years because of the awareness of the medical profession of infection hazards in these areas. Today, with a fuller knowledge of the degree of contamination of the air of the hospital environment, the zoning of the hospital departments by the use of separate systems becomes increasingly important.

This type of zoning has the added advantage of simplifying the systems and the controls which serve them. Simplification is possible because the requirements for specific temperature, humidity, and ventilation, with few exceptions, are identical within a department, although these requirements may vary considerably from department to department. The separate systems also offer a degree of protection in that a breakdown in one system will affect only a limited section of the hospital.

AIR-CONDITIONING SYSTEMS

The design of the hospital air-conditioning system will vary according to the size, type and layout of the structure, space allotment, orientation, climatic conditions, and many other factors. It is therefore impossible to prescribe a particular system which would be suitable for all hospitals.

Limited Systems

A few hospitals, due to climatic conditions, will require cooling only for selected areas, such as operating and delivery rooms, recovery rooms, special treatment rooms, nurseries, and obstetrical nursing units. These departments are usually served by individual systems because of the different requirements of temperature and humidity and also because it would not be desirable to mix air from some of these areas. Such systems would utilize fan-coil units in the conditioned area and central station equipment located outside the area with conventional duct systems for air transmission.

Total Systems

In planning an overall air-conditioning system for the hospital, a wide variety of designs may be considered, including low- and high-pressure central all-air systems adaptable to many modifications, as well as many types of individual room unit systems.

High-pressure systems, which are being used more often in hospitals today, have certain advantages over conventional low-pressure systems in that they require smaller duct systems and less elaborate central circuiting. The smaller ducts usually require less space and minimize interference with the many concealed utility lines. The systems also lend themselves to a variety of control arrangements. However, some of the advantages may be offset by the more expensive auxiliaries required. Many building designs may require the use of both high-pressure and low-pressure systems.

Central Systems. The large central systems which serve all or many of the areas in a building are not acceptable for hospital application because of the undesirability of mixing the air of the various departments. Smaller central fan-coil systems served by remotely located refrigeration and heating equipment with a unit or units on each floor to provide for departmental zoning, as required, are acceptable. These systems may be of single- or dual-duct design. Fan-coil units may be installed with or without outdoor air intakes, but if outdoor air intakes are not used, a separate ventilation system should be provided. Another type of central station system which utilizes individual room units is the high-pressure induction unit system.

For further information on central station systems see Chapter 1. Fan-coil, induction unit and dual-duct systems are discussed in Chapter 2.

Systems utilizing individual room units serve to effectively minimize the recirculation of air between patient rooms. However, if these systems are used in areas subject to high contamination, such as isolation rooms, they require disinfection after each patient is discharged.

Room Air Conditioners

This type of factory-built encased unit, designed for mounting in a window, through a wall or as a console, is considered the least desirable type of system for new construction. The principal objections to such units are: (1) the noise generated, (2) the lack of positive ventilation and humidity control, and (3) the service and maintenance problems resulting from the many individual units. These units have been used to some advantage in many of the less critical areas of older hospitals that do not have air conditioning systems.

The above systems are considered to be basic types, but by no means include all systems or variations of systems which may be adapted to meet the many complex requirements of the hospital.

DESIGN CRITERIA

It is not the intent of these criteria to cover engineering fundamentals or problems common to building construction, but rather to present special conditions which are peculiar to hospitals and of interest to the engineer.

From among the many hospital types, such as: general, mental, tuberculosis, and chronic disease, the acute general hospital was selected as a basis for the design criteria because of the variety of services it offers. These services include most of those offered in the other types, and with few exceptions, the criteria are applicable to all.

The air change rates as specified for specific areas are the outdoor air requirements for ventilation and in no way pertain to the air turnover required for thermal exchange.

For design purposes, the acute general hospital is divided into its principal service areas. The environmental requirements of each of these areas differ to some degree according to their function and the procedures carried out in them. These areas are: (1) administration department, (2) diagnostic and treatment facilities, (3) nursery, (4) nursing department, (5) surgical department, (6) obstetrical department, (7) emergency department, and (8) service department.

Administration Department

This department includes the main lobby, admitting and business offices. This area requires no unusual air treatment and should be conditioned for comfort of the occupants. A separate air handling system is considered desirable to segregate this area from the hospital proper.

Diagnostic and Treatment Facilities

This area includes the following departments: (1) laboratory, (2) pathology, (3) radiology, (4) physical therapy, and (5) occupational therapy.

Laboratories. Air conditioning for comfort with a satisfactory air distribution is necessary to provide an acceptable environment in the laboratories. Chemical fumes, vapors, heat from the equipment, plus the undesirability of open windows, all contribute to this need.

Particular attention should be given to the sizes and types of equipment used in the various laboratories. The heat gain

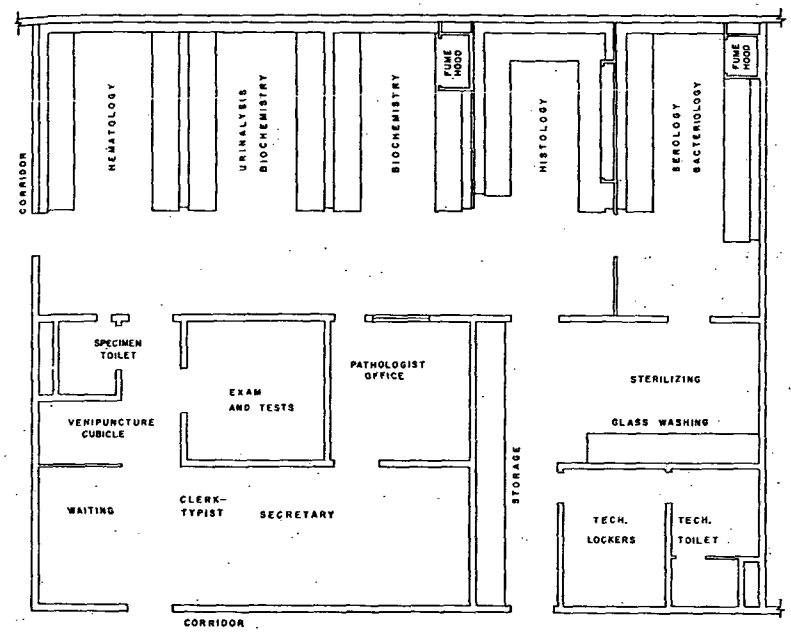

Fig. 2 .... Laboratory for a 200-bed Hospital[10]

from ovens, drying cabinets, kettles, sterilizers, electronic equipment, glass washers, and heating elements constitute the major portion of the cooling load.

The general air distribution and return systems should be constructed of conventional materials following standard designs for the type of systems employed. The exhaust duct systems serving safety hoods and fume hoods will require special materials to handle the exhaust products originating in the hoods. The exhaust ducts and fans serving all hoods should be noncorrosive. Exhaust ducts serving hoods in which radioactive materials, volatile solvents, and strong oxidising agents such as perchloric acid are used should be stainless steel for a minimum distance of 10 ft from the hood outlet and should be equipped with washdown facilities.

A supplementary air supply above the normal ventilation requirements should be provided to the laboratory to compensate for the quantity exhausted through the hoods. This supplementary air supply, which need not be completely conditioned, may be provided by a system which is independent of the normal ventilating system. The individual hood exhaust system should be electrically interconnected with the supplementary air system. However, should failure of the supplementary air system occur, the hood exhaust system should not also be shut off.

Exhaust fans serving hoods should be located on the roof to prevent any possibility of exhaust products entering the building.

For further information on laboratory air conditioning and hood exhaust systems, see Chapter 24.

Fig. 2 illustrates a laboratory for a 200-bed hospital.[10] In this laboratory, the exhaust air from the hoods in the unit for biochemistry, histology, glasswashing-sterilizing, and serology-bacteriology should be discharged to the outdoors with no recirculation. The serology-bacteriology unit should be pressurized relative to the adjoining areas to reduce the possibility of infiltration of aerosols which might contaminate the specimens being processed. The entire laboratory area should be under slight negative pressure to reduce the spread of odors or contamination to other hospital areas. Temperatures and humidities should be within the comfort range.

Bacteriology units should not have undue air movement, and care should be exercised to limit air velocities to a minimum. The sterile transfer room, which may be within or adjoining the bacteriology laboratory, is a room where sterile media is distributed and where specimens are transferred to culture media. To maintain a sterile environment the air supplied to this room must be filtered at the point of entry to the room. A filter with an efficiency of 99 percent in the