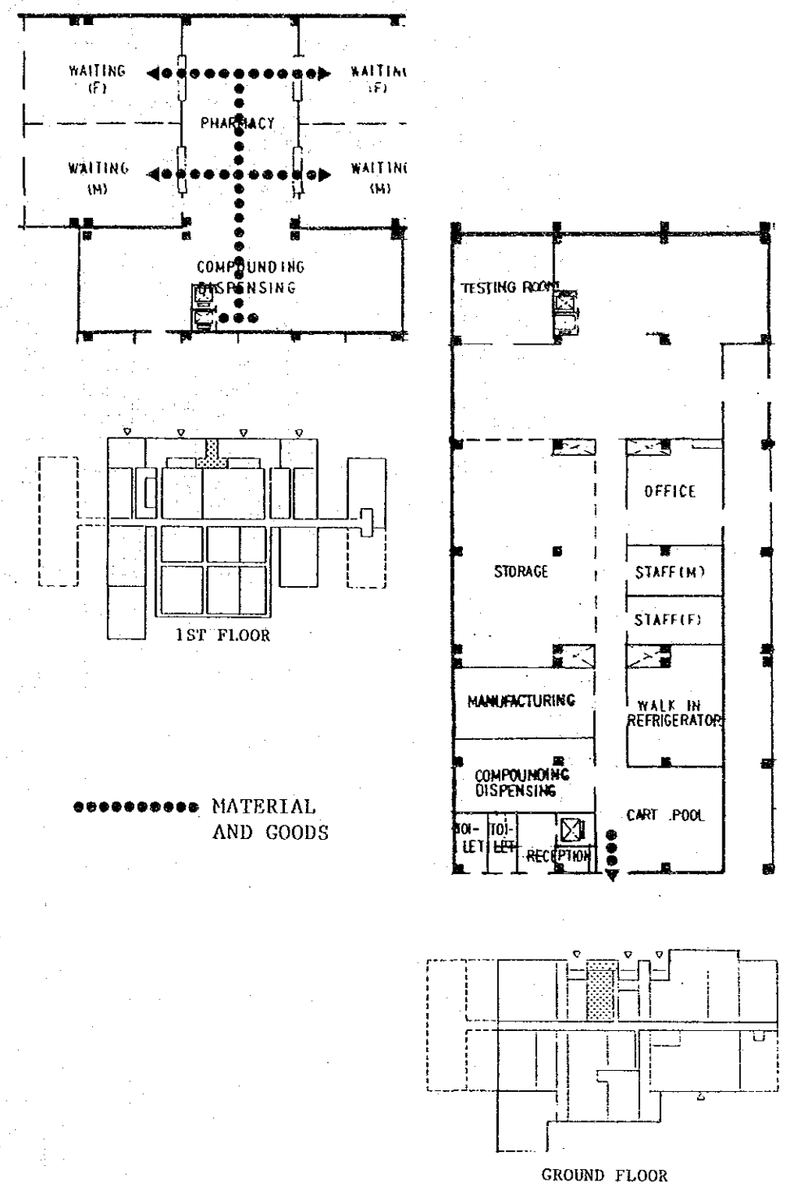


Figure 2-29 Pharmacy

7) Clinical laboratory (Figure 2-30)

(a) The following tests will be conducted in the Laboratory:

- biochemical
- pathological
- hematological
- cytological
- bacteriological
- virological
- serological
- electron microscopy

(b) The Autopsy Department will be located in the basement.

(c) The room to take urine, blood and other specimens of out-patients will be located in the physiology department on the first floor, and connected to the clinical laboratory by a dumbwaiter.

(d) One large room will be provided for general, biochemical and hematological testing, and small individual rooms for serological, virological, bacteriological and cytological tests to ensure strict safety. The automatic analyzers room, sterilizing room and others will be located in the middle of the laboratory.

(e) The planned extension will take place on the eastern end of the building.

(f) The medical instrument workshop to maintain hospital instruments will be located within this department facing the central north-south corridor.

8) Blood bank (Figure 2-30)

(a) The blood bank will be located next to the clinical laboratory. Blood collection from out-patients will be done on the first floor and sent up to the Blood Bank on the second floor by the dumbwaiter.

(b) Regular tests will be done at the blood bank.

(c) Blood for transfusion will be sent by a dumbwaiter to the operating rooms.

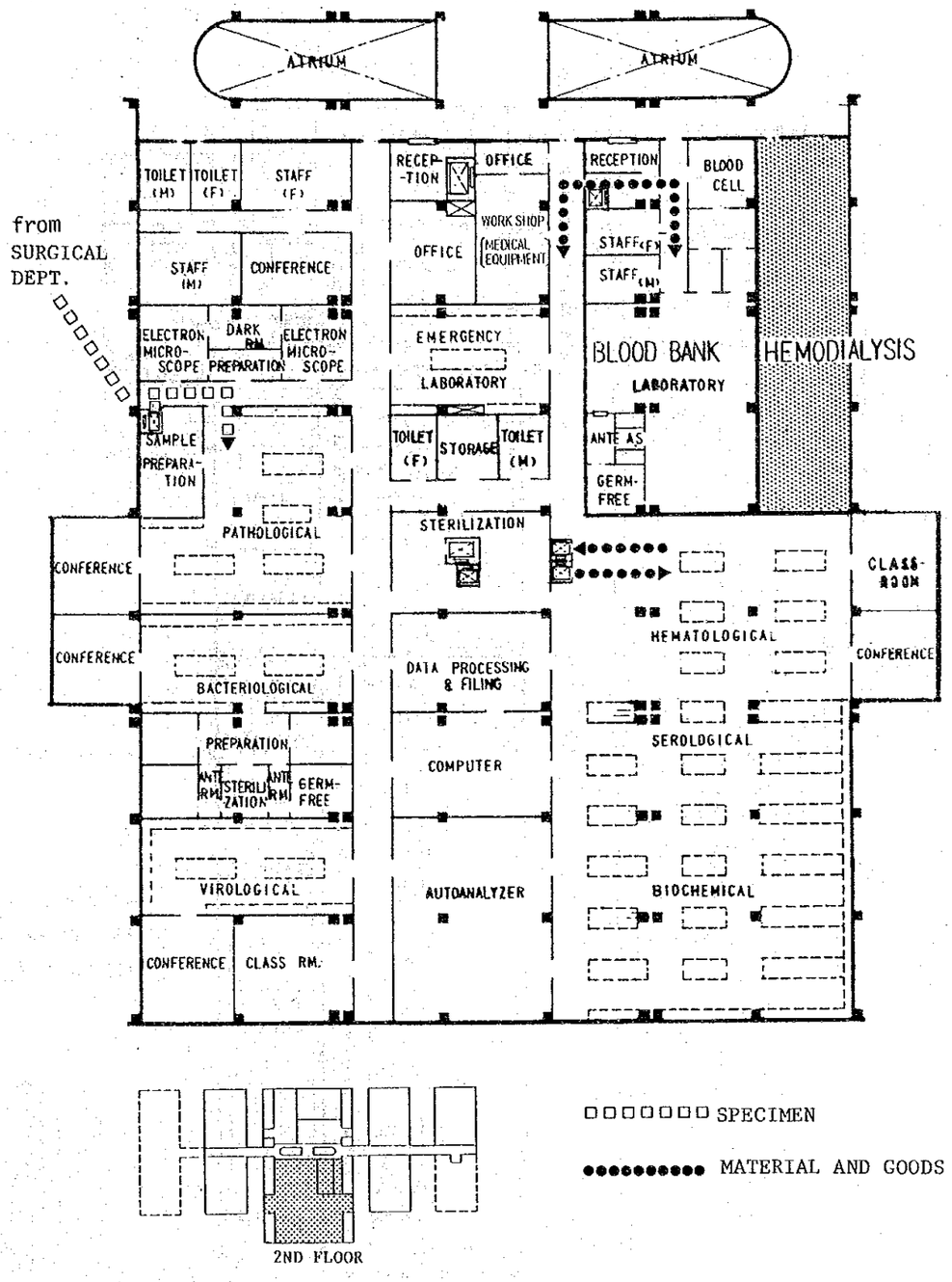


Figure 2-30 Clinical Laboratory and Blood Bank

9) Surgery (Figure 2-31)

(a) The number and composition of operating rooms will be as follows:

Bioclean operating rooms	2
General operating rooms:	
large rooms	2
medium rooms	14
Total	18

(b) A recovery room, together with a scrub-up and induction room, will be located beside each operating room.

(c) Medical materials and implements will be supplied after complete sterilization, employing a clean hall system. Two sub-sterilization rooms will be provided additionally in the operating department.

(d) Access routing

Patients	Will pass the transfer area with hatched passageways to enter the operating zone.
Hospital personnel	Will pass under air showers to enter the clean hall.
Supplies	Will be carried in carts from CSSD and pharmacy and stored in the clean hall; will be carried in passboxes to operating rooms.

(e) Air cleanliness control

The surgical department is divided into four zones in terms of air cleanliness levels:

Entrance to operating zone	Same cleanliness as in other departments
Semi-clean zone	Transfer area, corridor in operating zone and staff area
Clean zone	Class 100,000 in anterooms to operating rooms and clean hall
Operating rooms	Class 10,000 for general operating rooms and class 100 for bio-clean operating rooms

Note: Patients and used medical implements in the case of infectious diseases will be carried in sealed capsules.

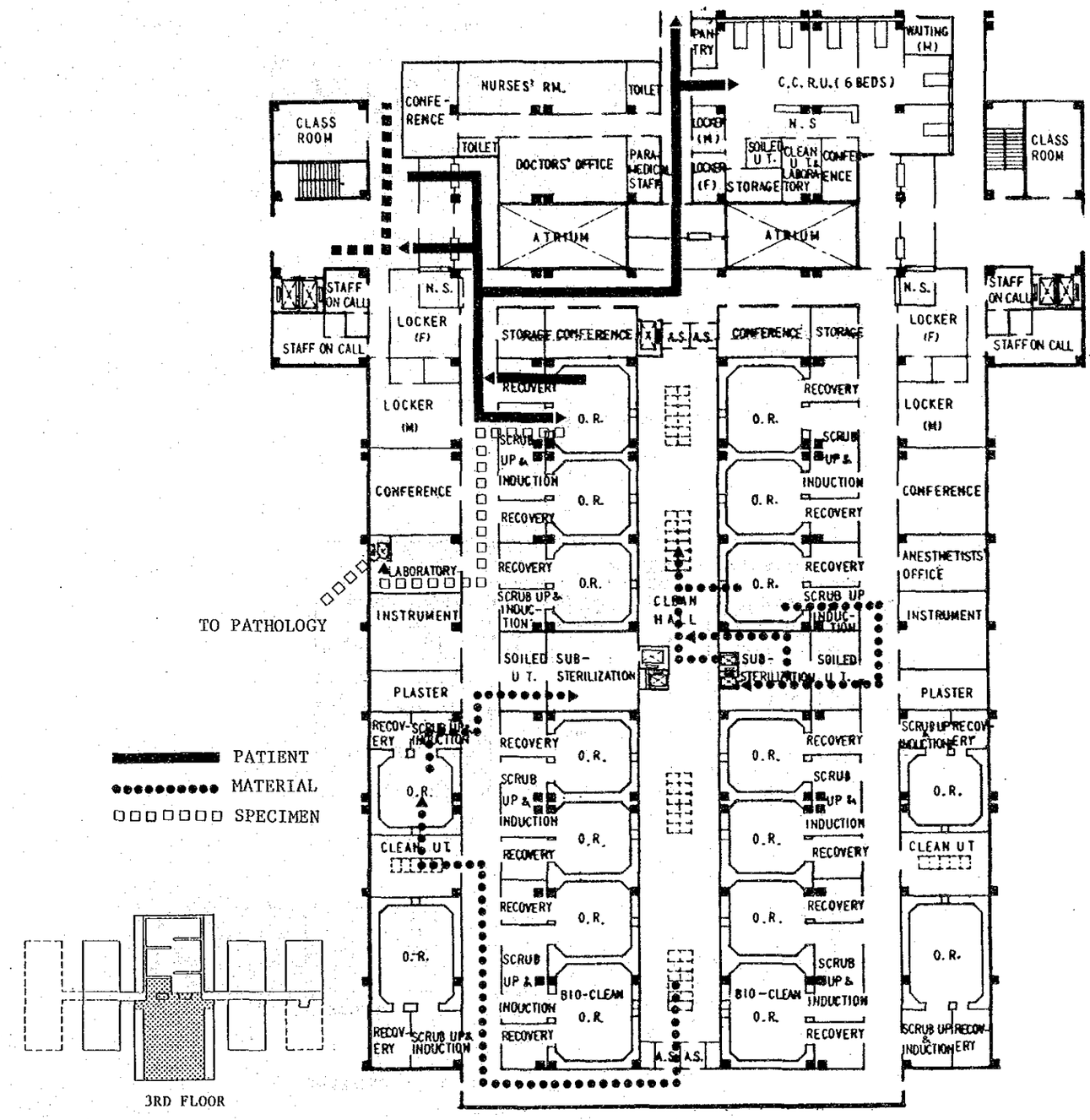


Figure 2-31 Surgical Department

10) Hyperbaric (Figure 2-32)

The Hyperbaric Department will be located beside the Casualty Department on the ground floor, facing the central north-south corridor.

11) Autopsy and morgue (Figure 2-33)

(a) The autopsy, a branch of the clinical laboratory, will be located in the basement, along with the morgue.

(b) The autopsy will be connected to the Surgical Department by an elevator. The deceased bodies from the wards will be conveyed by the elevators in the South and North Wings (1).

(c) The refrigerator in the morgue will have a capacity for 15 corpses.

(d) The corpses from the morgue will be conveyed through the trench to the utilities center and then transported away for burial preparation.

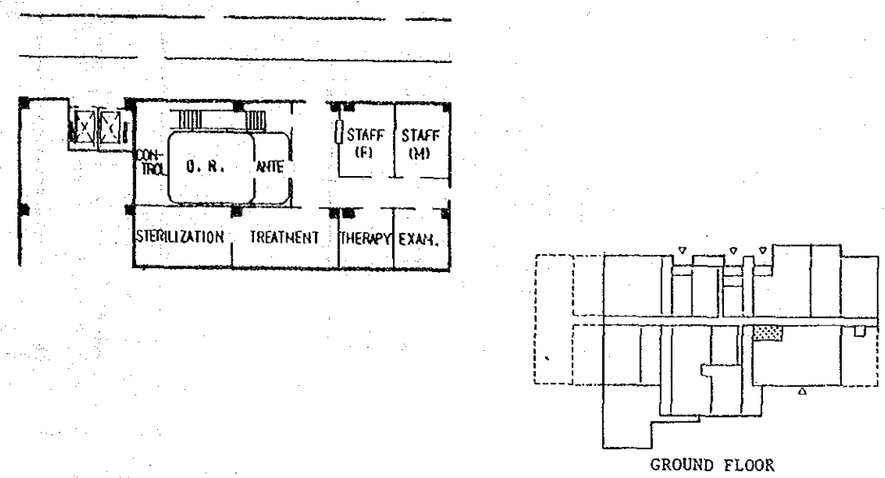


Figure 2-32 Hyperbaric

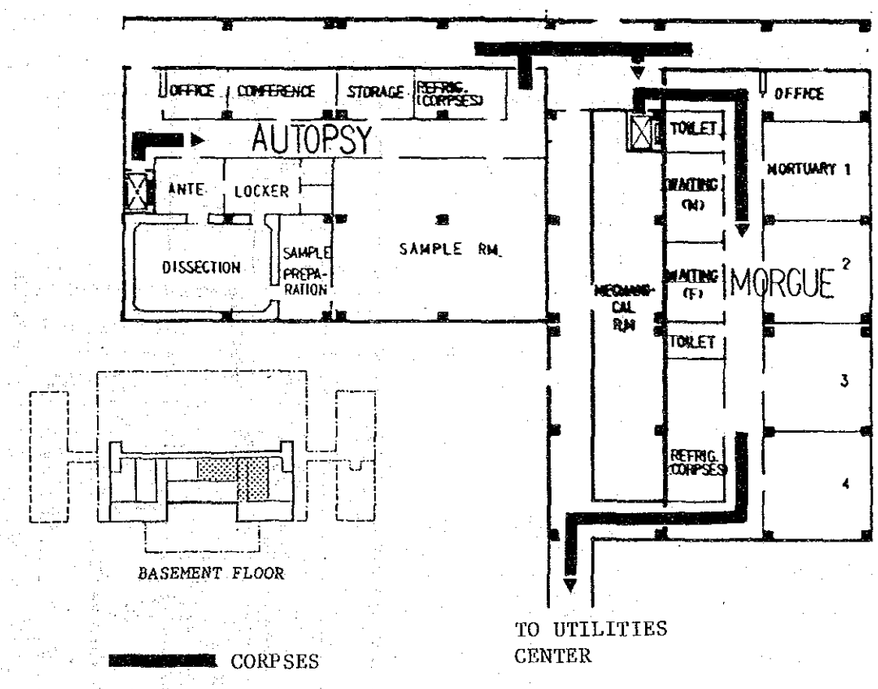


Figure 2-33 Autopsy and Morgue

C. Service department

1) CSSD (Figure 2-34)

(a) The department will be located directly below the operating zone of the surgical department.

(b) The autoclaves for sterilization will be of pass-through type to ensure the separation of clean and soiled materials and implements.

(c) Medical materials and impelements will be sterilized and stored in carts used for transportation.

2) Laundry and bed center (Figures 2-35 and 2-36)

(a) Linens used in the hospital will be washed and stored in the laundry.

(b) The bed center will be equipped with bed-sterilizing equipment.

3) Kitchen and dining hall (Figure 2-37)

(a) The kitchen will be located in the General Hospital, which has a larger number of personnel and in-patients.

(b) Food supplies for two weeks will be stored. A platform will be installed at the entrance. The kitchen will have a capacity to serve 800 in-patients and 2,000 hospital personnel.

(c) The kitchen will serve Arabic and Western dishes.

(d) The dining hall will be cafeteria-style with two service counters.

(e) A total of 750 seatings will be provided, zoned for VIPs, male and female diners.

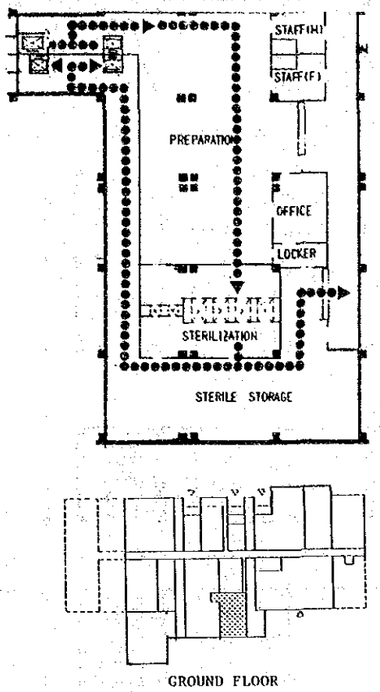


Figure 2-34 CSSD

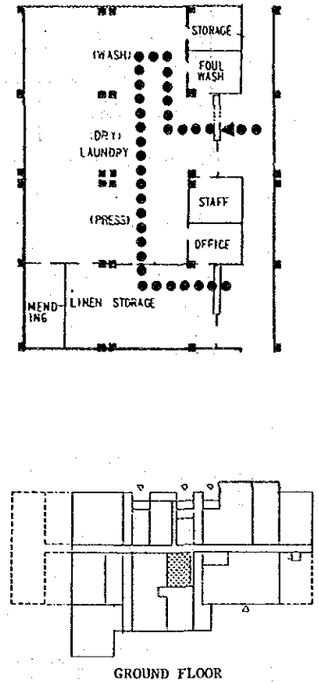


Figure 2-35 Laundry

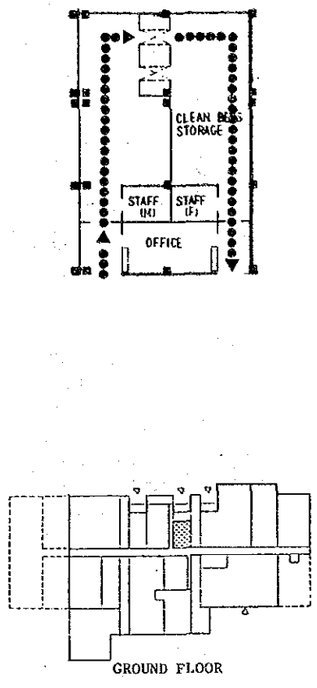


Figure 2-36 Bed Center

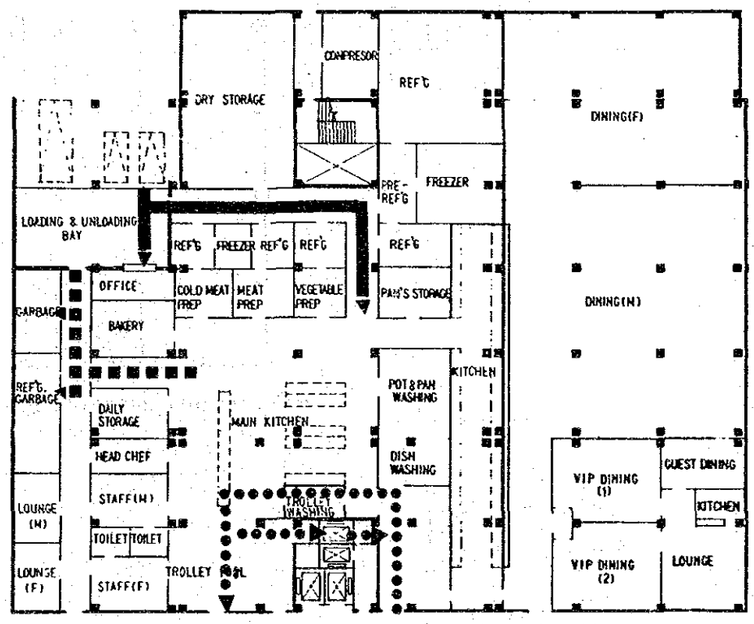
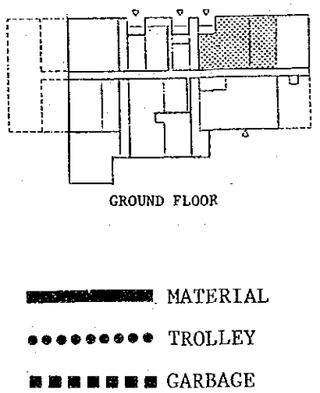


Figure 2-37 Kitchen and Dining



4) Storage (Figure 2-38)

(a) The medical and non-medical equipment and furniture will be stored on the ground floor.

(The equipment for the utilities and the architectural fittings such as the A.H.U., the pumps, the motors, the filters, the electrical goods and devices, the light-fittings, the valves, and the plumbing will be stored in a separate warehouse.)

(b) The carpentry workshop will be on the basement floor and the workshop for plumbing, mechanicals and electricals will be inside the utilities center.

(c) Storage space

		Storage Space (m^2)		Storage Volume (m^3)	
Central Storage	Special	120	1,250	300	4,820
	General	1,130		4,520	
Warehouse			400		1,600

(d) Many things, except medicines and foods, will be carried in and stored here, then be delivered to each department as occasion demands.

5) Locker rooms (Figure 2-39)

(a) The locker rooms will be located in the basement of the South Wing (1) and the North Wing (1).

(b) The number of lockers will be about 1,300.

6) Other service departments

(a) The housekeeping office will be on the ground floor. A satellite room for the housekeeping personnel and equipment will be in each ward. (Figure 2-40)

(b) The office for porter service will be in a corner of central storage. (Figure 2-38)

(c) The mail room will be located on the first floor of the North Wing (2).

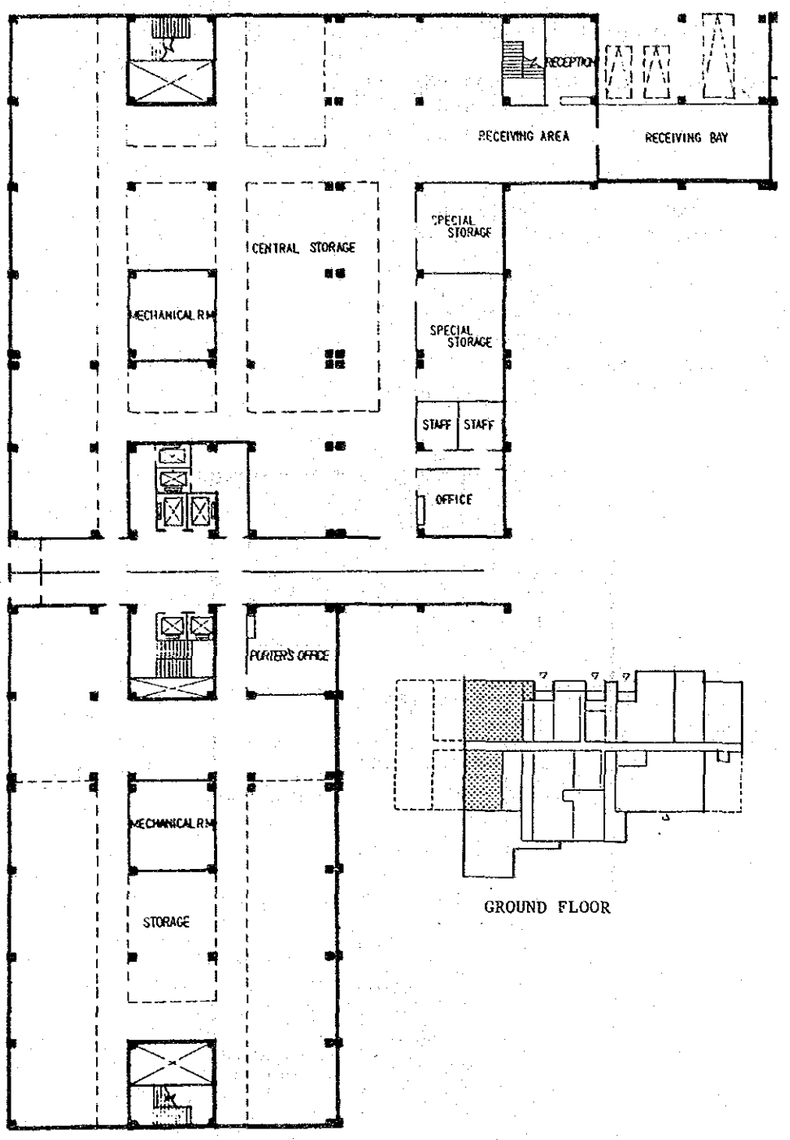


Figure 2-38 Storage and Porter-service Office

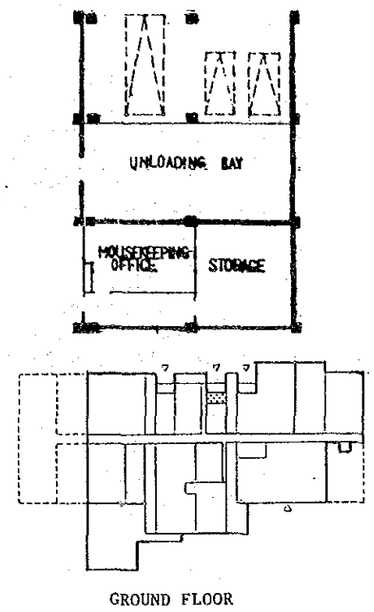


Figure 2-40 Housekeeping Office

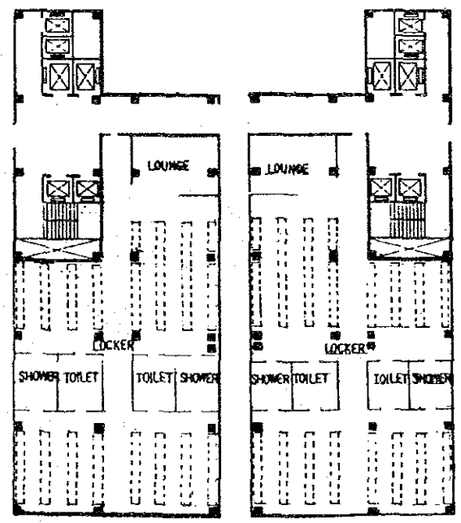


Figure 2-39 Locker Rooms

D. Administration

1) Hospital administration

The office of the key staff and general administration (offices, computer room, reception room, etc.) will be on the first floor of the North Wings (1) and (2).

2) Medical administration

(a) The offices of the medical director will be in the North Wing (1) and South Wing(1).

(b) Medical staff (doctors, chief nurses, and chief paramedical staff) will be provided with rooms on the first and second floors of the South Wing (1).

(c) Rooms for training (lecture rooms, classrooms, library, auditorium, etc.) will be located on the second floor of the South Wing (1).

3) Department administration

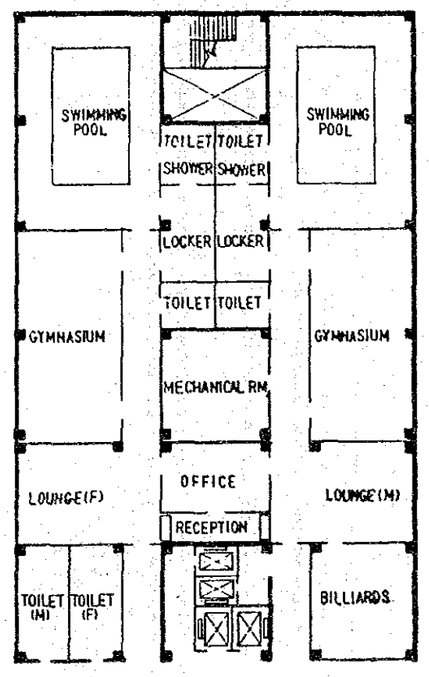
Administration offices (reception counters, medical-chart filing rooms, etc.) will be provided for each department in the Cancer Center and the General Hospital.

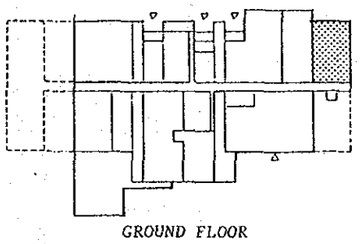
E. Recreation facilities (Figure 2-41)

(a) The recreation facilities will be located on the ground floor of the North Wing (2) for physical exercises and on the roof top of the Central Building for a roof garden.

(b) The recreation facilities on the ground floor will have two swimming pools (male and female), two gymnasiums, a billiard room and other facilities.

(c) The roof garden will be connected to the South Wing (1) and the North Wing (1) by sloping corridors, and will be connected to each floor of the Central Building by elevators. A lounge with coffee shops will also be provided in the roof garden.





GROUND FLOOR

Figure 2-41 Recreation Facilities

2.3.6 Subsystems

A. Internal transporting system

(a) Elevators will be provided for persons and bulky objects (meals, linens, garbage, etc.).

(b) Dumbwaiters will be provided to dispatch small objects (medicines, specimens, medical materials and implements, etc.).

(c) Clinical charts and office documents will be dispatched through pneumatic tubes.

1) Elevators (Figure 2-42)

To be provided as shown in Table 2-3.

Table 2-3 Distribution of Elevators

	Operating Speed	Cancer Center & Joint Use		General Hospital		General Clinic	Total
		South Wing (1)	Central Building	North Wing (1)	North Wing (2)		
Elevators for beds	60 m/min.	2	7	2	2	0	13
General-use elevators	90 m/min.	2	1	2	2	1	8
Meal-service elevators	60 m/min.	1	0	1	1	0	3
Soiled-utilities elevators	60 m/min.	1	0	1	1	0	3
Total		6	8	6	6	1	27

Transportation capacity of general-use elevators in each Wards Building: 880 persons/hour

Transportation capacity of elevators for beds in each Wards Building: 112 beds/hour

2) Dombwaiters

Between CSSD and Surgical Department 3
Between Pharmacy and ICU 2
Between Clinical Laboratory and Surgical Dept. .. 1
Between Blood taking room and Blood Bank 1
Between Cyclotron rooms and RI rooms 1
In General Clinic 4
Total 12

3) Pneumatic tubes

Pneumatic tubes will be systematically arranged to connect the administration offices of the out-patient departments, and diagnosis & therapy departments, nurse stations and the administration office of the service department.

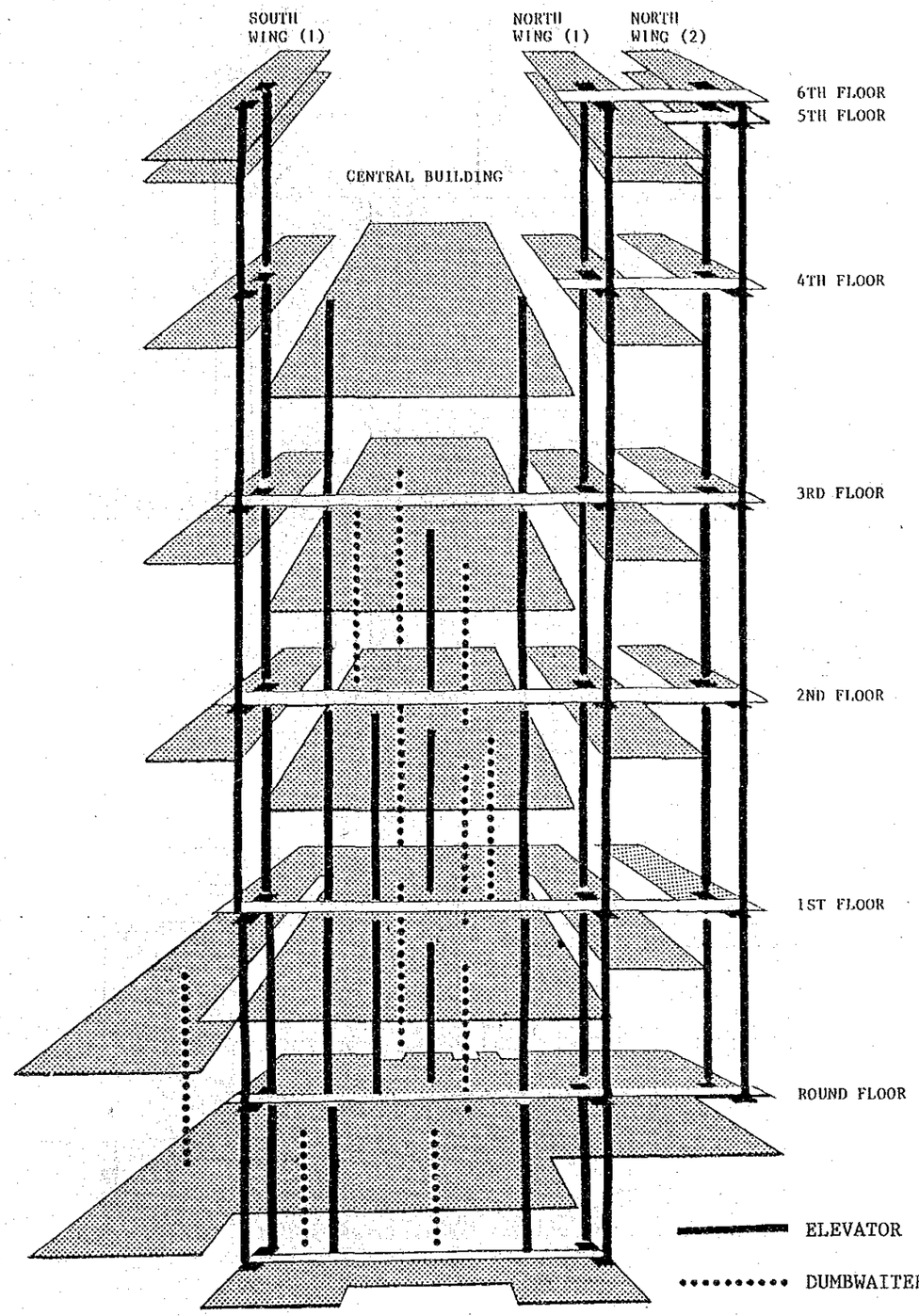


Figure 2-42 Elevators and Dumbwaiters Servicing Various Floors

B. Space planning for utilities

1) Trench system (Figure 2-43)

(a) An underground trench will be provided as the conduit for piping and wiring between the utilities center and the hospital buildings.

(b) The trench will be provided with a passage for maintenance in the middle, and wirings and pipings will be done on the walls on both sides of the trench.

(c) The trench will be extended at the time of the planned extension of the hospital buildings.

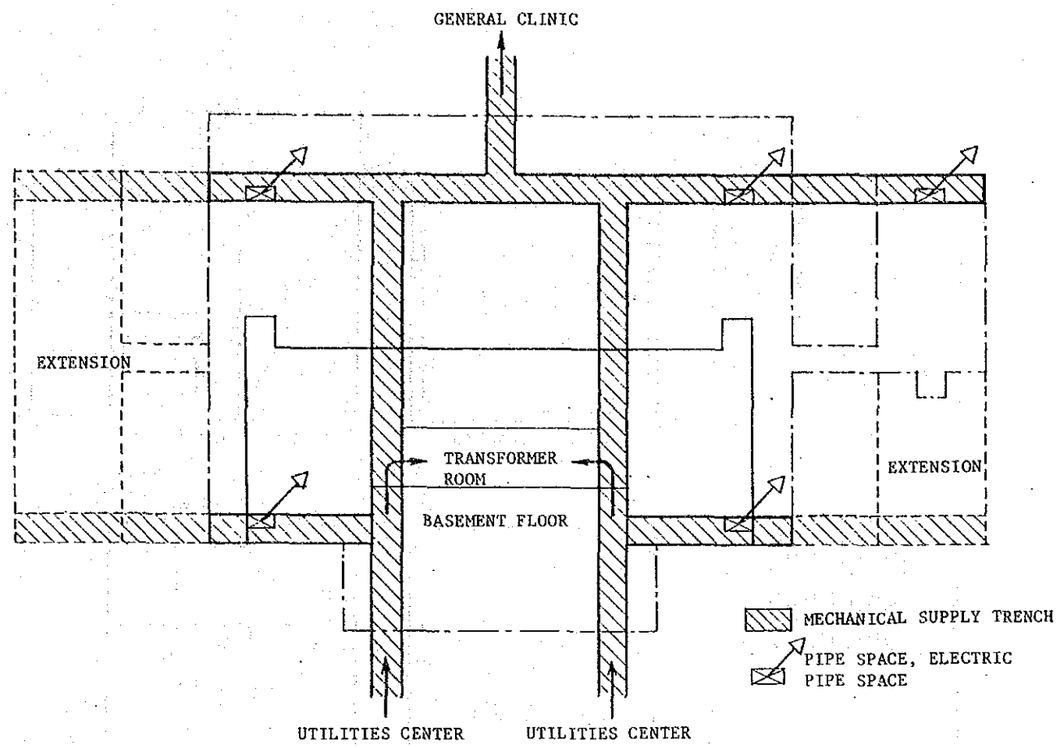


Figure 2-43 Trench Plan

2) Interstitial space (Figure 2-44)

(a) An effective insterstitial space of 1.8 m will be provided in the ceilings of the central diagnosis/ therapy departments and the wards (ground, first and second floors).

(b) Catwalks will be provided along the main piping in the interstitial space to ensure easy maintenance and future renovation.

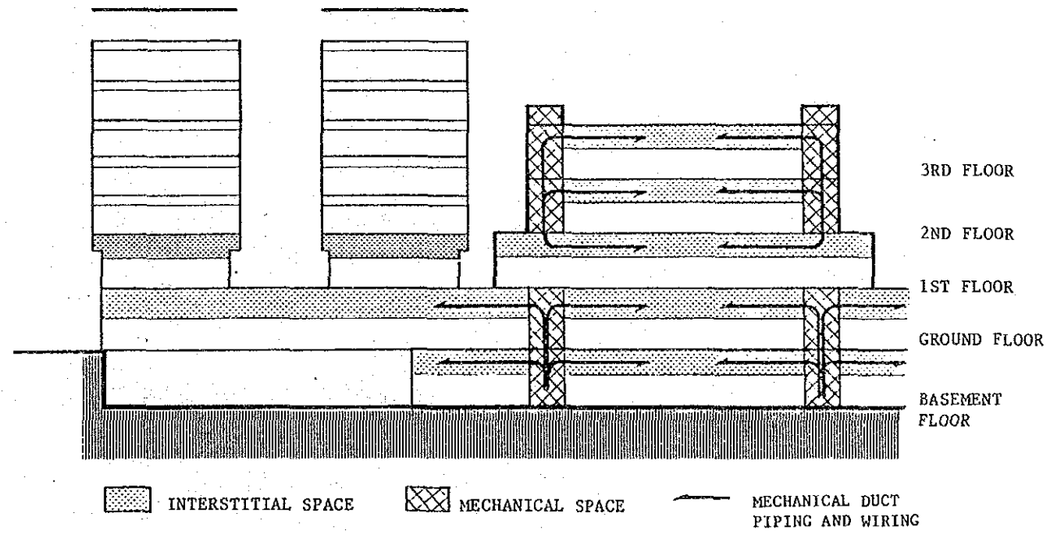


Figure 2-44 Interstitial Space

2.3.7 Building design

A. Grid planning (Figure 2-45)

(a) The basic grid of 7 m x 7 m will be employed as a module for planning all the floors.

(b) Advantages of the grid planning are as follows:

- Enables the use of standardized prefabricated members.
- Is compatible with the economic grid of the reinforced concrete structure.
- Helps Standardize the construction process and reduces the time and costs for construction.

B. Elevation design

(a) Basic concept

- Insulation of heat-receiving surfaces
- Interception of direct solar radiation
- Protection of privacy in the wards
- Modern adaptations of Islamic architectural styles

(b) Traditional arches in Islamic architecture will be employed as the central motif for the buildings.

(c) For protection from the afternoon sun, open corridors will be provided on the lower floors along the entrance side and outer openings will be reduced as far as possible on the upper floors.

(d) Fittings will have heat-insulating louvers and have a simple outer design to give a modern visual effect.

(e) Double roofs will be provided for the wards buildings to insulate heat from solar radiation.

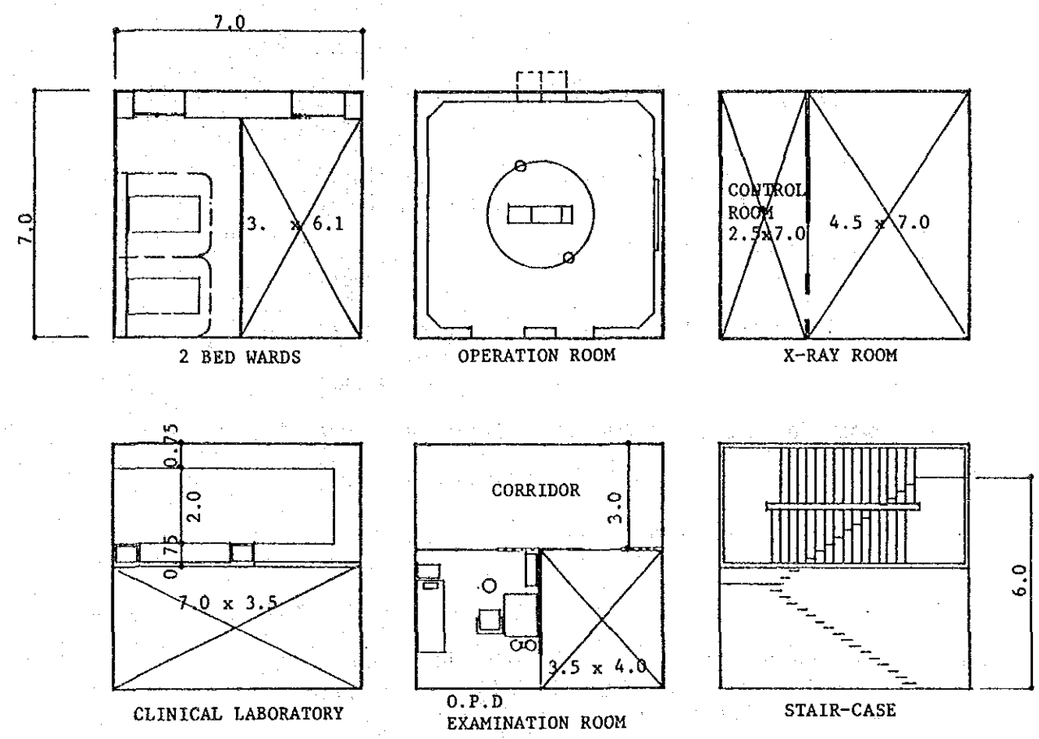


Figure 2-45 7 m x 7 m Grid Model

C. Building elements and systems

1) Exterior walls:

(a) The basic structural frame members, e.g., columns, girders and beams, and floor slabs, will be site-cast reinforced concrete, and the exterior walls will use precast concrete panels.

(b) Advantages of precast concrete panels:

- Greater durability and easy maintenance;
- The same cast forms usable repeatedly for standardized members;
- Reduction of the time and costs of construction;
- Greater accuracy of construction.

(c) Prefabricated double window fittings with a movable louver between the panes will be fitted to the precast concrete panels.

(d) Heat insulation:

Rooftops:	Provided with heat insulation and waterproofing. Wards buildings will be double-roofed to intercept direct solar radiation, and the rooftop of the central building will be provided with a roof garden to disperse heat from solar radiation.
Exterior walls:	Heat-insulating materials will be glued to the inside of precast concrete panels.
Windows:	Air-tight double window fittings with a movable louver

2) Interior walls:

(a) Four kinds of members will be used for interior walls:

Reinforced concrete:	Radiation-proof rooms and mechanical equipment rooms which need sound insulation.
Hollow concrete block:	Permanent fire-resistant walls
Light gage framing with gypsum boarding:	Regular partition walls
Prefabricated metal flushed panels:	Operating rooms, ICU booths, outpatient diagnosis/therapy rooms, etc.

(b) Fittings

Light steel doors:	General entrances, etc.
Light steel sliding doors:	Wards, etc.
Stainless steel doors:	Entrances to operating rooms, etc.
Special doors with internal lead plate:	X-ray and RI rooms, etc.
Air-tight steel doors (sound-proofed):	Mechanical equipment rooms, etc.
Steel doors:	Outer entrances, fire doors, entrances to utilities shafts, etc.

3) Prefabricated ceiling panels

(a) Rooms which call for no special ceiling specification will be provided with standardized ceilings with openings for lighting fixtures and air-conditioning outlets and inlets.

D. Finish schedule

1) Exterior finish

Roofs: Waterproofing with insulation and precast concrete cover

Walls: Saudi Arabian Marble pitching

Floors (open corridor): Marble pitching

2) Interior finish

(a) Entrance of lobbies

Ceilings: Mineral fiber foam board
Walls: Marble pitching
Floors: Marble pitching

(b) VIP Wards

Ceilings: High quality wall paper
Walls: High quality plywood
Floors: Carpet

(c) Wards

Ceilings: Mineral fiber board
Walls: Plastic wall paper
Floors: Vinyl chloride sheet

(d) Examination rooms, Clinical laboratory, X-ray rooms, etc.

Ceilings: Mineral fiber board
Walls: Emulsion paint finish
Floors: Vinyl chloride sheet

(e) Operating rooms

Ceilings: Mineral fiber board
Walls: Baked paint steel wall panel
Floors: Conductive tile or epoxy resin-coated floor

(f) Offices

Ceilings: Mineral fiber board
Walls: Emulsion paint finish
Floors: Vinyl asbestos tile

2.4 Other Facilities

2.4.1 Housing

A. Site planning and circulation (Figure 2-46)

(a) The main entrance gate will face the east-side public road, approximately at the center of the site.

(b) The zoning will be divided into a villa zone, a married zone, a male zone, a female zone and a recreation zone. The recreation zone will be located in the center of the housing zone and along the utilities center. The villa zone will be at the far north end of the housing zone and the female zone will be located at the south side.

(c) The zones will be separated by a road and walkways. A north-south main road will be located along the recreation zone. The zones will be enclosed by roads and provided with garbage pools.

(d) Parking spaces will be provided for the villa, the married, the male and the recreation zones. The ground level of the married and male apartment zones will have piloti parking. All open parking space will provided with covering structures for protection from sun and rain.

(e) Each zone and/or building will be provided with walls (1.8 m height) for security.

B. Building design

(a) The villas will be composed of terrace houses, while the residences for married staff and senior nurses will be of multi-storied flats; for bachelors they will be of multi-storied studio type apartments, and for single nurses and female staff they will be of multi-storied two-bed dormitory type.

(b) The recreation center building will be facing the plaza. A restaurant overlooking the outside pool will be located in it. Two tennis courts, squash courts and children's play lots will also be located in the recreation zone.

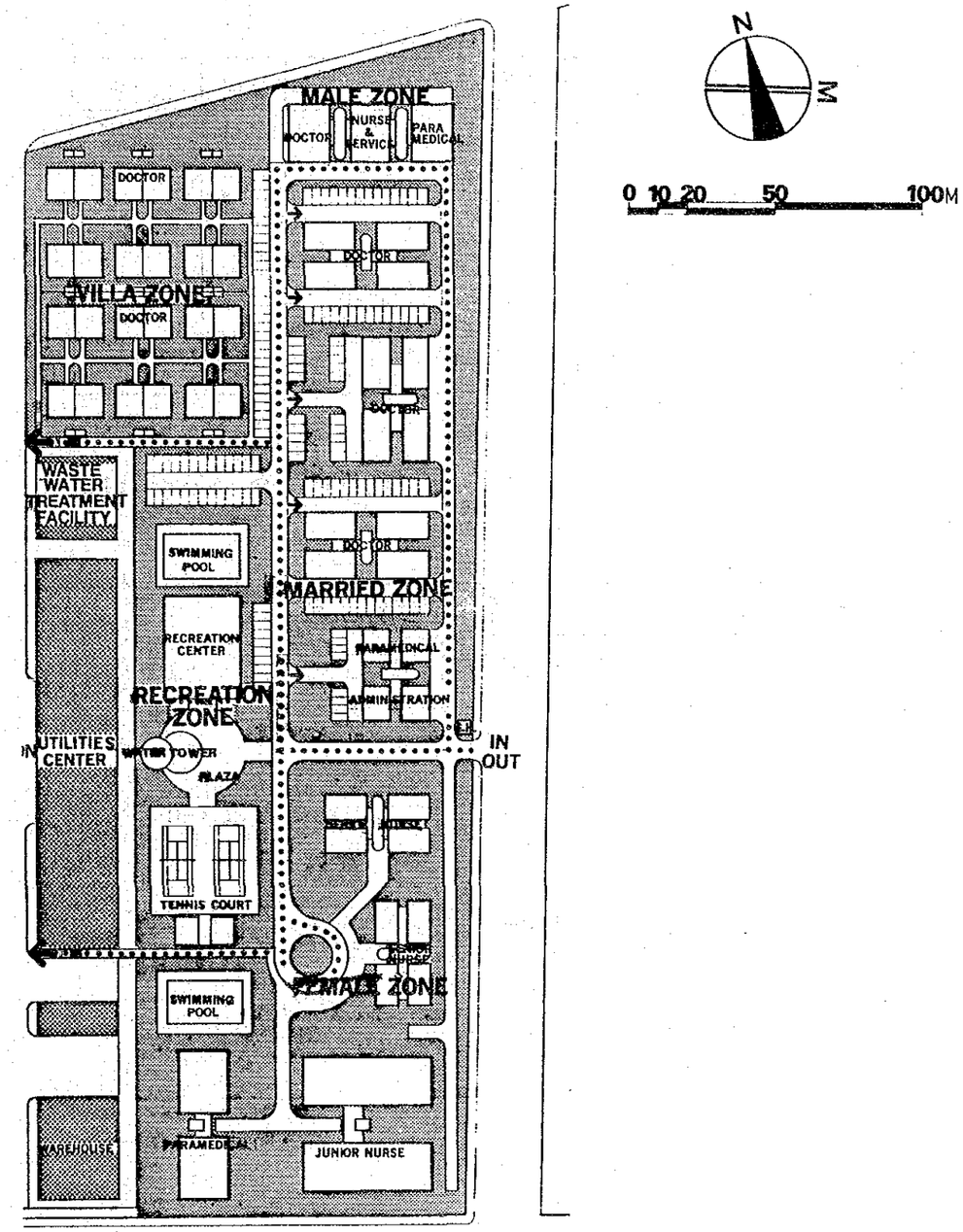


Figure 2-46 Site Plan

C. Data on housing

(a) Number of units and inhabitant staff

Zone	Building Types	Kinds of Inhabitants	No. of Units		No. of Staffs	
Villa	Court-house (V)	Doctors	24		24	
Married	Flat (M-1)	Doctors	84	112	84	112
	Flat (M-2)	Paramedical staff	16		16	
	Flat (M-2)	Maintenance and service staff	12		12	
Male	Studio type (S-1)	Doctors	28	112	28	112
	Studio type (S-2)	Male nurse	16		16	
	Studio type (S-2)	Paramedical staff	34		34	
	Studio type (S-2)	Maintenance and service staff	34		34	
Female	Flat (S-3)	Senior nurses	112	512	112	912
	Two-bed room (S-4)	Junior nurses	300		600	
	Two-bed room (S-4)	Female paramedical	100		200	
Total		Doctors	136	760	136	1,160
		Nurses	428		728	
		Paramedical staff	150		250	
		Maintenance and service staff	46		46	

(b) Types of units

Type		A. No. of Units in Each Floor	B. No. of Stories	C. No. of Buildings	D. Total Units	F. Floor Space of Each Unit
V	Doctors	2	2	12	24	207.0 m²
M-1	Doctors	4	7	3	84	172.8 m²
M-2	Paramedical, Maint. & Service Staff	4	7	1	28	115.2 m²
S-1	Doctors	4	7	1	28	60.5 m²
S-2	Paramedical, Maint. & Service Staff	12	7	1	84	40.3 m²
S-3	Senior Nurses	8	7	2	112	60.5 m²
S-4	Junior Nurses	46	7	1	300	21.6 m²
S-4	Female Paramedical Staff	16	7	1	100	21.6 m²

(c) Estimated number of occupants

Zone	Type	No. of Units	No. of Occupants per Unit	Total Occupants by Type	Total Occupants by Zone
Villa	V	24	4	96	96
Married	M-1	84	4	336	434
	M-2	28	3.5	98	
Male	S-1	28	1	28	112
	S-2	84	1	84	
Female	S-3	112	2	224	1,024
	S-4	400	2	800	
Total				1,666	

(d) Number of parking stalls

	Villa Zone	Married Zone	Male Zone	Female Zone	Recreation Zone	Total
Number of Stalls	30	172	24	0	36	262

(e) Ratio of total ground floor and total floor spaces to housing zone

	$\frac{\text{Total Building Area}}{\text{Housing Zone Area}}$	$\frac{\text{Total Floor Space}}{\text{Housing Zone Area}}$	$\frac{\text{Persons}}{\text{Housing Zone Area}}$
Proposed Plan	$\frac{11,250\ m^2}{48,837\ m^2} = 23.0\%$	$\frac{53,490\ m^2}{48,837\ m^2} = 109.5\%$	$\frac{1,666\ \text{persons}}{48,837\ m^2}$ $\left[\frac{341\ \text{persons}}{10,000\ m^2}\right]$

2.4.2 Parking

A. Parking building

(a) The multi-storied parking building, with the General Clinic on the first floor, will be built on the west side of the site.

(b) The vehicular circulation will be based on a one-way traffic system.

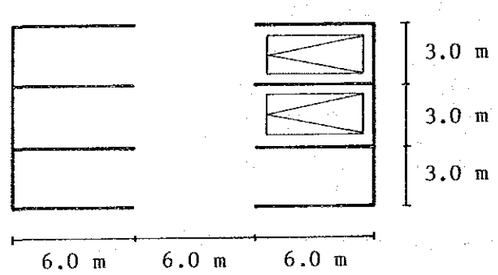
(c) The parking space on the first, the ground and the basement first floors will be for patients and visitors only. The basement second floor will be for patients, visitors and staff, and the basement third floor at the bottom will be for staff only.

(d) A passageway located between the ground and the first floors will lead to the General Clinic and the Cancer Center from a bus stop along the public road to the west.

(e) The various floors of the parking building will be serviced by four elevators and three stairways.

B. Size of parking

(a) The basic size of the parking stalls and the parking street will be as follows:



C. Number of stalls (Table 2-4)

(a) The parking spaces will be located on the ground floor of the hospital and on the open ground in the site, as well as in the parking building.

Table 2-4 Number of Parking Stalls in the Hospital Zone

		Number of Stalls				Total
		Patients & Visitors	Staff	Emergency Patients	Services	
Parking Building	1st Floor	100	-	-	-	1,882
	Ground Floor	425	-	-	-	
	Basement 1st Floor	443	-	-	-	
	Basement 2nd Floor	232	211	-	-	
	Basement 3rd Floor	-	471	-	-	
Hospital and Outdoor	Ground Level	-	-	52	213	641
	Basement	-	376	-	-	
Total		1,200	1,058	52	213	2,523

2.4.3 Mosque

(a) The Mosque will be located on the east side of the main entrance gate to the hospital to provide easy access from the hospital and the housing zone.

(b) The praying hall will accommodate approximately 500 persons.

(c) The minaret will be located on the north side of the mosque and will be 23.5 m high.

2.4.4 Overnight accommodations

(a) The overnight accommodations will be located between the Mosque and the main entrance gate to the hospital to provide easy access from the outside and from the hospital.

(b) Forty-four two-bed rooms will be provided, together with an office and a shop on the ground floor.

2.4.5 Utilities center

(a) Two underground utilities trenches will be placed between the utilities center and the hospital.

(b) Water tanks and pumps will be located on the basement floor and a main station for power and heat sources will be located on the ground and first floors.

(c) The waste water treatment facilities will be located underground, beside the utilities center.

(d) The utility equipment and architectural fittings will be stored in the warehouse above the RI waste water treatment facilities.

(e) The deceased bodies, the wastes generated from the research animals and other such waste matters (excluding garbage) will be conveyed from the hospital basement floor through the underground trenches to the utilities center, and from there be elevated to the ground floor by two elevators.

(f) The water tower will be located in the recreation zone facing the plaza.

2.3.6 Ancillary facilities

A. Guard houses

(a) A guard house will be located at each entrance gate of the site.

B. Liquid oxygen tanks

(a) Liquid oxygen tanks will be located on the south side of the site beside the warehouse. A medical gas service room will be in the warehouse.

C. Oil tanks

(a) Oil tanks will be underground on the south side of the site.

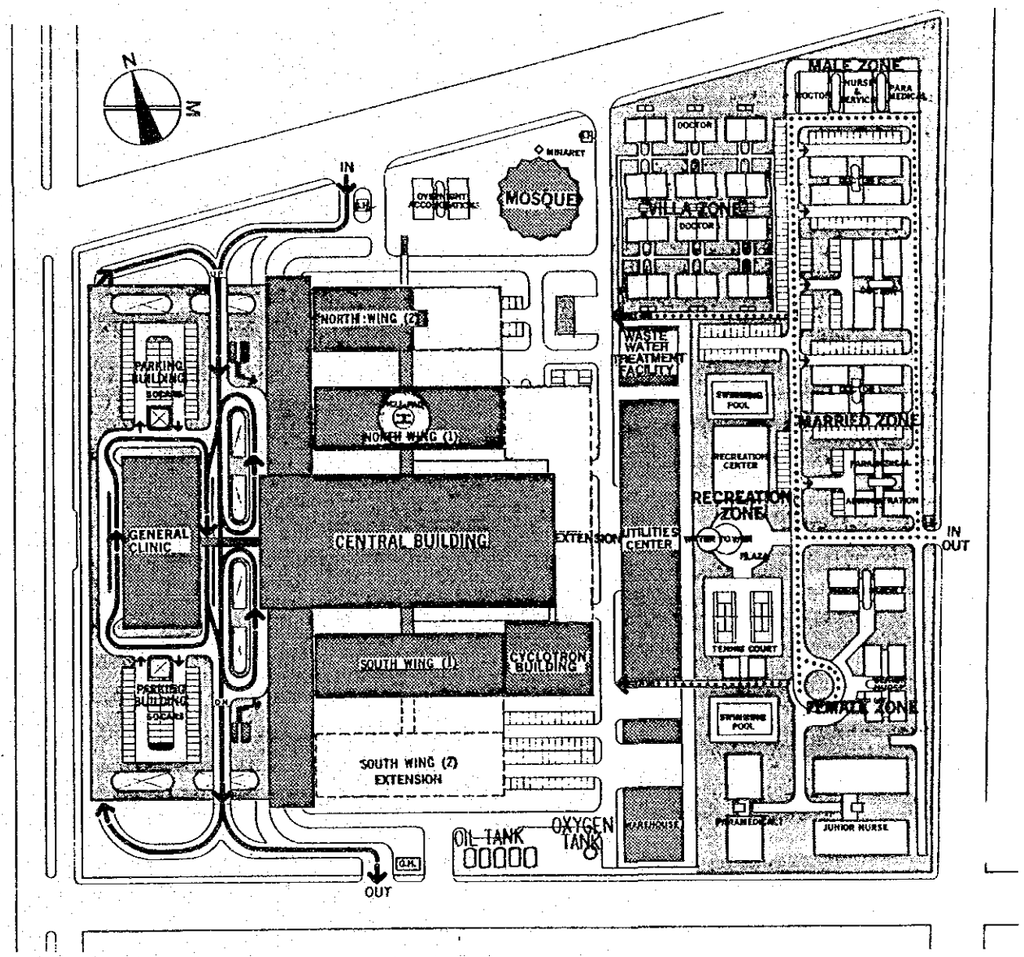


Figure 2-47 Site Plan

3. STRUCTURAL SYSTEM

3. STRUCTURAL SYSTEM

3.1 General

The project site is located at lat. 21°28"N and long. 39°1"E. Maximum temperature not infrequently exceeds 40°C, and the surface temperature of the buildings climbs even higher. The structural planning, therefore, has to consider the influences on the structures from the wide variation of the outdoor temperature and the differences between indoor and outdoor temperatures. Concrete placed under high temperature, for instance, will lead to construction cracks due to rapid drying. After careful examination of stress and deformation effects by temperature changes, it is concluded that the length of the buildings should be sub-divided into 30 to 50 meters or even less (Appendix 3-1).

Two major advantages from the subdivision are:

(a) Concrete placement at one time will be kept down to an appropriate volume, enabling an efficient flow from the concrete mixing plant.

(b) Subdivision of construction lots will raise the efficiency of work logistics.

3.1.1 Structures of various buildings

A. Hospital (Central Building)

Reinforced concrete structure; four floors above ground, with a one-floor basement.

B. Wards

Reinforced concrete structure; eight floors above ground, with a one-floor basement.

C. Parking building and general clinic

Reinforced concrete structure; two and partly three floors above ground, with a three-floor basement.

D. Mosque

Steel structure (space frame); one floor

E. Residential housing

Villa zone	Reinforced concrete structure; two floors
Male zone	Reinforced concrete structure; eight floors
Married zone	Reinforced concrete structure; eight floors
Female zone	Reinforced concrete structure; seven floors
Recreation center building	Reinforced concrete structure; two floors
Overnight accommodations	Reinforced concrete structure; six floors

F. Utilities center

Steel structure; one and partly two floors above ground with one-floor basement. The underground structure will be of reinforced concrete.

G. Waste water treatment facilities

Reinforced concrete structure; underground

H. Water tower

Steel structure

3.1.2 Design criteria

With regard to concrete member design, the United States and the United Kingdom both employ the ultimate strength design, but the two countries differ in the treatment of buckling with regard to structural steel member design (see Appendix 3-2 for detailed comparison). The structural design criteria employed for the present project, as shown below, refer to the US codes and standards which have more detailed design manuals and other information.

Stress analysis	Elastic analysis
Concrete member design	ACI 318-77
Structural steel member design	AISC, AWS
Loads	UBC and ANSI

3.1.3 Soil and foundation

According to the report of a soil survey conducted at the project site in 1976, the soils consist of slightly clayey sand and gravels with some rocks and are highly uniform and compact. From 60 to 120 cm in depth from the surface, there is a subsoil layer with a resistibility of over 200 bars, which is considered adequate to support the foundation works of the buildings. Further below, from 4.0 to 7.0 meters from the surface, there is another, much harder, layer with a resistibility exceeding 1,000 bars. A more detailed soil survey will be needed to identify a suitable boring method and range for this lower layer (see Appendix 3-2).

A. Soil-bearing capacity

It is reasonably expected that the upper layer of over 200 bars has the long-term soil bearing capacity of 40 tons/m², whereas the lower layer of over 1,000 bars has the capacity of 100 tons/m².

B. Foundation

All the buildings will be provided with direct foundation works on the layer of over 200 bars.

3.1.4 Materials

A. Concrete (sulfuric acid proof cement)

Codes and standards for design materials:

ASTM (US)	C94 (quality of concrete); C39 (Concrete test); C150 (quality of Portland cement); C33 (quality of aggregates)
JIS (Japan)	A1101 to A1138 (concrete test); JASS5 (quality of concrete); R5210 (quality of Portland cement)
BS(UK)	3148 (water-cement ratio); 12 (Portland cement); 1881 (concrete test); 4027 (sulfide proof Portland cement); 882 & 1201 (natural aggregates)

Compressive yield strength:

fc = 3 ksi	The villas and the mosque
fc = 4 ksi	Hospital, wards, general clinic and parking building, utilities center, the recreation center building and the residential houses except the villas.

B. Reinforcement

Codes and standards for design materials:

ASTM	A29 & A615 (steel bars); ACI 318-77 (reinforcing steel process of reinforcing steel)
JIS	G3112 & G3117 (steel bars); Ministry of Construction & Architectural Institute of Japan codes (bending process of reinforcing steel)
BS	4449 (hot rolled steel bars); 4461 (cold finished steel bars); 4466 (bending process of reinforcing steel)

Tensile yield strength:

fy = 40 ksi (Gr 40)	The villas and the mosque
fy = 60 ksi (Gr 60)	Hospital, wards, general clinic and parking building, utilities center, the recreation center building and residential houses except the villas.

C. Structural steel

Codes and standards for design materials:

ASTM	A6 (quality of materials); AWS (welding standards); AISC (steel structure code)
JIS	G3192 & G3350 (quality of materials); G3444 (carbon steel tubes for general structural purposes); Architectural Institute of Japan Code (steel structure)
BS	4, Parts 1 and 2, (quality of materials); 5135 (metal-arc welding); 449 (steel structure code)

Tensile yield strength:

fy = 36 ksi	The Utilities Center, the water tower and the mosque

3.1.5 Design load

A. Live load

Live load is shown by room or building in Table 3-1.

Table 3-1 Live Load

(UBC or ANSI)

Room	Live Load		Remarks
	PSF	kg/m²	
Roof	20	100	
Roof garden, helipad	100	490	Concentrated load of helicopters considered separately
Wards, nurseries, toilets, ICU CCU, CCUR	40	200	
Storage, bathrooms, soiled utilities	125	625	
Administration, VIP wards, offices	50	250	
Hemodialysis, blood bank, clinical laboratory, out-patient depts., physiology, and other research rms.	60	300	Load of heavy equipment considered separately
Auditorium	50	250	
Radiodiagnosis, rehabilitation	100	490	
Surgical dept., delivery rms.	60	300	
Entrance hall, corridors, dining hall	80	400	
Kitchen, laundry	150	740	
Parking building	100	490	
Main driveway, service zone	250	1,220	Load of heavy vehicles (20 t) considered separately
Utilities (Fan room)	100	490	Load of heavy equipment considered separately
(ditto)	150	740	
(Boiler rm.)	300	1,470	
(Power intake & transformer)	200	980	
Library (Reading rm.)	60	300	
(Stack rm.)	150	740	
Residential houses	40	200	

B. Wind load (ANSI)

Exposure: C (flat, open country)

Maximum instantaneous wind velocity: 48 knots/h
48 x 6,080 = 291,840 ft/h

Wind load (W):

$W = Qp \times Cp \times A$ ---------- (1)

where,

Cp = external pressure coefficient for walls; windward Cp = 0.8 and leeward Cp = -0.6,

A = area in square feet, and

Qp = effective velocity pressure on parts and portions of buildings and structures

$Qp = Kz \cdot Gp \cdot Q_{30}$ ---------- (2)

$Q_{30} = 0.0256\ V_{30}^{2}$

V_{30} = 291,840 ft/h ÷ 5,280 = 55.3 miles/h

where,

Kz = velocity pressure coefficient at height Z (height above ground in feet), which varies with the type of exposure,

Q_{30} = basic wind pressure in psf, and

V_{30} = basic wind speed in miles per hour.

Taking the design basic wind speed of 60 miles/h, Qp is calculated from the equation (2) as follows:

Height		Qp	
ft	m	psf	kg/m²
30 or less	9.0 or less	14	70
50	15.0	15	75
100	30.0	18	90
150	45.0	19	95
200	60.0	20	100
250	76.0	21	100

W can be obtained by applying Qp and other values to the equation (1).

C. Seismic load

According to the information made available at the Department of International Earthquake Engineering of Building Research Institute, Seismic zone is existing in the center of the Red sea, the offing from Al-quntudhah. (Figure 3-1)

Table 3-2 Seismic Records within 500 km from Jeddah

Dates	N Lat.	E Long.	Depth	Magnitude	Distance from Epicenter[1]	Surface Acceleration[2]
1913 2 27	17.5	39.0	0	5.8	418	12.2
1913 3 27	16.5	39.0	0	5.5	529	9.2
1915 9 23	16.0	39.0	0	6.8	584	16.1
1921 8 14	15.5	40.5	0	5.6	656	8.5
1942 11 18	12.0	40.0	0	5.6	1,031	6.5
1955 11 12	25.3	34.58	0	6.0	647	10.3
1967 3 11	19.67	38.74	31	6.3	185	25.3
1967 5 17	19.68	38.68	33	5.8	185	14.9
1969 3 31	27.67	33.99	33	7.1	832	15.1

Notes: 1) Distance from the epicenter is calculated by the scale of 110.7 km per lat. 1° and 103.97 km per long. 1° in the area around lat. 21°N.

2) Surface acceleration (a) for the diluvial formation is obtained from the equation;
$a = 28.50 \times 10^{0.207M} \times D^{-0.598}$,
where M stands for magnitude and D for distance from the epicenter.

Source: Figures in the first four columns are taken from the computer printout obtained from the Building Research Institute, Ministry of Construction by the courtesy of Dr. Hattori.

According to a study on the effects of earthquakes, the base shear (Cb) of buildings is measured to be around 0.2 during earthquakes with the surface acceleration of 80 to 100 gals.

As shown in Table 3-2 above, earthquakes which occur with a probability of once every ten years have the surface acceleration of approximately 15 gals, and those with a probability of once every seventy years, 25 to 30 gals. On the basis of this finding, it is judged that the surface acceleration suitable to determine the design base shear for the present project is 15 gals. Structures will be so designed that they may show cracks but will not collapse from earthquakes with the surface acceleration of 30 gals. The design base shear for the present project is thus calculated to be as follows:

Cb = 15/100 x 0.2 = 0.03

The structures which must withstand natural disasters will be strengthened by an occupancy importance factor (I) of 1.5 and for other structures (I) will be 1.0.

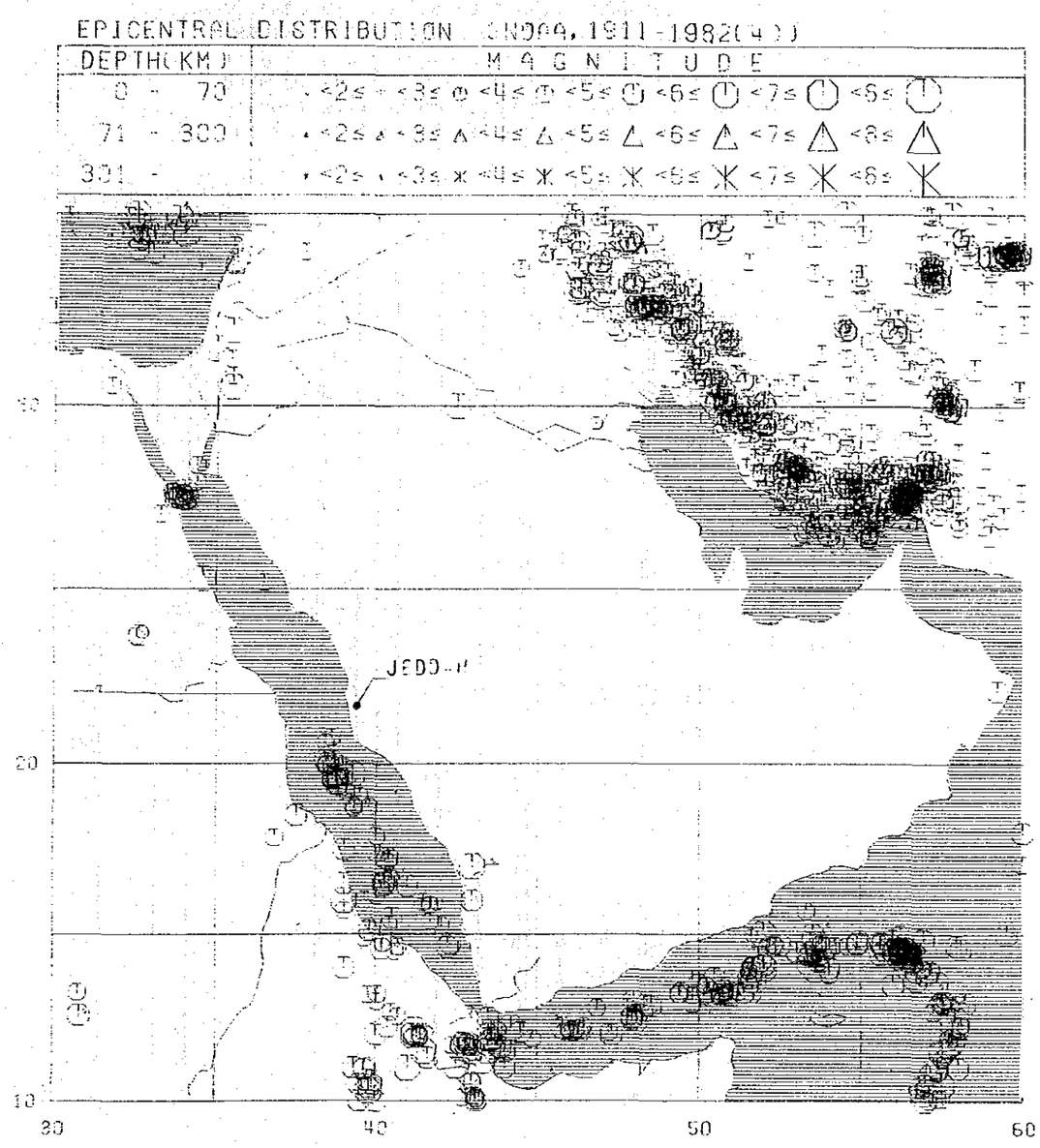


Figure 3-1 Epicentral Distribution

3.2 Systems

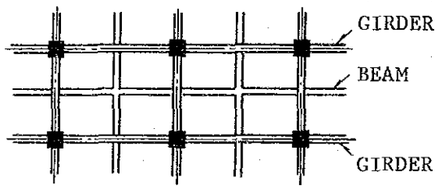
3.2.1 Hospital (Central Building) (Figure 3-2)

A. Structure and scale

Reinforced concrete structure and four floors above ground with one-floor basement.

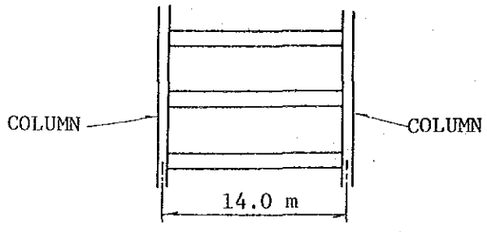
B. Beams

Because partition walls will be made of concrete blocks and thus the plane framework of partitions will not be uniform, the rigidity will be increased by smaller slab partitions by adding cross beams, as shown below.



C. Columns

Concentrated vertical load will be larger in places where the span of column spacing is 14.0 m, and considering the added axial force during an earthquake, the column depth will have to be much larger. Therefore, it is decided not to provide a main column in the mid-point of a 14.0 m beam, as shown below.



D. Foundation girders

A visual slenderness effect must be considered with regard to the columns of the ground floor. However, the floor height is 5.5 meters, which is higher than elsewhere, and thus would require a larger column depth when pin supports are to be employed to the base of the columns. Accordingly, it is decided that foundation girders will be employed to secure the base of the columns and to obtain a better visual effect.

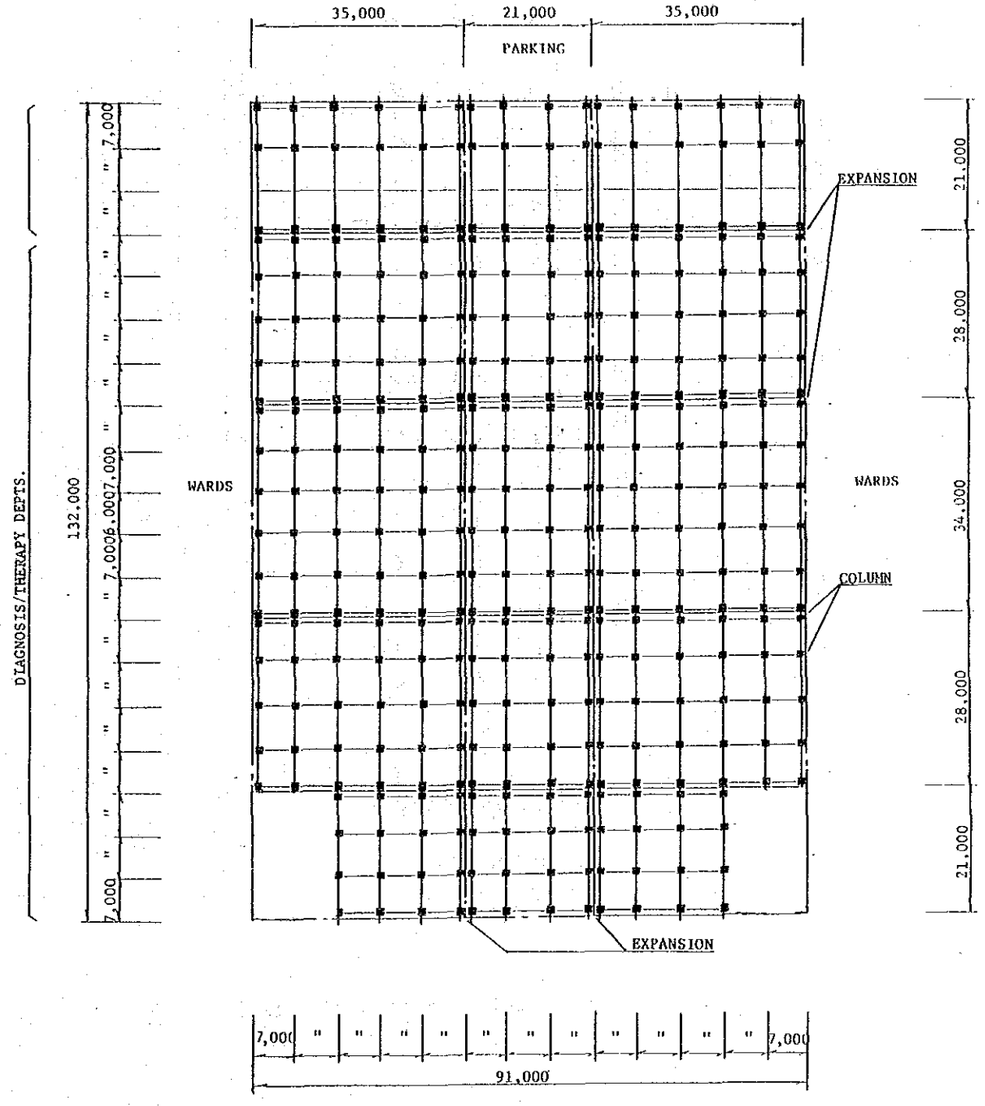


Figure 3-2 Framing Plan (Typical Floor)

3.2.2 Wards (Figure 3-3)

A. Structure and scale

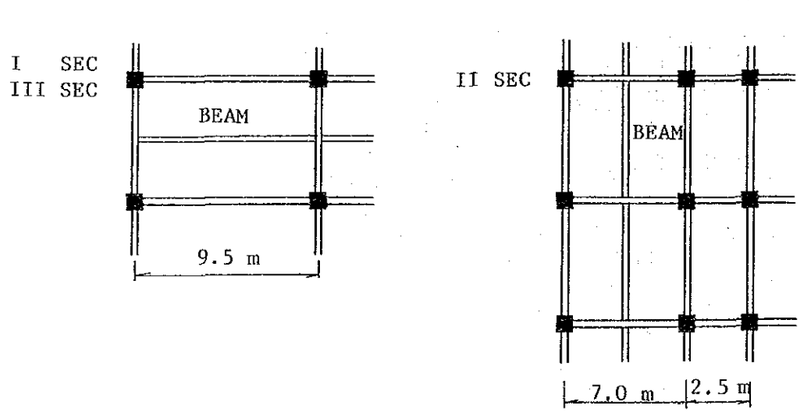
Reinforced concrete structure and eight floors above ground with a one-floor basement.

B. Columns

Section II, where the helipad will be constructed on rooftop, has a larger live load, requiring a considerably higher beam depth to the column section than elsewhere. Therefore, mid-point columns will be provided to the 9.5 meter-span beams of the entire floors.

C. Beams

With regard to Sections I, II and III, partition walls of concrete blocks will be randomly segmented in the central areas with a beam span of 7.0 meters, requiring crossbeams similar to the Central Building. In other sections, beams will be arranged as shown below.



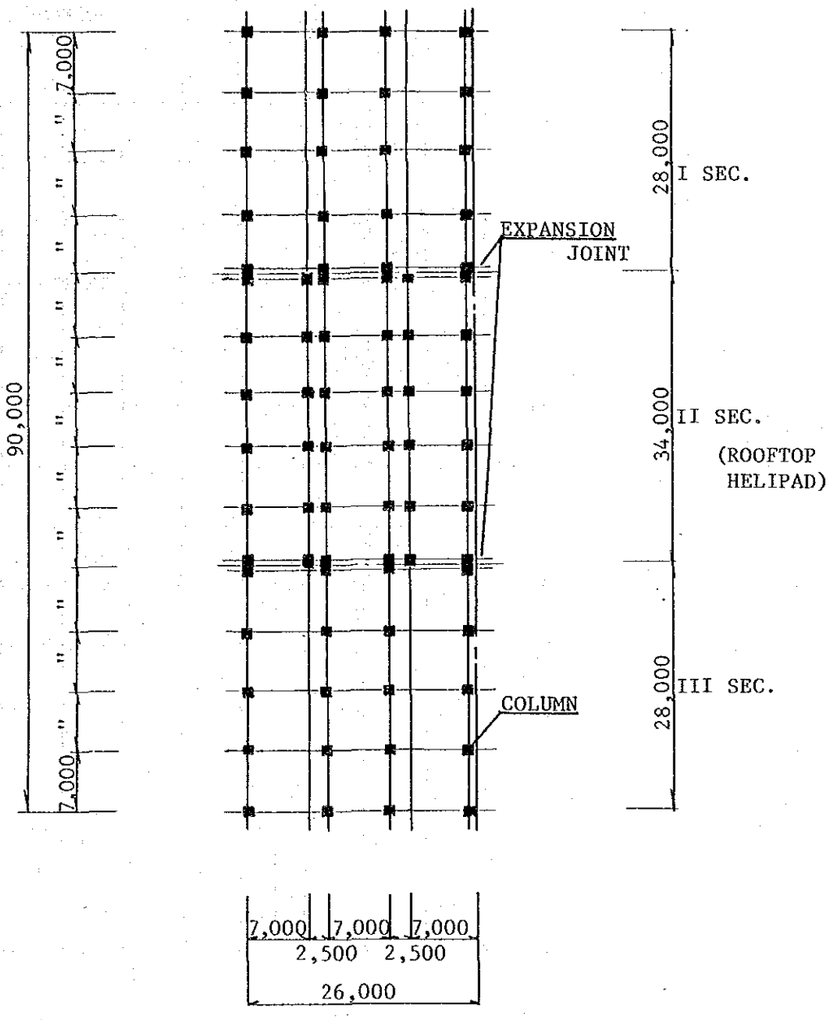


Figure 3-3 Framing Plan (Typical Floor)

D. Foundation girders

Same as in the Central Building.

3.2.3 General clinic and parking building (Figure 3-4)

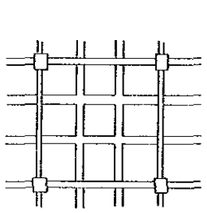
A. Structure and scale

Reinforced concrete structure and three floors above ground with a three-floor basement.

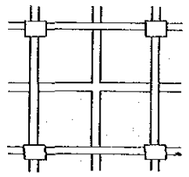
The first and second floors above ground will be used as a general clinic, while the ground and basement floors will be used for parking. The overhead passageway connecting the General Clinic and the Hospital will be of a 31.5 m steel frame truss.

B. Beam

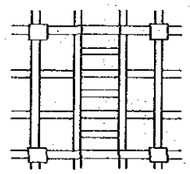
The elevated approach road to the Hospital and the General Clinic will be designed to carry the load of an ordinary public road, since heavy vehicles such as large buses and fire engines may run on it. The parking on the ground and basement floors will be for vehicles such as sedans and small trucks.



1ST FL. BEAMS UNDER THE APPROACH ROAD

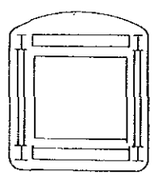


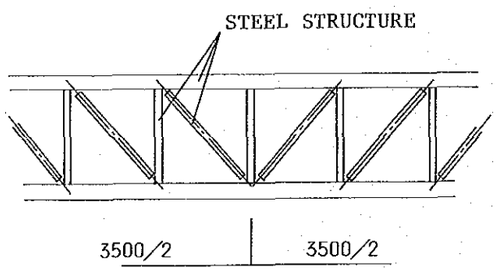
BEAMS UNDER THE GENERAL PARKING AREA



1ST FL. BEAMS ABOVE THE PASSAGEWAY

C. Overhead passageway





D. Expansion

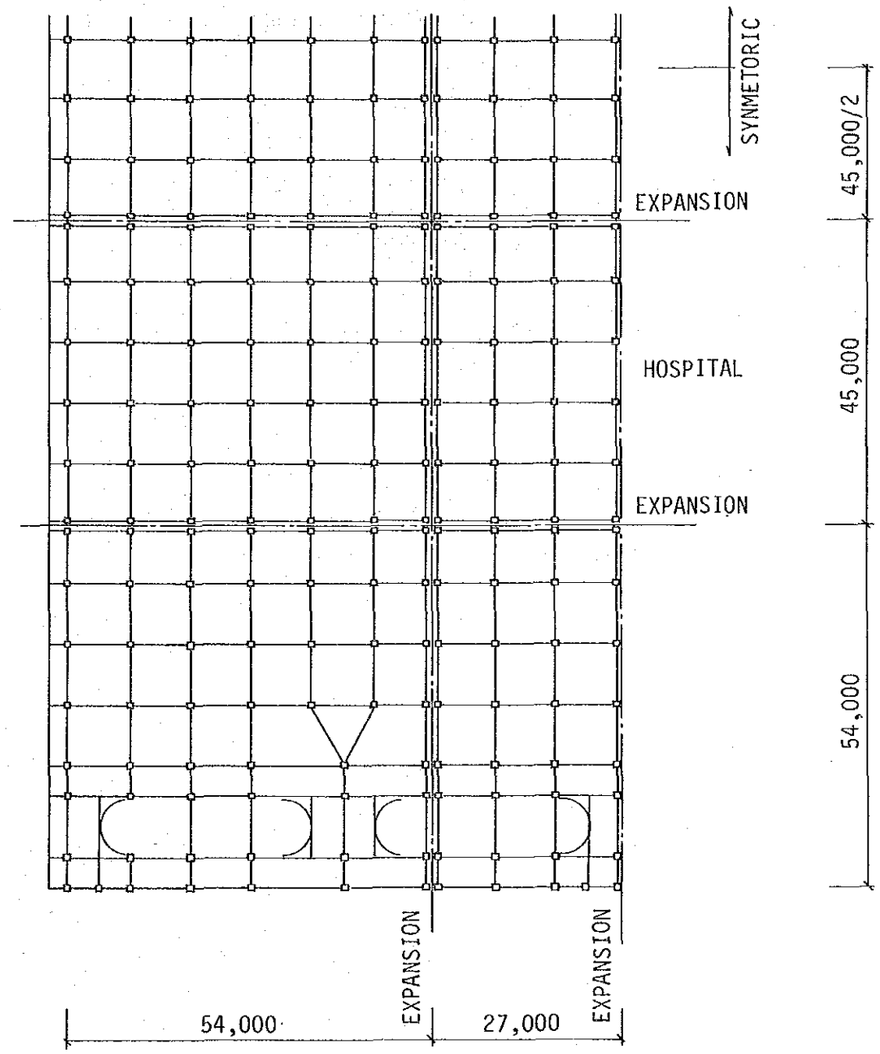


Figure 3-4 Framing Plan (Typical Floor)

3.2.4 Buildings for housing and overnight accommodations

A. Structure and scale

Reinforced concrete structure and the number of floors are shown in Table 3-3. As shown in section 3.1.4, the material strength of each structure, such as steel reinforcement and concrete, is changed in accordance with the size of the structure.

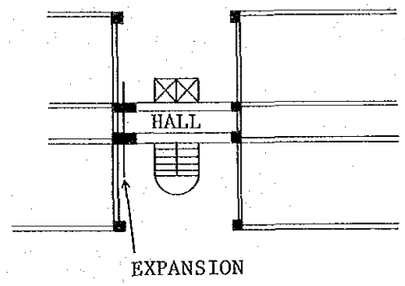
Precast concrete panels will be used for the exterior walls, and concrete blocks will be used for the interior partition walls.

Table 3-3 Various Structure of Housing

Names of Building	No. of Floors	Maximum Length of Structure	Expansion	Concrete Length	Steel Reinforcement Strength
Villa	2	19.2	-	3 ksi	40 ksi
Apartments for single male	8	57.6	-	4	60
Apartments for married doctors	8	43.2	0	4	60
Apartments for married paramedical	8	31.2	0	4	60
Apartments for senior nurses	7	45.6	-	4	60
Apartments for junior nurses	7	50.4	0	4	60
Apartments for female paramedical	7	50.4	0	4	60
Recreation Center Building	2	30.0	-	4	60
Overnight accommodations	6	26.4	-	4	60

B. Expansion

Thermal stress will concentrate at the joint portions of the hall connecting the building of the married zone for doctors and paramedicals and the dormitory of the female zone for paramedicals. Expansion joints will be provided for the hall portion since dry shrinkage cracks will occur in the concrete. Expansion joints will also be provided for the lounge portion between the two buildings of the junior nurses' dormitory.



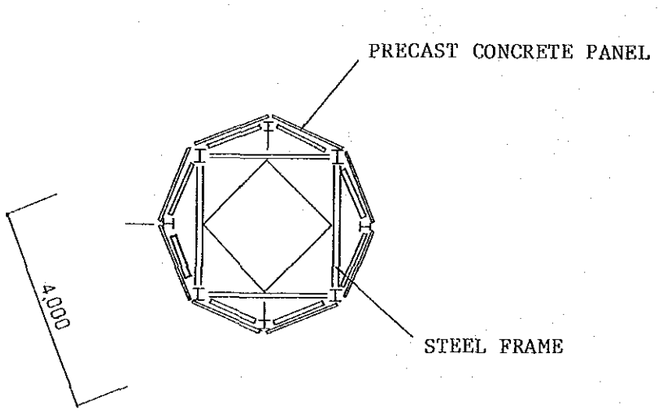
3.2.5 Utilities center and water tower

A. Structure and scale

The ground floor will be of reinforced concrete and the floors above the ground floor level will be part of a steel frame structure. The first and second floors will be a deck floor structure, and heavy items such as machinery will be supported by cross beams. Cross beams will be arranged to prevent heavy items from being placed on the slab and to be able to accommodate changes in machine arrangement.

B. Water tank tower

The water tank will be designed to be placed 65 m above the ground level and will have a volume of 150 m^3. A safety factor of two times will be considered, since should the tower fall due to some natural disaster, the damage will extend over a wide area. Steel frames which are of a uniform quality and which can be fabricated to high precision will be used for the main structure, and the exterior will be covered with precast concrete panel.

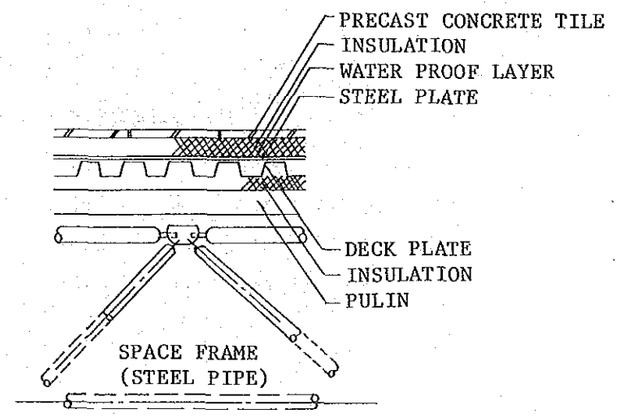


3.2.6 Mosque

A. Structure and scale

The roof structure of the Mosque will be a space frame structure constructed with steel pipes. The exterior walls and the column will be of reinforced concrete.

The exterior walls and the columns are arranged to construct a 16-face structure which will resemble a 38 m cylinder. The space frame for the roof will be an octagonal shape supported at 8 points. The roof will be constructed as shown in the figure below to provide a light weight roof with adequate insulation.



The minaret will be a square tower of 150 cm (outer dimension) and 100 cm (inner dimension).

4. AIR-CONDITIONING AND VENTILATING SYSTEM

4.1 General

- 4.1.1 Design concepts
- 4.1.2 Design criteria

4.2 Systems

- 4.2.1 Refrigeration systems
- 4.2.2 Air-conditioning piping
- 4.2.3 Air-handling system
- 4.2.4 Ventilating system
- 4.2.5 Smoke exhausting system

4. AIR-CONDITIONING AND VENTILATING SYSTEM

4.1 General

4.1.1 Design concepts

The air-conditioning and ventilating systems for the proposed Cancer Center and its joint-use facilities with the General Hospital will be so designed as to satisfy all the basic requirements for an efficient and comfortable environment for users of the facilities. Major requirements are as follows:

(a) Reliability
(b) Technical and operational efficiency
(c) Energy efficiency
(d) Easy maintenace and operation; minimization of mishandling
(e) Safety
(f) Non-polluting
(g) Flexibility for future expansion and renovation
(h) Economy
(i) Sufficient protection from sand and salination hazards
(j) Water use efficiency
(k) Sufficient protection from air- and water-borne contamination

4.1.2 Design criteria

A. Applicable codes and standards

Design and materials criteria will conform to the codes and standards already listed in 1.4, and when deemed necessary, to the National Bureau of Standards (NBS) as well.

B. Scope of work

1) Scope for planning

The present report mainly refers to the Cancer Center and its joint-use facilities with the General Hospital. The same basic design criteria and conditions are presumed to apply to the General Hospital and its attached facilities.

2) Capacity requirements

Capacity calculations are based on the space requirements of the present project plus its immediately planned extension.

C. Outdoor meteorological conditions

Summer: Dry bulb temperature ... 41°C
Relative humidity 42%

Winter: Dry bulb temperature ... 13°C
Relative humidity 60%

D. Indoor temperature and humidity standards

(As shown in Table 4-1.)

Table 4-1 Indoor Temperature and Humidity Standards

Room Designations	Summer		Winter	
	Dry Bulb Temperature (℃)	Relative Humidity (%)	Dry Bulb Temperature (℃)	Relative Humidity (%)
Wards (General)	26 to 27	45 to 50	22 to 23	40 to 45
Wards (Burns)	———	45 to 50	———	40 to 45
Examination Rooms	26 to 27	45 to 50	21 to 22	40 to 45
Waiting Lobby	26 to 27	45 to 50	20 to 21	40 to 45
Operating Rooms	23 to 27	50 to 60	23 to 27	50 to 60
ICU	23 to 26	50 to 60	23 to 26	50 to 55
Recovery Rooms	24 to 26	50 to 60	24 to 26	50 to 55
Delivery Rooms	24 to 26	50 to 60	24 to 26	50 to 55
Nurseries	25 to 27	50 to 60	25 to 27	50 to 60
CSSD	26 to 27	———	21 to 22	———
Laboratories	26 to 27	45 to 50	21 to 22	40 to 50
X-ray Rooms	26 to 27	45 to 50	23 to 24	40 to 45
Rehabilitation	26 to 27	45 to 50	21 to 22	40 to 50
Animal Room	20 to 26	30 to 70	20 to 26	30 to 70
Pharmacy	26 to 27	45 to 50	21 to 22	40 to 45
Administration	26 to 27	45 to 50	21 to 22	40 to 45
Storage	28 to 30	50 to 60	———	———

Notes: 1) Rooms not designated in the table will employ standards for the designated ones with similar functions.
2) Temperature and humidity are freely controllable in operating rooms and animal rooms.
3) The deviation of temperature and humidity is respectively controlled at ±1°C and ±5% for operating rooms, ±2°C and ±10% for wards and other rooms.

E. Ventilation and pressure balance

(As shown in Table 4-2.)

Table 4-2 Ventilation and Pressure Balance Standards

Room Designations	Minimum Outside Air Change (times/hr.)	Minimum Total Air Change (times/hr.)	Pressure Balance
Bioclean Rooms	15	200	P
Operating Rooms (General)	5	25	P
Operating Rooms (General, all outside air)	25	25	P
Operating Rooms (Septic)	5	25	N
Delivery Rooms	5	25	P
Nurseries	5	15	P
Recovery Rooms	6	15	P
ICU	6	6	P
Wards	2	4	E
Ward Corridors	4	4	E
Isolation Bedrooms (Infectious disease)	12	12	N
Anterooms to Isolation Bedrooms	6	6	N
Treatment Rooms	6	12	E
X-ray TV	6	6	E
X-ray Rooms (Treatment)	6	6	E
Physical Therapy Rooms	4	4	N
Soiled Utility	4	12	N
Clean Utility	4	12	P
Autopsy Room	6	15	N
Laboratories (General)	6	6	N
Laboratories (Culture, graft)	4	4	P
Laundry (General)	10	10	E
C.S.S.D. (Preparation)	variable	10	N
C.S.S.D. (Storage)	2	4	P

Notes: 1) P = Positive, N = Negative, E = Equal.

2) Rooms not designated in the table will employ standards for the designated ones with similar functions.

F. Air cleanliness control

Standards of air cleanliness will be as shown below.

Table 4-3 Air Cleanliness Standards

Room Designations	Air Cleanliness Level
Operating Rooms (Bioclean)	Class 100
Operating Rooms (General)	10,000
Operating Rooms (Septic)	10,000
C.C.R.U.	10,000
C.C.U., I.C.U.	10,000 - 100,000
Delivery Rooms	10,000
Recovery Rooms	10,000 - 100,000
Germ-free Wards (Bioclean)	100
C.S.S.D.	10,000 - 100,000

Notes: 1) Classes of air cleanliness respectively indicate the number of small dust particles (larger than 0.5μ) per liter of air.

2) Rooms not designated in the table will employ standards of designated ones with similar functions.

G. Air-conditioning zones

Rooms and spaces in the hospital will be classified by the hours of air-conditioning as shown in Table 4-4.

Table 4-4 Zoning by Air-conditioning Hours

Zones by Hours of Air-conditioning	Room Designations
All-day Zone (24 hours)	Wards, Radioisotope (Wards), Blood Bank, Delivery, Nurseries, C.C.R.U., C.C.U., Morgue (Part), Research (Animal), Pharmacy (Storage), Storage, Locker Rooms, Casualty, Residential Houses
Day-time Zone	General Clinic, Administration, Out-patient Department, Pharmacy, Physiology, Rehabilitation, Endoscopy, Research, Radiodiagnosis, Radioisotope, Hemodialysis, Clinical Laboratories, Dining, Kitchen, Bed Center, Workshop, Radiotherapy, Hyperbaric, C.S.S.D., Laundry
Variable Zone	Mosque, Surgical Department, Indoor Recreation Facilities, Autopsy, Morgue (Part), Auditorium & Lounges

Note: Rooms not designated in the table will employ standards of designated ones with similar functions.

4.2 Systems

4.2.1 Refrigeration system

The air-conditioning system will employ all-weather air-cooled turbo refrigerators (single package model), which will be installed on the roof-top of the utilities center.

A. Refrigerating equipment

(a) Refrigerating equipment will consist of air-cooled turbo refrigerators, chilled-water pumps, headers and piping (Figure 4-1).

(b) A refrigerator unit package, a hermetic compressor, an evaporator and a condenser (Figure 4-2).

(c) Refrigeration load, including the immediately planned extension, is estimated to be about 4,300 USRT. Ten sets of 545 USRT refrigerators will be installed, with two sets as standby. For future expansion, additional sets of the same model can be installed as required (See Appendix 4-1).

(d) Electricity will be used to operate the refrigerators, three sets of which will be connected to the emergency generator system, as well as to the commercial power system.

(e) The number of refrigerators in operation can be changed, depending on the refrigeration load at any given time.

(f) Primary chilled-water pumps will be provided with standbys.

B. Refrigerating equipment of circulating cooling water for freezers and refrigerators

(a) Freezers and refrigerators will be of water-cooled models.

(b) Circulating water will be cooled by the air-cooled package turbo refrigerators, which will be installed on the roof-top of the utilities center, together with cooling-water pumps, headers and piping (Figure 4-3).

(c) Two sets, one a standby, of 160 USRT refrigerators will be installed.

(d) Two refrigerators and cooling-water pumps will be connected to the emergency generator system, as well as to the commercial power system.

(e) One of the cooling-water pumps will be a standby.

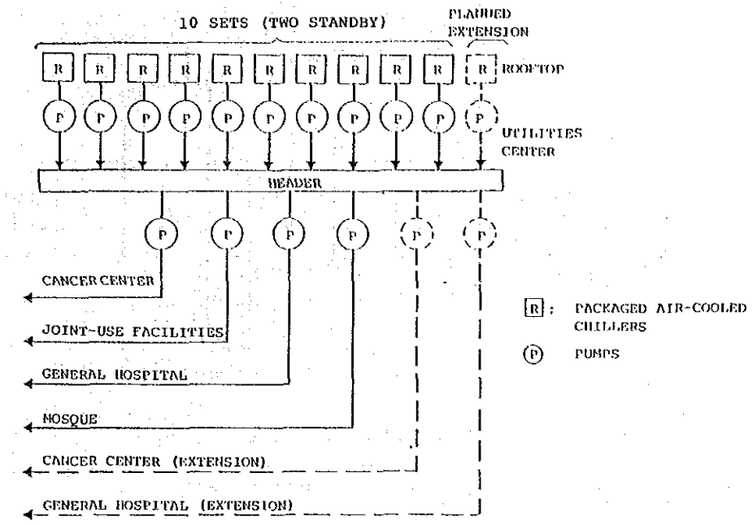


Figure 4-1

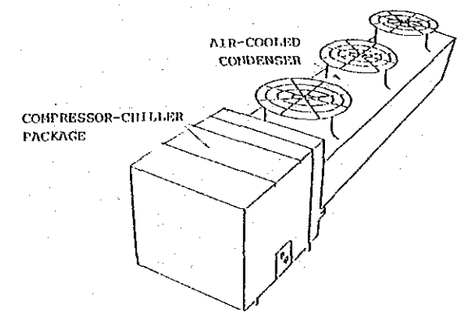


Figure 4-2 Air-cooled Turbo Refrigerator

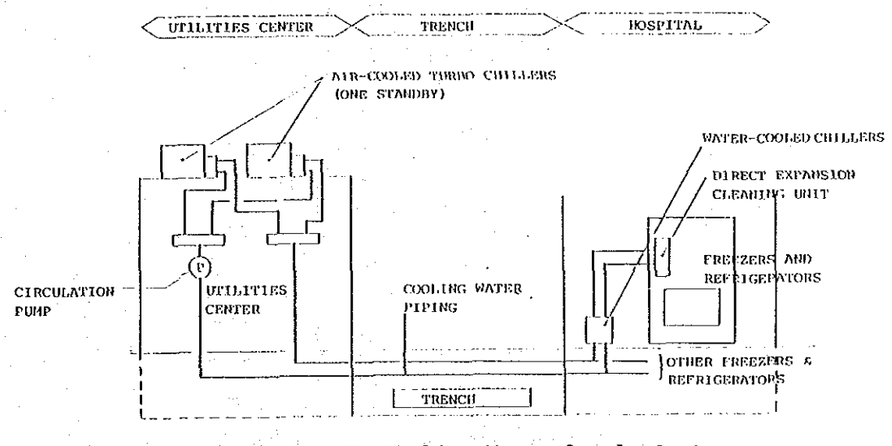


Figure 4-3 Cooling Water Supply System

4.2.2 Air-conditioning piping

Chilled water for cooling will be piped from the chilled-water pumps of the utilities center via the trench to the respective conditioners in the hospital buildings. And steam or electric heaters will also be utilized for heating. Circulating cooling water for freezers and refrigerators will be piped from the cooling-water pumps of the utilities center via the same trench to be fed into the condensers of the respective units.

Piping system will be as follows:

(a) Pipe works will consist of headers and chilled water pumps, as shown in Figures 4-4.

(b) Three of the chilled water pumps for air-conditioning will be connected to the emergency generator system as well as to the commercial power system. All pumps for circulating cooling water to freezers and refrigerators will be connected to the emergency generator system as well.

(c) Double piping will be provided to feed chilled water to the air-handling units and the fan coil units.

(d) Steam for humidifying will be supplied from the steam header in the utilities center to the respective air-handling units by the piping through the trench.

4.2.3 Air-handling system

A. Diagnosis & therapy departments (Figure 4-5)

Air-conditioning for the examination rooms and the like will be done via low-speed ducts, which convey temperature- and humidity-controlled air supplied by the air-handling unit in the mechanical room. Devices for the system are a sand trap filter, an air handling unit, and roll filters (AF 170%) and where necessary, a VAV unit and a total heat exchanger as well.

B. Administration offices

Same as in A.

C. Wards (Figure 4-6)

Air-conditioning for wards will be done by fresh air supplied from the outside air-conditioner installed in the penthouse of the ward building. Room temperature will be controlled by the fan coil units. The system will consist of fan coil units, a sand trap filter, an air-handling unit and a total heat exchanger.

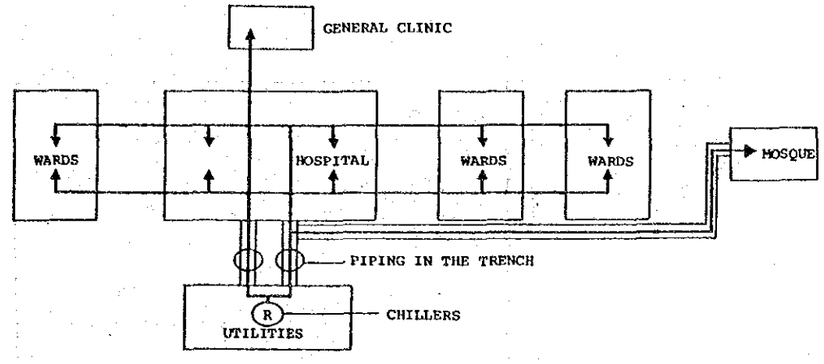


Figure 4-4 Chilled Water Piping System

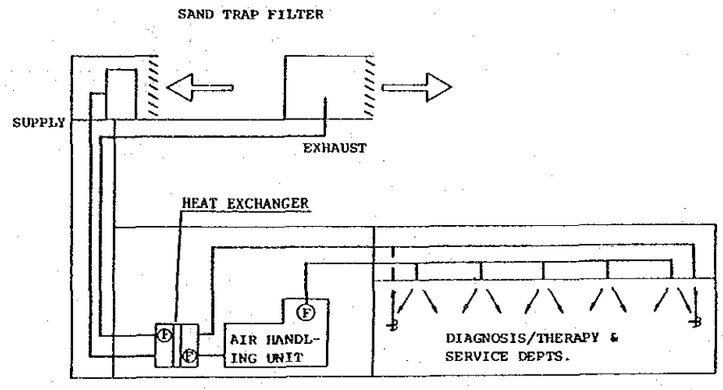


Figure 4-5 Air-conditioning Duct System for General Diagnosis/Therapy and Service Departments

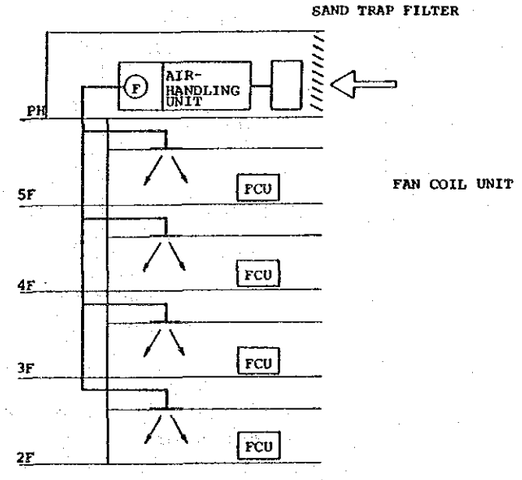


Figure 4-6 Air-conditioning Duct System for General Wards

D. Bioclean rooms (Figure 4-7)

Air cleanliness:

The cross flow laminar flow pattern will be employed to maintain the air cleanliness level of class 100 uniformly in the rooms.

Temperature control:

The required temperature will be maintained by electric heater and a constant volume supply of chilled water, enabling minor temperature adjustments in the individual rooms.

Humidity control:

Dry steam is used for humidifying.

E. Operating rooms, ICU, CCU, burns wards and new-born nurseries (Figure 4-8)

Air cleanliness:

The conventional flow pattern will be employed to clean the air of floating particles and prevent the suppuration of wounds and incisions.

Temperature and humidity control:

Same as in bioclean rooms.

F. Other rooms

(a)	RA Wards:	SF + HE + OAHU + CF
(b)	Virus Examination Room:	SF + OAHU + HEPA
(c)	Pharmacy:	SF + HE + AHU/HEPA
(d)	Mosque:	SF + HE
(f)	Kitchen:	SF + OAHU

SF = Sand trap filter;
HE = Heat exchanger, air source type;
AHU = Air-handling unit;
OAHU = Air-handling unit, all-fresh air intake type;
AHU/HEPA = Air-handling unit with HEPA filter;
HEPA = High efficiency particulate filter;
CF = Charcoal filter + HEPA filter + medium efficiency filter + pre-filter.

Rooms not specified above will employ either one of the systems already described in A. to F. according to their functions.

The air-conditioning equipment for important rooms, such as the bioclean room and the operating room, must be provided with a back-up system.

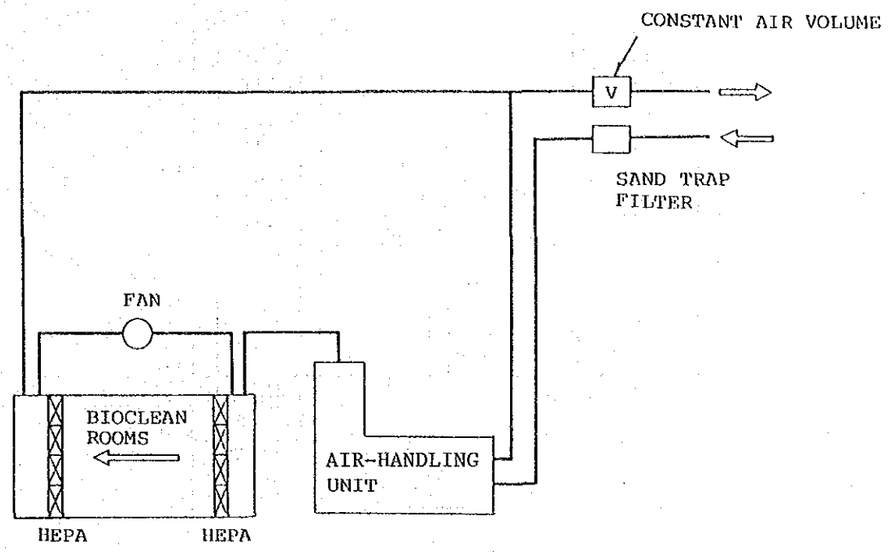


Figure 4-7 Air-conditioning Duct System for Bioclean Rooms

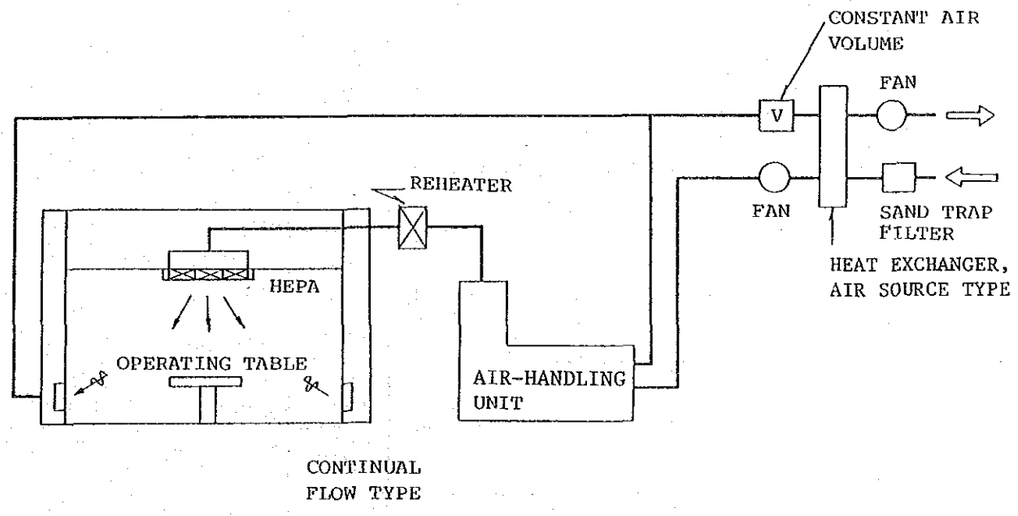


Figure 4-8 Air-conditioning Duct System for Operating Rooms

4.2.4 Ventilating system

(a) (a) The ventilating system will consist of exhaust fans and low-speed air ducts, and where necessary, hoods, charcoal filters, and HEPA filters as well (Figure 4-9).

(b) Lavatories, soiled-items handling rooms, autopsy room and like will be provided with effective ventilating devices.

(c) Bathrooms, shower rooms and the like will be provided with effective humidity exhuasters.

(d) Exhausters for RI rooms and virus and bacteria handling laboratories will be equipped with appropriate treatment devices.

(e) The frequency of air changes will be as shown in Table 4-5.

(f) A ventilation facility will be supplied for the parking deck to discharge exhaust gas from motor cars.

Table 4-5 Air Changes by Room

Rooms	Minimum Outside Air Change (times/hr.)	Minimum Total Air Change (times/hr.)	Pressure Balance
Lavatories	Variable	10	Negative
Bedpan Storerooms	Variable	10	- ditto -
Bathrooms	Variable	10	- ditto -

4.2.5 Smoke exhausting system

Smoke exhausters will be provided to ensure safe emergency escape during fires (Figure 4-10).

(a) The smoke exhausting system will consist of smoke vents, high-speed ducts, and exhaust fans.

(b) Exhaust fans will be installed in the mechanical rooms of the penthouses to be connected via high-speed ducts to the respective vents arranged by each smoke exhausting zone.

(c) Exhaust fans will be connected to the emergency generator system as well as to the commercial power system.

(d) A smoke exhauster utilizing the ventilating tower will be provided for the parking deck.

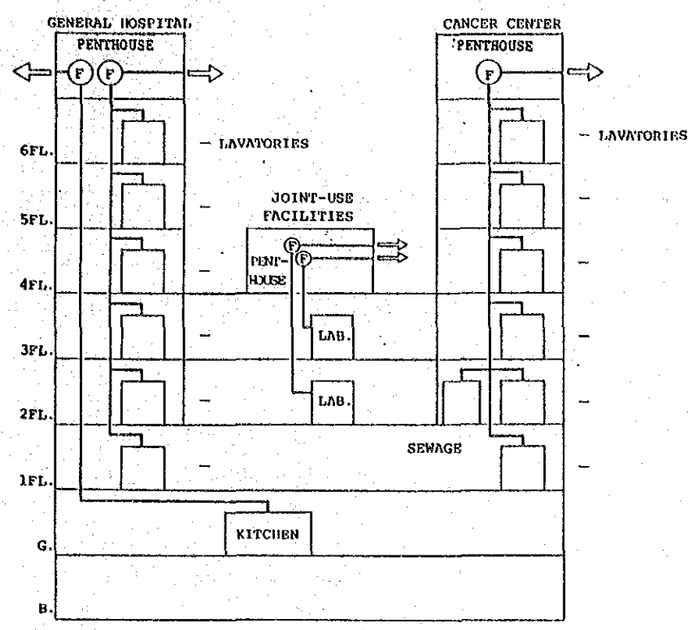


Figure 4-9 Ventilating System

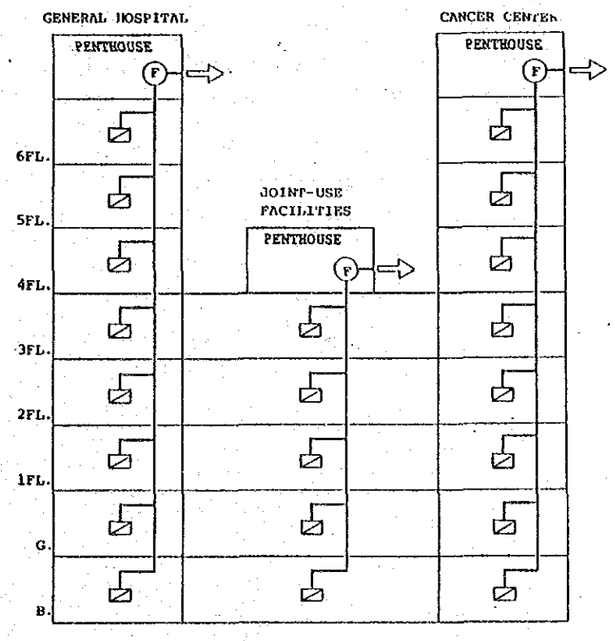


Figure 4-10 Smoke Exhausting System