DESIGNING FOR ENERGY CONSERVATION - THE CYPRESS FAIRBANKS MEDICAL CENTER HOSPITAL

LARRY B. WIERNIK
Commercial Representative
Houston Lighting & Power Co.
Houston, TX

PATRICIA A. RANZAU
Supervisor-Conservation Activities
Houston Lighting & Power Co.
Houston, TX

ABSTRACT

The concept of designing for energy conservation has long been a concern of Houston Lighting & Power (HL&P), culminating in the development of a local energy conservation design award competition in 1980. This competition sponsored by HL&P and the American Institute of Architects (AIA), strives to increase interest and provide incentive for energy conscious building design among the building community. The success and importance of this competition has been recognized by the Texas Society of Architects who will pattern a state wide competition after this one. Judges evaluate the building entries on architectural design, competitive cost of utilized materials and effective energy conservation techniques. A building that is attractive, energy efficient and economically constructed has the winning combination. This paper details the design concepts of a 1984 Grand Award winner, the Cypress Fairbanks Medical Center Hospital, in the Fourth Annual Energy Conservation Design Award Competition.

Cypress Fairbanks Medical Center Hospital is a 130-bed general care hospital owned by New Medical Horizons II, Ltd. The 95,000 square foot facility is comprised of three 40-bed medical/surgical in-patient care nursing floors, and the first floor which houses administrative, business, diagnostic, treatment and ancillary services. The hospital is adjoined by a 40,000 square foot medical/professional office building. The construction budget was $8,678,184. The hospital was occupied May 10, 1983.

The firm of Page, Southerland, Page Architects and Engineers was responsible for the design and engineering of the facility. From the initial conception of the facility, the design professionals faced strict requirements. In addition to having an extremely limited construction budget, they also had to adhere to the mandates that there was at least one outside window in all patient rooms and an efficient and successful design to meet high outside air code requirements for the HVAC system.

Page, Southerland, Page Architects and Engineers targeted several design areas for feasible energy saving design concepts. These areas included the building envelope, insulation, HVAC, and lighting.

BUILDING ENVELOPE

The building envelope consists of the structural elements of the building: the walls, roof, floors, as well as the doors and windows of the facility. In designing the facility the architects concentrated on preventing heat gain, which increases air conditioning requirements, through the building envelope. Building orientation, shape, window exposure, wall and roof insulation, and reflective and absorptive surfaces were all relevant considerations.

In looking at the orientation of a building, the east and west exposures experience the greatest amount of heat gain. The longest dimensions of the Cypress Medical Center are oriented northwest and southeast.

All of the external windows are 1/4" solar bronze and internally shaded by 3" wide vertical blinds. First floor windows are shaded by a 4-foot overhang. The patient rooms on the upper three floors are shaded by a 3-foot left and right fin projection.

INSULATION

The prevention of heat transfer through the roof and walls of the building was another major concern in designing the energy efficient building. The hospital has a built-up roof with a gravel finish, 2" vèrmiculite insulation, 2-1/2" of rigid insulation board and 1" steel deck. The result is a U-value of 0.048, which converts to a R-19 insulation level.

The exterior of the building is a combination of materials including a 1" synthetic plaster and expanded polystyrene rigid insulation board, 1/2" gyp board sheathing, 3-1/2" of foil-faced fiberboard insulation bars and 5/8" gyp board. The U-value is 0.068, which converts too R-11 insulation value. The finish of the external shell is durable and attractive, yet inexpensive.

The air conditioning duct work is externally wrapped with 2" foil-faced glass fiber insulation. The minimal thermal resistance is R-8 at 75°F. The heat pump pipework is uninsulated as the water temperature stays between 65 and 95°F.

HVAC

Inherently, hospitals require large quantities of outside air which is very expensive to air condition in our hot and humid part of the country. Conventional central forms of air conditioning make this situation worse by a) running continuously regardless of occupancy and b) supplying outside air for the whole system based on the worse case. For example, if the central system provides air to patient rooms that require two air exchanges of outside air and six air exchanges of room air, then outside air at the central air handling unit must be provided in the same ratio of 33% outside air and 66% return air.

These two problems of continuous operation and large outside air quantities were overcome in the design of the Cypress hospital by the use of a unitary system of water source heat pumps. Each patient room has its own unit and can be turned off when unoccupied. The system is also used in areas that only have daytime operation, such as administration, pharmacy, laboratory, and X-ray. The energy savings are a result of providing only the amount of outside air required by code requirements to each occupied space. The system can be completely shut off in any given area.

The total heating load for the hospital and professional building is 1,386,000 BTU/hour. The total cooling load is 359 tons of air conditioning. The outside air cooling requirement for the hospital is 116 tons or 0.0012 tons/square foot.

The architects were faced with designing a system to handle the following minimum hospital code requirements for ventilation:

Area	Outside air exchanges/hour	Total air exchanges/hour
Operating Rooms	5	25
Nursery	5	12
Patient Rooms	2	6
Soiled Linen	0	8 exhaust
Anesthesia Storage	0	10 exhaust
Administration/offices	10 CFM/person	1 CFM/square foot minimum

Water source heat pump technology is not new. Several commercial water source heat pump systems potentially show lower overall costs as compared to most standard commercial heating and cooling equipment.

The water source heat pump system consists of approximately 200 units in the hospital and 45 units in the professional office building. Unit capacities range from 3/4 ton in patient rooms up to 6 tons for larger areas such as physical therapy and dining rooms. Each unit is independently controlled by a programmable night set-back thermostat, except in those areas with 24-hour operation. The units are inter-connected with a two-pipe reverse return system which is connected to the fire sprinkler system. Water is circulated through the system by duplex pumps and the temperature is maintained between 65°F and 95°F by an evaporative cooler and modular gas-fired boilers. When the water temperature is between 66°F and 85°F neither the boilers or evaporative cooler are running.

Outside air is ducted to individual units and pretreated by heat pumps providing 100% outside air. Each heat pump is provided with a manual roll filter which can be operated through an escutcheon plate without removing the ceiling tile.

One of the biggest advantages of the water source heat pump system is its operating diversity. It is anticipated that under normal operating conditions only 65% to 80% of the units will run at the same time. This will be reduced even further in areas not requiring 24-hour operation. Another energy saving feature of the water source heat pump system is the transfer of heat energy through the water piping system. This takes place anytime there is both a heating and a cooling load on the building, usually in Spring or Fall. Core units cooling will be adding heat to the water system which is then used by the perimeter units requiring heating. In this way, heat energy is transferred from the building core where it is not required, to the perimeter where it is required. Almost all conventional systems cool then reheat the same air, which can prove to be a great waste of energy.

Due to the high levels of filtration and humidity control, a conventional chilled water system was used for the three operating rooms and cardiac care unit. The system consists of an air-cooled chiller, duplex water pumps and air handling units with individual reheat, filtration and humidification for each space.

Maintenance consists of adjusting each heat pump roll filter every six to eight weeks with a crank handle inserted through the escutcheon plate mounted in the ceiling tile. The anticipated life expectancy of the roll filter media is 2 - 3 years.

Although the large number of units may increase the overall frequency of maintenance, the hospital feels this is more than offset by the fact that one unit failure does not shut-down the entire hospital air conditioning as would be the case with a central chilled water system.

LIGHTING

Lighting, like HVAC, is a major component in institutional energy consumption. Depending on the hours of operation, lighting often surpasses all other elements of energy usage. Hospitals generally operate lighting 24 hours a day.

The area of lighting was analyzed for maximum efficiency in the planning stages of Cypress Fairbanks Hospital. This building was designed such that natural light can be utilized in various areas. Each patient room, and most of the outer offices, have tinted windows allowing vast quantities of natural light. The natural light, combined with fluorescent lamps, provides a cool effect.

The amount of light throughout the building is enhanced by the colors of the walls. All walls are painted natural colors of off-white and light beige. These colors help to reflect natural and fluorescent light without causing glare problems. Hallway lighting is provided by standard 2' x 4' recessed fluorescent fixtures. The fixtures contain only two lamps and are placed further apart than traditional spacing. This design is intended to keep the light levels relatively low in the hallways as high levels are not required in these areas. The light level in the hallways is approximately 20 footcandles between fixtures.

Patient rooms contain high quality light.

This is achieved by natural light gain and a 2' x 4' recessed fluorescent 4 lamp fixture. A two lamp fixture above each bed provides indirect and/or task lighting for the patient. Light levels in the patient rooms range from 40 to 110 footcandles depending on which lights are used.

All hospital offices have standard 2' x 4' fluorescent 4 lamp fixtures above task areas. The higher light levels are maintained in the areas due to the amount of task work performed. Light levels in these areas are approximately 110 foot-candles. Standard 2' x 4' fluorescent 2 lamp fixtures similiar to the hallway fixtures are used in waiting/sitting rooms.

All fluorescent fixtures contain standard 40 watt lamps. In the operating room and delivery rooms, all lighting has battery back up systems in case of any power failure.

Approximate watts per square foot for lighting follow:

Intensive care unit and dietary, 2.1 watts per square foot

Operating room, 3.0 watts per square foot

Patient rooms, 1.1 watts per square foot

Nearly all outdoor security and parking lot lighting is supplied by energy efficient high pressure sodium lighting. This lighting is controlled by photocells.

Figure 1 is a photograph of the hospital. Figure 2 shows the monthly electrical consumption from June 1983 through May 1984. Figure 3 is a site plan of the hospital complex. Figure 4 is a layout of the first floor, Figure 5 is a layout of the second floor and Figure 6 is a layout of the nursing units on the third and fourth floors

CONCLUSION

The Cypress Fairbanks Medical Center Hospital is an excellent example of suberb and innovative energy design and application.

Houstong Lighting & Power Company was proud to recognize the hospital and its design professionals as winners in the Fourth Annual Energy Conservation Design Awards competition.

REFERENCES

1. Page, Southerland, Page Architects & Engineers; Houston, Texas.

2. Cypress Fairbanks Medical Center Hospital; Houston, Texas.

3. Houston Lighting & Power Company; Houston, Texas.

Information for this paper was supplied by the above.

Figure 1 Photograph of Cypress-Fairbanks Hospital

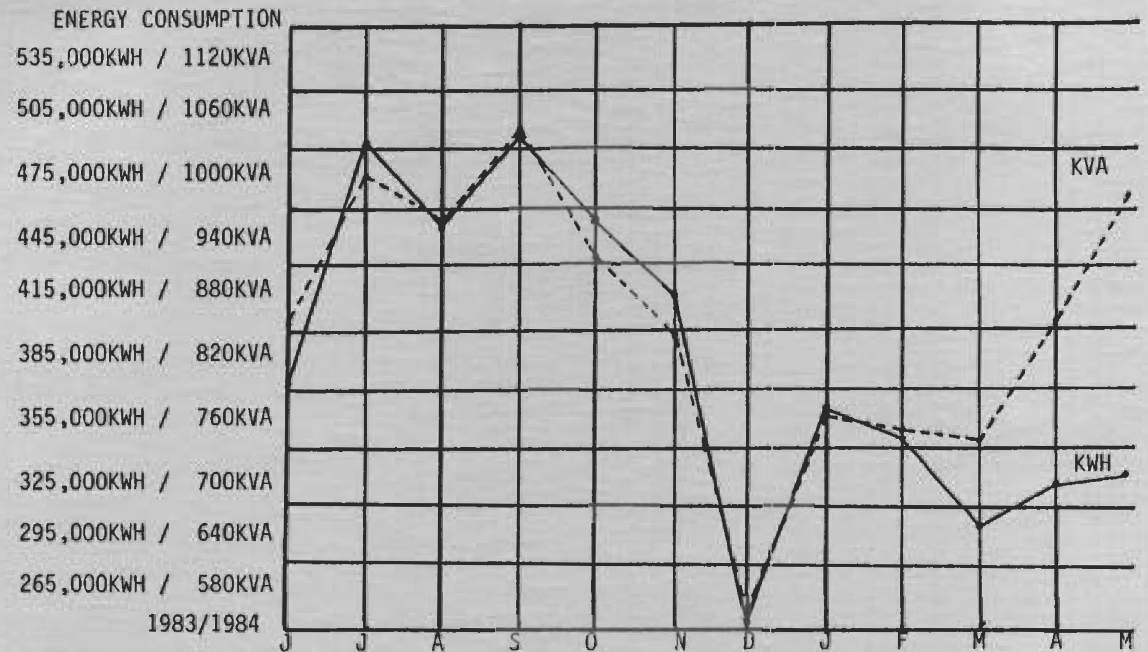

Figure 2 Energy Consumption, June 1983 to May 1984

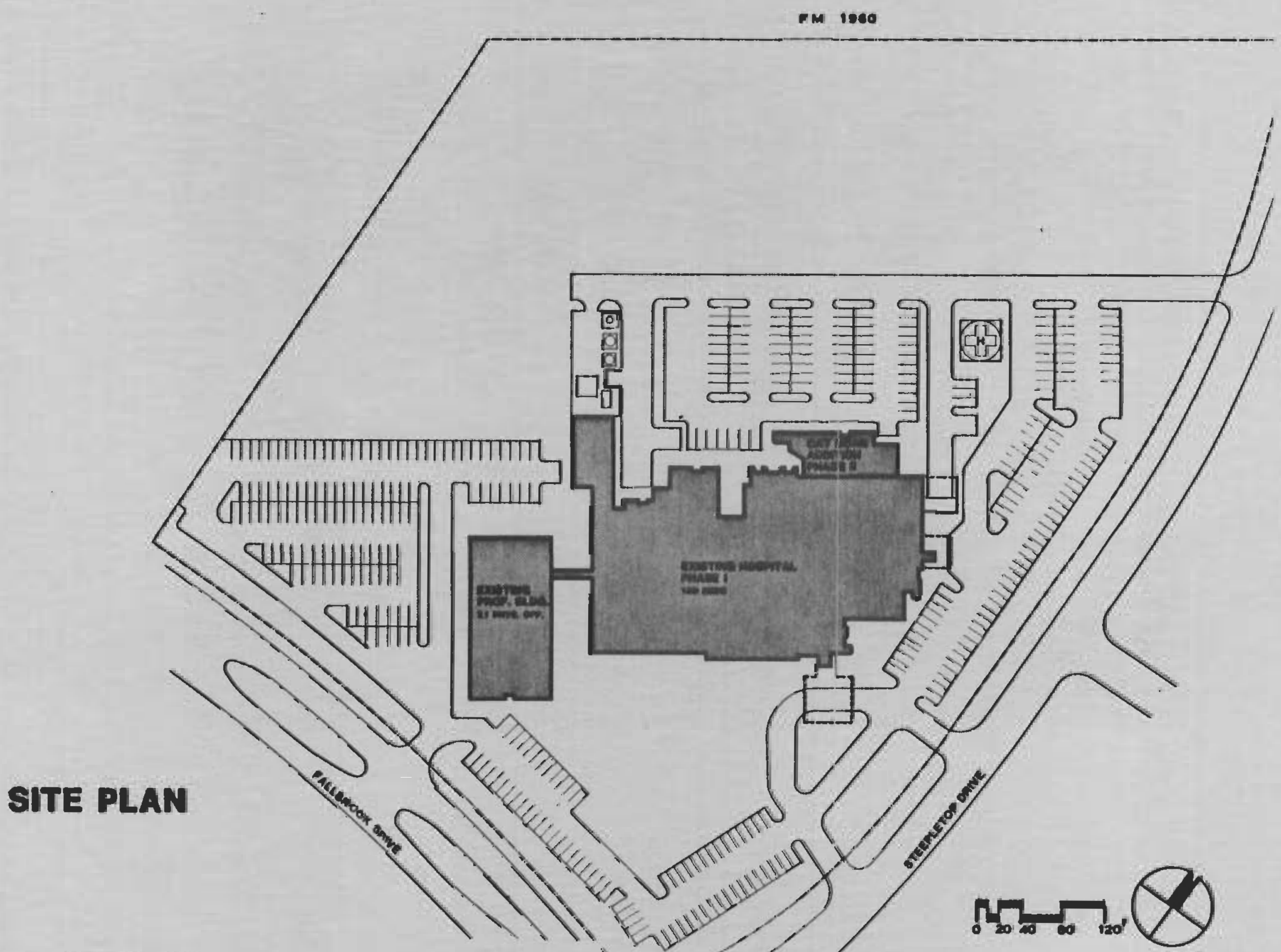

Figure 3 Site Plan for Cypress-Fairbanks Hospital

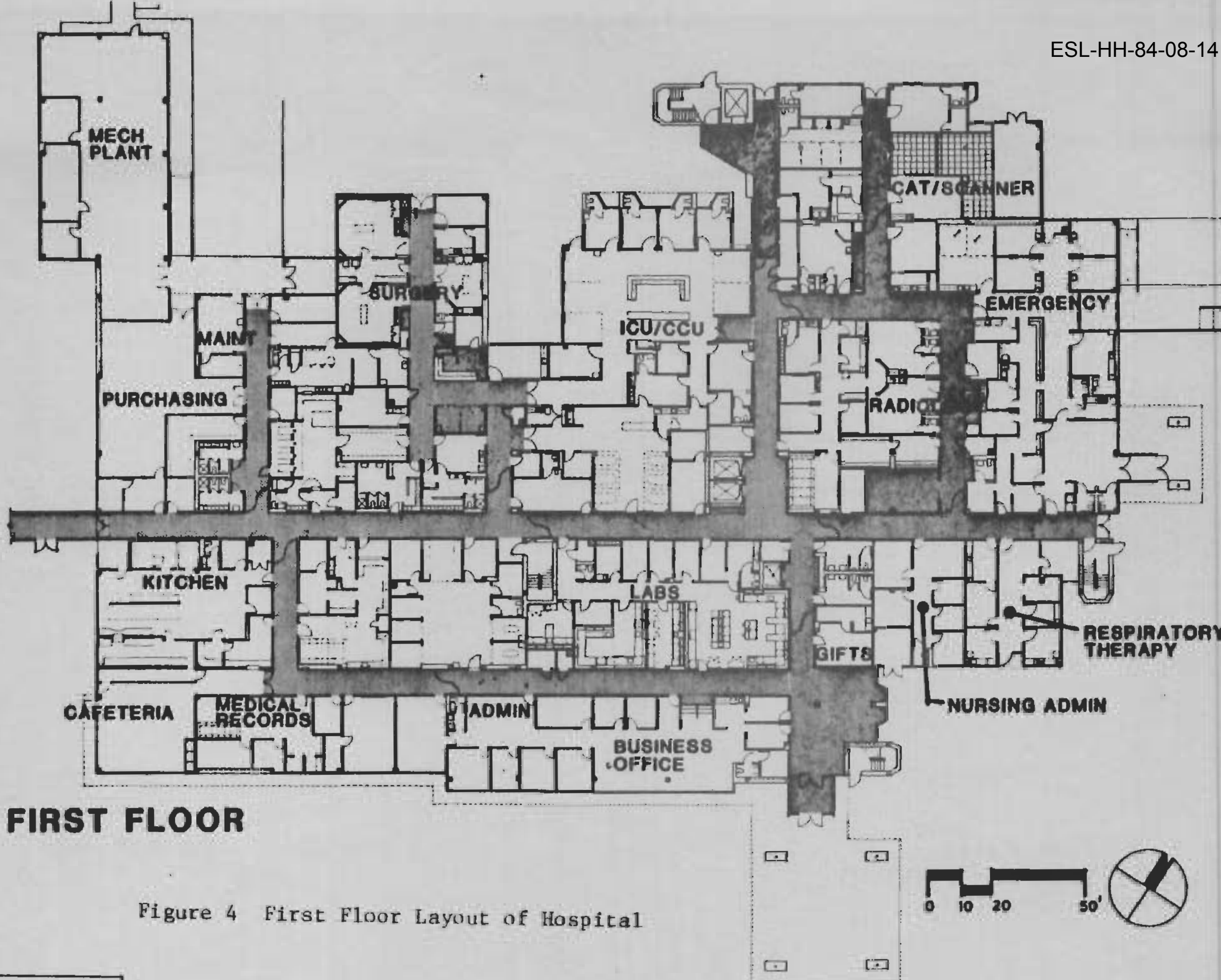

Figure 4 First Floor Layout of Hospital

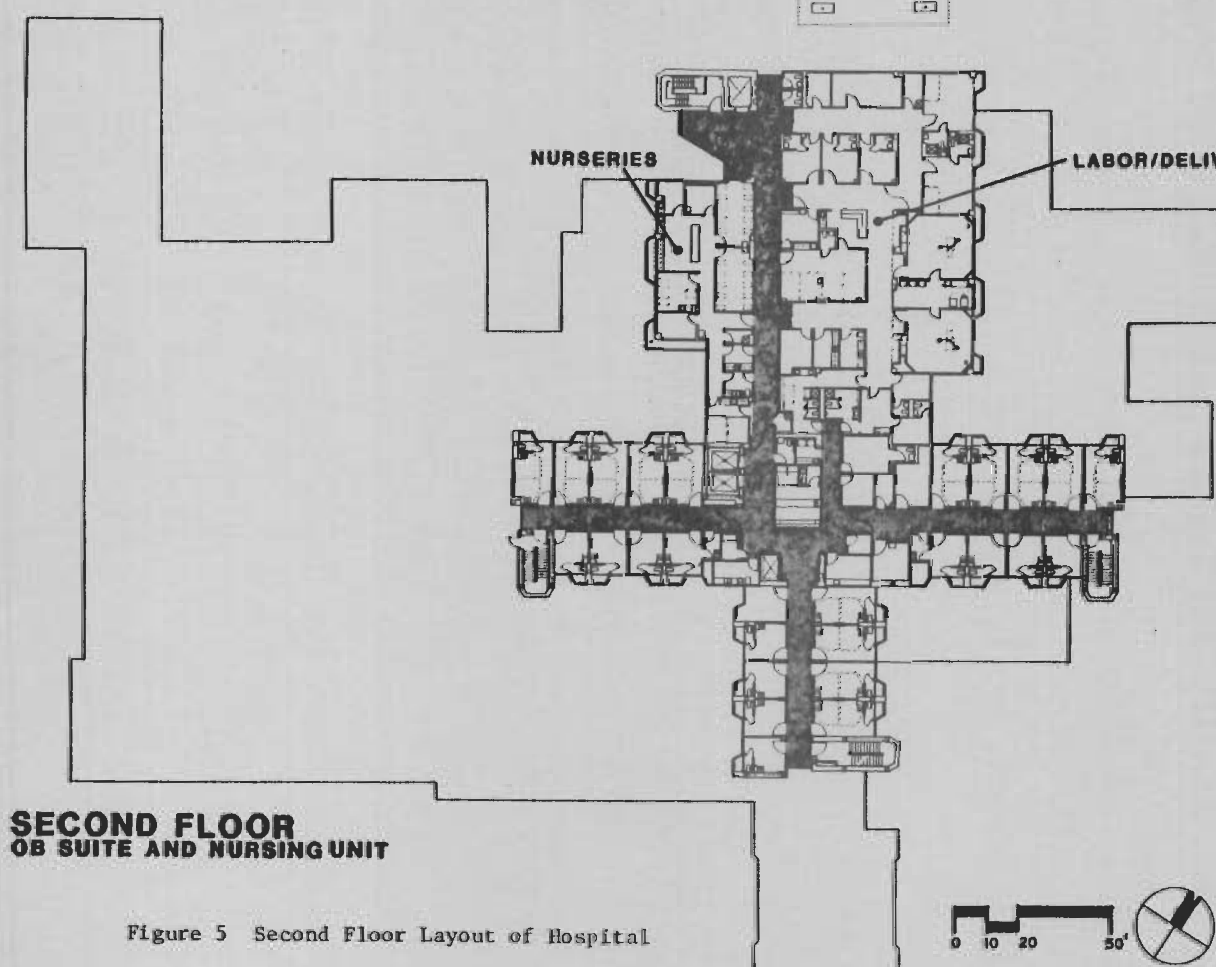

Figure 5 Second Floor Layout of Hospital

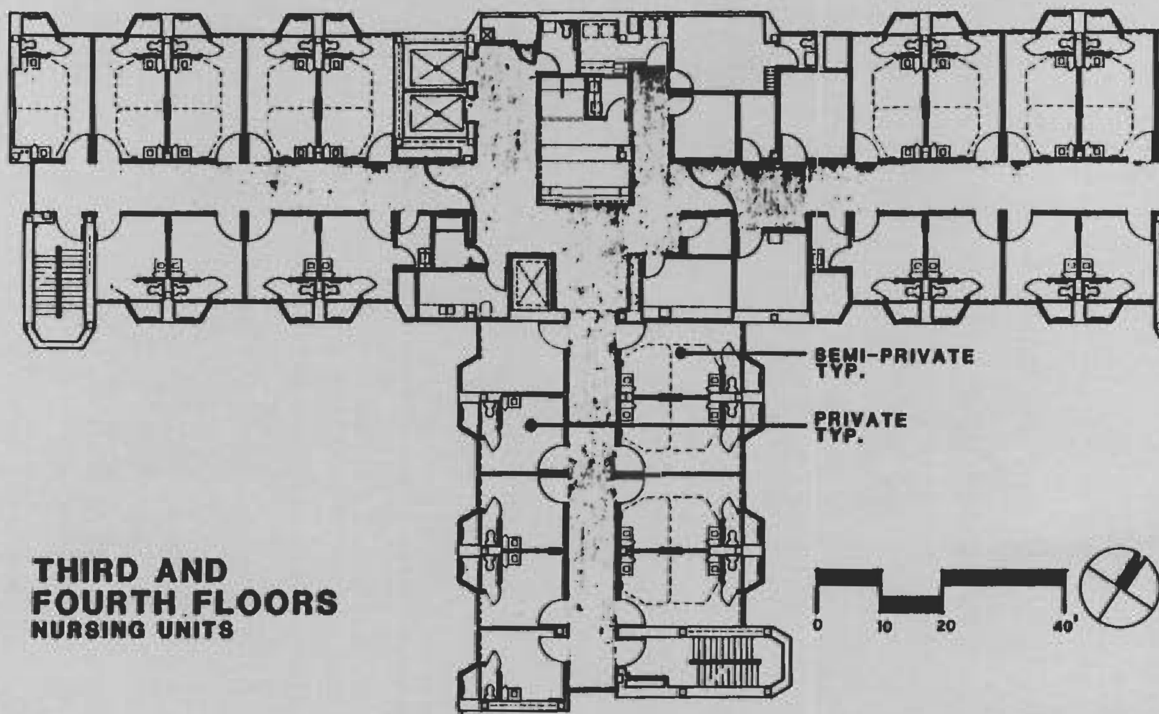

Figure 6 Third and Fourth Floor Layout of Hospital