FOOD

The heat given off by food is somewhat difficult to estimate. In the summer, men as a rule usually eat more hot food than women, who prefer salads or light sandwiches. A fair average for a mixed group restaurant may be taken at 35 Btu per person. The turnover per hour must likewise be taken into consideration. In sandwich shops and quick service cafeterias the turnover may be as high as three persons per seat per hour. Other types of restaurants vary according to price and service class. For the restaurant in Fig. 1 a turnover of two persons per seat per hour will be taken as an average figure. The heat gain from the food will then be

$$300 \times 35 \times 2 = 21{,}000 \text{ Btu per hour}$$

The total Btu per hour gain would be—

South wall and glass	14706
West wall and glass	20350
North wall and glass	1615
East wall	6660
Floor	17537
Ceiling	12110
Infiltration	19415
Lights	14343
People	72000
Food	21000
	199736 Btu per hour sensible heat

With a spray type dehumidifying system an entering air temperature of 12 deg less than the maintained condition may be used because of the high ceiling. With maintained conditions of 80 F (db), 65 F (wb), 56½ F (dp), and entering conditions of 68 F (db), 60 F (wb) and 56½ F (dp), neglecting for the moment the moisture gain in the enclosure, the dew-point temperature in the dehumidifier would be 56½ F, assuming a saturation-type dehumidifier.

With a sensible heat load of 199736 Btu per hour and a 12-deg difference between the entering and maintained conditions, the volume of air required would be:

$$\frac{199736 \times 55.2}{12 \times 60} = 15313 \text{ cfm}$$

$$\frac{15313}{13.35} = 1146 \text{ lb per minute}$$

With 384,000 grains of moisture per hour to be picked up, the entering dew-point temperature should be low enough so that after the pick-up the dew-point temperature will be 56½ F.

$$\frac{384000}{1146 \times 60} = 5.6 \text{ grains per pound to be picked up}$$

Grains per pound at 56½ F	= 68.10 (dp)
	− 5.60
	62.50 grains per pound

in entering air which corresponds to a dew-point temperature of 54.17 F.

With an entering dry-bulb temperature of 68 F and a dew-point temperature of 54.17 F, the entering wet-bulb temperature will be 59.56 F.

A check of the air quantity may be made on the basis of total heats. The total heat to be picked up is as follows:

199736	Btu per hour sensible heat
56000	Btu per hour latent heat
255736	Btu per hour total heat

The total heat per pound of air available is the total heat at the maintained wet-bulb temperature minus the total heat at the entering wet-bulb temperature.

Total heat at 65 F (wb)	= 29.65
Total heat at 59.56 F (wb)	= 25.89
	3.76 Btu per pound

$$\frac{255736}{3.76 \times 60} = 1135 \text{ lb per minute}$$

This is within 1 per cent of the quantity previously calculated.

The exhaust system over the service counter has been designed to handle 1500 cfm and the exhaust system for the washrooms handles 100 cfm for each washroom or a total of 200 cfm. Exfiltration through the revolving door has been calculated to be 565 cfm. The total quantity of fresh air to be handled would then be

Exhaust hood	1500
Washroom exhaust	200
Exfiltration	565
	2265 cfm or 169 lb per minute

The 1146 lb per minute of air includes the quantity lost by exhausting and exfiltration of 2265 cfm or 169 lb per minute. This air must be taken from the outside.

The refrigeration required to cool the air would be that necessary to cool 977 lb per minute of recirculated air from 65 F (wb) to 54.17 F (dp) plus 169 lb per minute of fresh air from 75 F (wb) to 54.17 F (dp).

Total heat at 65 F (dp)	= 29.65
Total heat at 54.17 F (dp)	= 23.13
	6.52 Btu per pound

$977 \times 6.52 = 6370$ Btu per minute

Total heat at 75 F	= 37.72
Total heat at 54.17 F	= 23.13
	14.59 Btu per pound

$169 \times 14.59 = 2466$ Btu per minute or a total of 8836 Btu per minute.

As a ton of refrigeration is equal to 200 Btu per minute, this system would require $\frac{8836}{200} = 44.18$ tons of refrigeration.

Reheating. Heating 1146 lb per minute from 54.17 F to 68 F would require

$$\frac{1146 \times (68 - 54.17) \times 13.35 \times 60}{55.2} = 229{,}985 \text{ Btu per hour.}$$

As the total heat of the steam may be assumed as 1000 Btu, it would require 230 lb of steam per hour.

BY-PASS METHOD

The by-pass method comprises a dehumidifier, a fan, a system of dampers operated either automatically or manually, reheaters, pump, motor, piping and accessories similar to a dehumidifier system. In the by-pass system the outside air and sometimes part of the return air is carried through the dehumidifier and the remainder of the return air is by-passed around the dehumidifier to the fan inlet and mixed with the