2. Promote uniformity of temperature distribution.
3. Direct the cooled air positively and rapidly where it is most effective.
4. Reduce the amount of space taken up by cooling apparatus.
5. Provide a system readily responsive to manual or thermostatic control.
6. Increase the capacity of the cooling surface by passing air over it at high velocity.
7. Provide, under favorable temperature conditions, a convenient means of either manual or automatic defrosting of cooling surface.
8. Provide a neat appearing sanitary apparatus for obtaining required temperatures in cold storage rooms.

In addition to their prime function of cooling cold storage rooms, product cooling units have the advantage of air circulation to alleviate condensation occurring on walls and ceilings. In meat prechill rooms they eliminate fog entirely. Outside air intakes are adaptable where the stored product requires ventilation. Apple storage rooms and banana ripening and storage rooms fall in the latter class.

Types of Cooling Units

A common type of product cooling unit is designed for floor mounting and is obtainable in various sizes having two, three or four outlets which may be arranged to discharge in selected directions, thus making it possible to choose a location best suited for air direction for the placing of the product within the room and for piping connections. Cooling units are generally made of steel tubing suitably coated to prevent corrosion, or of aluminum or some alloy.

Where floor space is not available, relatively smaller units of the suspended type may be employed. These units are usually equipped with extended surface coils made either of steel or non-ferrous metal. Where a large amount of moisture must be condensed from the room it is possible to avoid coil frosting by using a floor mounted brine spray unit.

Drip pans collect moisture when cooling surfaces are defrosted. Refrigerants are supplied directly to the interior of the coils in all cases, and the heat from the room is drawn from the air, passing over the cooling surfaces.

Cooling Media

Cooling units are suitable for operation on gaseous refrigerants such as ammonia, methyl chloride, sulphur dioxide, carbon dioxide. Cold water or brine can also be used. The choice of refrigerant is governed by the design and construction of the cooling coil.

Determining Heat to be Absorbed

The heat gain of a room to be equipped with cooling units is determined in the same manner as for any other product cooling system. This consists of direct sunlight gain, radiation gain, infiltration and product load. Where air is brought in from the outside directly through the unit for ventilation purposes, the heat gain necessary to reduce the air from outside temperature to room temperature must be added to the transmission and other gains. Units are then selected from the manufacturers' rating tables. The gains thus far mentioned are sensible heat gains. The latent heat load resulting from moisture precipitation, must also be taken into account in many cases.

Example 1. A fur storage room is to be maintained normally at a temperature of 32 F. At intervals, however, the room is to be lowered to 20 F, which temperature will be maintained for several days, after which 32 F will again be held. What is the cooling load?

The room is located in the basement of an existing building and has no outside exposure. Maximum temperature of rooms surrounding walls and ceilings, 90 F. Floor is on ground. Room has a vestibule entrance. Four lights of 100 watts each will be burning part of the time. No occupants in room except at infrequent intervals. Brine available at a minimum temperature of 10 F.

Size of Room: 25 ft long by 20 ft wide by 9 ft high.
Walls: 6-in. concrete, 4-in. cork and ½-in. plaster finish.
Ceiling: 4-in. concrete, 4-in. cork and ½-in. plaster finish.
Floor: Cinder fill, 6-in. concrete, 4-in. cork, 2-in. concrete.

Solution. The cooling load will be the sum of the following items:

Sunlight gain (Btu per hour)	*none*
Lights: $4 \times 100 \times \frac{3.4}{4}$ (25 per cent use assumed)	340
Cooling unit motor, ½ hp	1260
Transmission	
Walls: $90 \times 9 \times (90 - 70) \times 0.066$	3742
Ceiling: $20 \times 25 \times (90 - 70) \times 0.067$	2345
Floor: $20 \times 25 \times (90 - 30) \times 0.065$	2275
Infiltration	
$\frac{4500 \times (90 - 20)}{8 \text{ hr} \times 55.2}$	713
Product Load:	
None	
	10675
Safety factor (10 per cent)	1067
Total sensible heat load	11742 Btu per hour

The cooling unit selected must be capable of absorbing 11742 Btu per hour of sensible heat.

Temperature and Volume of Air Circulated

The drop in temperature of the air through a cooling unit is comparatively small, while the volume handled is large. This feature permits of greater heat transfers per unit of surface and a minimum moisture precipitation. Consequently, the temperature difference between the room and discharged air is small, making it of little consequence whether the intake to the unit is located at the floor or at the ceiling.

Example 2. In Example 1, assume that air enters the base of the cooling unit at 20F and leaves outlets at 17 F. This is a 3-deg reduction in temperature. Compute the volume of air in cubic feet per minute that unit must handle.

Solution. The weight of dry air at 17 F is 0.0835 lb per cubic foot. Specific heat = 0.24. Volume of air to be handled per minute =

$$\frac{11742}{60 \times 3 \times 0.24 \times 0.0835} = 3280 \text{ cfm}$$

Therefore, the cooling unit selected should handle not less than 3280 cfm and should have enough coil surface to absorb 11742 Btu per hour when circulating air at 20 F and sufficient 10-F brine supplied to the coils. Unit should be of floor mounted type.