the rising air does not come into direct contact with another tier of occupants.

For ceiling heights 10 ft. and lower the quantity of air per person to dissipate this excess heat is $\frac{200}{60 \times .075 \times .24 \times 6} = 30$ cu. ft. per person per minute.

This amount may be reduced somewhat on the assumption that the component of heat from lights is usually introduced near the ceiling and may be allowed to heat the outgoing air to a greater difference.

Effect of High Temperature and Humidity

If a room is crowded in weather 85 deg. outside, with relative humidity 70 per cent, to give each occupant 30 cu. ft. of air per minute, it may be assumed that there will be an increase of temperature of at least 5 deg. due to body heat and heat from equipment.

A moisture increase from the bodies of the persons may be assumed as 10 grains per minute or 0.30 grains per cu. ft. of air handled. Under such a condition some method of air cooling will be needed to get satisfactory ventilation.

A good air washer can reduce the temperature of the air passing through it about 70 per cent of the difference between the wet and the dry bulb temperatures. Its operation would hardly be worth while without a cool water supply. It will be understood that the example cited is an extreme case of temperature and humidity. The beneficial effect of an air washer will increase in proportion as the relative humidity of the outside air is lower.

Experience, however, shows that a supply of fresh air which proves to be adequate for maintaining effective temperature in winter will usually prove inadequate for the same purpose in hot weather. While an increased volume of air supply is often of material benefit, the use of refrigeration brings the final hot weather solution, not so much in actual temperature drop as in humidity control.

Using as much as 30 cu. ft. per minute air supply per person especially with an upward system, as through floor mushrooms, drafts will be felt at introduction temperatures more than 5 or 10 deg. cooler than the average room temperature.

For this reason and for the additional reasons of sanitation and control, the downward system of ventilation is perhaps more efficacious in large and intensively occupied places of assemblage.

On account of transporting all of the heat from lights downward and of forcing the body-heated air back over the occupants it is usually necessary to do much more cooling of the air than can be done with the air washer alone, and it is necessary to employ refrigeration. The air is brought in at a point high enough to permit of its being diffused and brought to the proper condition before coming into contact with the occupants. It can be seen, therefore, that the air supply per person per minute for assembly rooms might be as low as 10 cu. ft. in winter, as high as 30 cu. ft. in summer, with air washers, and anywhere between these two figures for the entire year, with refrigeration.

Recirculation

Where recirculation of air in ventilation work is permitted, care should be taken that the recirculated air is thoroughly reconditioned by cleaning and deodorizing, and if necessary, dehumidifying. The saving in operating costs obtainable by recirculation of the air in ventilation systems must not be obtained at the expense of quality. A reduction in the quality of the ventilation when recirculation is used can be prevented by the installation and use of complete mechanical ventilation equipment for this purpose.

A reasonable arrangement is to provide apparatus for handling not less than 30 cu. ft. of fresh air per person per minute, with provisions for recirculating any amount up to as much as two-thirds of this.

The percentage of air recirculated may be varied to suit the seasonal changes so as to conserve heat in winter and refrigeration in summer.

Toilets and similar rooms in buildings using recirculation should be separately ventilated, employing mechanical supply and exhaust with the exhaust in excess of the supply in order to prevent objectionable odors from diffusing into other parts of the building.

TABLE 1. AMOUNT OF NEW AIR TO BE SUPPLIED PER PERSON[1]

	Cubic Feet per Minute			Number of Air Changes per Hour
	Without Humidification or Recirculation	With Humidification but Without Recirculation	With Humidification and Recirculation	
SCHOOLS—				
Class Rooms	30	20	5 to 10	.....
Assembly Rooms	15 to 20	10 to 15	5 to 10	.....
Gymnasiums	30	25	15 to 20	.....
Toilets	.....	.....	.....	10 to 20
Locker Rooms	.....	.....	.....	5 to 10
Kitchens	.....	.....	.....	20 to 60
Lunch Rooms	.....	.....	.....	10 to 20
THEATERS—				
Seating Space	30 to 50	20 to 30	10 to 15	.....
HOSPITALS—				
Wards	30 to 40	20 to 30	.....	.....
Kitchens	.....	.....	.....	20 to 60
Dining Rooms	.....	.....	.....	10 to 20
Toilets	.....	.....	.....	10 to 20
HOTELS—				
Dining Rooms	.....	.....	.....	10 to 15
Kitchens	.....	.....	.....	20 to 60
Ball Rooms	.....	.....	.....	5 to 10
Work Space	.....	.....	.....	5 to 10
Assembly Rooms	20 to 30	15 to 20	10 to 15	.....

The Synthetic Air Chart

Long experience and elaborate experiments and tests have demonstrated that certain qualities of air, especially the qualities of temperature, humidity and motion, result in the greatest health and comfort. These