

Table 1 . . . Approximate Chilling Time

| Food                      | Hours at 35 F |
|---------------------------|---------------|
| Beef (halves or quarters) | 36-72         |
| Pork, lamb and veal       | 24-48         |
| Poultry and other fowl    | 5-10          |
| Fish                      | 2-6           |

locker plant applications. Since a locker plant is required to handle a wide variety of products, it is necessary to select a method that will permit the plant operator to apply it to all of the foods to be frozen. The *blast freezer* or the *contact freezer* has been specified for the great majority of plants. Either method is well adapted to the handling of miscellaneous products in packages of varying size and shape, and will freeze with sufficient speed to satisfy the most critical processor. Regardless of which method is used, freezing should be accomplished with reasonable speed in order to produce a high quality product, and to have as much food as possible pass through the freezer in a given amount of time.

The storage requirements for frozen foods in the commercial freezing plant or the frozen food locker plant are identical as to temperature and general conditions. A temperature of 0 F with a normal variation of  $\pm 2$  to 3 F deg is generally considered practicable and satisfactory. The humidity in such storage rooms should be kept as high as practicable by designing the plant with a small difference in temperature between the room and the refrigerant.

#### PLANT CLASSIFICATIONS

The great majority of all locker plants are *walk-in type*, with all facilities on one floor level. In a few cases due to space limitations the plant, or part of it has been located either in a basement or on the second floor.

A limited number of plants of other types known as the *warm-room type* have been so built that the patron can secure frozen foods from his locker without entering a low-temperature storage room. Locker customers evidently do not mind going into the cold locker rooms of the *walk-in type*; hence, the limited number of *warm-room* plants. Some *warm-room* installations have been made in apartment houses and grocery stores. These use assemblies of about 16 to 100 lockers arranged similar to a reach-in refrigerator.

The frozen food locker plant serving the average community must be designed to furnish the various services which the prospective operator has found desirable. The average plant should be equipped to handle meat as 85 to 95 percent of its volume. The services to be rendered should, therefore, be planned accordingly. These services consist of chilling, aging, cutting, wrapping, freezing and storing. Operators in some areas will want to provide additional meat services such as pickling, smoking, lard rendering, slaughtering, poultry dressing, sausage making, grinding, etc. Other services for the handling of fruits and vegetables will constitute less than five percent of the plant activity and will consist of cleaning, blanching, packaging and freezing. Less fruit and vegetables are stored in plants today due to the popularity of the home freezer.

Plants which may perform only parts of the services outlined above are usually referred to as limited service plants. Most patrons are willing to pay for other additional services. Such decisions will be influenced by the community, the type

of patron and other nearby plants. Some patrons will produce everything which they bring into the plant for processing, while others will buy their meats in primal cuts. Some will produce their own fruits and vegetables for storage and some will buy them. Meats from popular brand packing houses are often in great demand by patrons. Even the farm producer who raises hogs only, for example, will often want to vary his menu with a few choice cuts of beef. In certain areas the processing and storage of game is a major item, and the plant operator must therefore recognize the need for special facilities. He must also be familiar with state game laws.

The percentage of townspeople or other non-farmers who may be expected to patronize a plant is usually much less than for farm families. Some observers maintain that 10 percent is a reasonable figure to apply to this latter group because some smaller towns and villages are in general farming areas.

The patronage of locker plants by farmers in many areas will run from 70 to 90 percent. Locker renters living on farms averaged 64 percent of all locker renters in 1954. There are no data available on farm and non-farm home freezer users. The distance to a nearby plant, the kind of service available and the length of time it has been in operation are factors which affect usage.

#### DESIGN AND CONSTRUCTION

##### General Requirements

A locker plant must be designed to handle a wide variety of foods. It is therefore necessary to provide facilities to handle properly the various kinds of locally produced foods as well as those which may be brought in by patrons.

*Chilling.* Meats, fish, fowl or game should be chilled immediately after killing. Thorough chilling at this time produces a better flavored product and facilitates the handling and cutting. The approximate chilling time of various items is given in Table 1.

The products mentioned in this table should be held in the chilling or aging room until prepared for freezing. Beef, to be aged, should be hung in the aging room at approximately 35 F for several days as desired. Vegetables should be cleaned, packaged and frozen as soon as harvested (the same day, if possible). For this reason, chilling is usually unnecessary unless overnight storage is required during peak season. Some fruits may be held for a short time in the chill room at 35 F to make them firmer and more suitable for handling. This depends upon their degree of maturity. Other fruits and berries should be cleaned, packaged and frozen as soon as possible.

Chill room temperatures may vary from 34 to 36 F, but for purposes of calculation, it is suggested that 35 F be used. Many plants are provided with rooms for curing meat. The design temperature of these rooms should usually be 38 to 40 F. During the process of cutting, wrapping or packaging, and labeling, there will be some rise in temperature of the products being handled. To keep this rise to a minimum, meat and other products in process should be allowed to remain in the chill room until they are ready to be handled and then should be placed in the freezer as soon as possible.

*Freezing.* After packaging, the next step is freezing. The items to be frozen should be arranged in the freezer in such a way that freezing may be accomplished with reasonable speed to produce a better product and so that the food will pass through the freezer rapidly enough to utilize fully the productive capacity of the equipment. Freezing of family-size packages with suitable speed may be done satisfactorily in a locker plant by several different methods such as:

#### Locker and Freezer Provisioning Plants

1. Contact freezing by placing the product in contact with low-temperature plates or coils, using refrigerant temperatures of -15 F or below.

2. Contact freezing with the assistance of a blast of air over the products to be frozen.

3. Blast freezing in air with the air temperature 0 F or less. Freezers are usually of such capacity that two or three loadings per day are possible with product delivered at approximately the temperature at which the food is to be stored.

The reduction of temperature of the foods being frozen to temperatures far below the ultimate storage temperature is wasteful and unnecessary.

*Storage.* Practical experience by plant operators and research by food technologists and others has shown that 0 F is the proper design temperature for locker room storage. Some of the earlier plants were designed to operate at storage temperatures as high as 15 F.

Some have been content to do a partial job of correction by providing temperatures of 5 or 10 F.

It has been necessary for many of these early plants to change their storage temperatures. Indisputable evidence has existed for many years that frozen foods should be stored at a temperature of 0 F ( $\pm 2$  deg) if they are held for other than very short periods of time. *Good moisture vapor proof packaging is also an essential for successful long time storage.*

Research conducted confirms the 0 F storage temperature. This work showed that even when properly packaged and prepared under exacting laboratory conditions, most foods showed significant deterioration within three months when

Table 2 . . . Approximate Storage Period for Frozen Foods

| Product                                  | Months at Temp of |      |      |
|------------------------------------------|-------------------|------|------|
|                                          | 0 F               | 5 F  | 10 F |
| Fruits, Vegetables, Beef, Veal           | 10-12             | 8-10 | 3-4  |
| Lamb, Mutton, Poultry, Eggs              | 8-10              | 6-8  | 3-4  |
| Pork, Butter                             | 6-8               | 4-6  | 2-3  |
| Ground meat (unsalted), Cream            | 4-6               | 3-4  | 1-2  |
| Bacon and Ham (mild cured, not smoked)   | 4-5               | 3-4  | 1-2  |
| Fish, Ground meat with salt in seasoning | 3-4               | 2-3  | 1-2  |

(Also see Chapters 36 to 44.)

stored at +10 F. Diehl, Tressler, Winter and numerous others have proved the 0 F requirement for other than short time storage.

Extensive work through several years conducted at the Western Utilization Research Branch of the USDA has been reported in a series of papers beginning in the December 1956 issue of *Food Technology*. This work again confirms the requirement of steady temperature of 0 F for frozen food storage.

Table 2 showing approximate storage periods possible is submitted here as further evidence that 0 F should be generally recognized as the proper design temperature for locker storage rooms.

Suitable design recommendations for the average frozen food locker plant are given in the condensed Table 3.

Table 3 . . . Locker Plant Design Conditions

| Type of Space                           | Room Temperature                         | Refrigerant Temperature                                                                                                  | Insulation Thickness, In. |
|-----------------------------------------|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Work room, Process room and Kitchen     | Atmospheric <sup>a</sup>                 | None                                                                                                                     | None                      |
| Chill room                              | 34-36 F. Design for 35 F <sup>a</sup>    | 20 to 25 F below room temperature, for gravity circulation; 10 to 15 F below room temperature for forced air circulation | 3-8" <sup>a</sup>         |
| Aging room                              | 34-36 F. Design for 35 F <sup>a</sup>    | Same as chill room                                                                                                       | 3-8" <sup>a</sup>         |
| Curing room                             | 38-40 F. Design for 40 F <sup>a</sup>    | Same as chill room                                                                                                       | 3-8" <sup>a</sup>         |
| Freezing room (Gravity air circulation) | -10 to -20 F <sup>d</sup>                | -20 to -30 F                                                                                                             | 6-12" <sup>a</sup>        |
| Freezer cabinet (In locker room)        | Not important <sup>d</sup>               | -15 to -20 F                                                                                                             | 1-2" <sup>a</sup>         |
| Blast freezer                           | Depends on type system used <sup>d</sup> | -10 to -15 F                                                                                                             | 6-12" <sup>a</sup>        |
| Locker room or bulk storage             | 0 F <sup>e</sup>                         | -15 to -20 F                                                                                                             | 6-12" <sup>a</sup>        |

<sup>a</sup> Properly sealed and erected corkboard or equivalent.

<sup>b</sup> May be air conditioned for employees' comfort if desired.

<sup>c</sup> Chill, age and cure rooms may be operated at 32 to 40 F with reasonably good results. Chill and age rooms are usually preferred at 34 to 36 F and cure rooms a little higher, or about 38 to 40 F. It is suggested that 35 F be used as a design temperature for chill and age rooms. The refrigeration coils in these rooms should operate on a defrosting cycle.

<sup>d</sup> Freezing may be done in a freezer room, or in a cabinet freezer, or in a blast freezer. If a freezer room is used, it is necessary to consider both heat leakage and product load. If a freezer cabinet is installed in a locker room, the product load only need be considered, since the chilling in the locker room will take care of the heat leakage where the freezer cabinet is located. A blast type freezer may be located in a special room or in the locker room. It may be used for freezing only, or may be used to refrigerate the locker room and handle the freezing load also.

<sup>e</sup> It should be remembered that freezer temperatures may show considerable variation during loading periods. The amount of variation depends principally upon:

(1) Capacity of freezer in relation to load.

(2) Size, shape and initial temperature of packaged product.

(3) Method of loading—i.e., batch or continuous.

Controls should be adjusted so as to hold the air temperature of the locker room as constant as possible. Variations of  $\pm 3$  F are customary.

<sup>f</sup> Ultra-violet lamps may be used in these areas.

<sup>g</sup> Common walls between two refrigerated rooms should be insulated with at least minimum thickness shown.