preceding unit, the alumina adsorbs approximately 25 per cent of the moisture in the air and takes up about 1.3 per cent of its weight of water. During the second step when it is operating alone, it takes up 100 per cent of the moisture in the air until the weight of the water adsorbed is brought up to about 6.7 per cent. During the third step when the unit is operating with the succeeding unit, it extracts about 75 per cent of the moisture in the air until the water weight adsorbed comes up to about 10 per cent of the weight of the adsorber. The time allowable for reactivating is equal to the time occupied by the second unit adsorbing alone, plus the time when the second and third units are adsorbing in series, plus the time when the third unit is adsorbing alone, at the expiration of which time the first unit will be again required.

The temperature of air used for alumina reactivation is usually between 300 and 700 F and the air flow rate will have to be higher with the low temperature air than it will be with reactivating air of higher temperature. For example, air at 400 F for reactivating will, at 10 cu ft per hour per pound of alumina, require about 6 hours for reactivation. In the three unit system, after reactivation the cooling of the activated alumina may be carried out with considerable rapidity by using dry air from the adsorption unit for circulation through the unit which has just completed reactivation. The final temperature of the unit before it goes back into service should be not over 200 F. As a basis for computing the amount of cooling air required for reactivation, each cubic foot of cooling air has been found capable of removing 2.2 Btu when heated from 85 to 200 F and of providing a sufficient margin of safety in operation.

Design of System

When designing air conditioning systems, the capacity of equipment is decided by selecting apparatus of sufficient size to maintain predetermined temperatures and humidities in treated spaces when arbitrarily established maximum atmospheric temperatures occur coincident with given conditions of population, lighting, and power consumption. These factors determine the maximum duty of the cooling system. The duty does not necessarily determine the size or capacity of the refrigeration apparatus. The refrigerating capacity is expressed in *tons*, each ton being equal to the absorption of the heat given up by one ton of ice at 32 F melting to water at 32 F in 24 hours. This is equivalent to heat absorption at a rate of approximately 200 Btu per minute, or 12,000 Btu per hour.

After the maximum duty is determined, the other factors concerning the installation must be investigated. The total heat to be removed by the cooling system has many sources, some substantially constant and others extremely variable. These sources can be roughly classified as follows, the first column indicating the order in amount and the second the order in variability:

1. Fresh air supplied.	1. Fresh air supplied.
2. Population.	2. Transmission through the structure.
3. Transmission through the structure.	3. Light and power consumed.
4. Light and power consumed.	4. Population.

By combining these two columns, a third grouping is obtained as follows:

1. Fresh air supplied.	3. Population.
2. Transmission through the structure.	4. Light and power consumed.

In this last arrangement, the first two items are governed by atmospheric conditions and they are therefore subject to tremendous fluctuations in value. As they generally form 40 to 60 per cent of the entire maximum load, the duty of the cooling system will be much less than maximum most of the time.

The transmission through the structure is especially influenced by the sun. (See Chapter 8.) In many cases, because of the heat flow resistance of the structure, the heat from the sun is retarded until it is compensated for by a reduced general temperature out-of-doors.

A survey of Weather Bureau records indicates that maximum temperatures occur less than 5 per cent of the cooling period and also that the duration of peak conditions is never more than three or four hours.

Two factors control the size of the refrigeration system, the evaporator or suction temperature, and the condenser or head temperature. With the knowledge that the system will operate most of the time with a load of not over 60 per cent of maximum, and that maximum demands will occur infrequently and only for short periods, some provision must be made to insure economical operation under average conditions. This can be done by overloading the machine under extreme demands and basing the design on normal or average loads. Flexibility in arrangement can be provided in several ways.

Variations in load change the efficiency of any machine and a refrigerating system can be costly and inefficient if improperly designed or operated. Fortunately, the trouble can be concentrated in the compressor and the problem relieved of many complications. It is comparatively easy to furnish condensers and evaporators to carry the maximum load so arranged that they will function properly at small demands. They affect the compressor performance to some extent but most of the compressor problems are in the machine itself.

Variations in load are usually effected by lowering the suction temperature and pumping a larger volume of gas per ton through a greater pressure range. This is possible because the latent heat of the refrigerant remains nearly constant throughout the small range used and the specific volume varies rapidly with change in pressure. As the compressor must remove the refrigerant evaporated, the evaporator temperature fixes the displacement required. The objection to such method is that the total power consumed remains nearly constant and the power per unit of cooling increases rapidly as the total output is reduced. Such operation is satisfactory as long as the load is kept within 10 per cent of the rating of the compressor but this condition does not commonly occur in air conditioning applications.

Operating Methods

It is possible to divide the entire refrigeration system into a number of small units, which will allow cutting in and out of compressors and condensers as the load fluctuates. This, however, is an expensive method as a number of small units are usually more expensive than one large unit. There is a certain amount of duplication of equipment necessary, which