removed from the product at the rate at which the moisture comes to the surface of the casing. Any attempt to speed the drying rate results in over drying the surface of the sausage, resulting in a condition known as *case hardening*. This condition is identified by a dark ring inside the casing, close to the surface of the sausage which precludes any further attempt to remove moisture from the interior of the sausage. On the other hand, if sausage is dried at too slow a rate, excessive mold occurs on the surface of the casing leading to an unsatisfactory appearance on the casing with some types of mold.

It is recommended that the sausage dry room be located where the adjoining spaces do not have a widely diverging temperature difference. For example, locating the dry room above a low temperature cooler causes condensation on the floor of the dry room and leads to mold on the lower rows of sausage. Insulation of variable thickness on all sides of the dry room is desirable to avoid changing conditions due to fluctuations from the adjoining spaces. The height of the sausage dry room to obtain the best results should not exceed 12 to 14 ft to the top stick in order to avoid stratification and to maintain within close limits the required temperature and humidity conditions necessary for this type of installation. It is recognized that there are higher dry rooms operating with satisfactory results.

Sausage racks on which the sausage sticks are suspended in the dry room are of wood or steel uprights and rails. Rails of 1 in. galvanized pipe centered through wood uprights are suggested for ease of cleaning. The rails for supporting the sausage sticks may be installed with the distance from the floor to the top of the first rail 3 ft, the distance between rails 2 ft, with a distance between the top rail and the ceiling of the room not less than 1 ft. The centering of the rails is, of course, dependent on the length of the sausage stick used by the individual sausage manufacturer. Where pipe or wood rails are used the centers should not exceed the length of the sausage stick less 4 in.

Sausage sticks in general are spaced on 6 in. centers on the racks, with the sausages of the variety known as salami, 4 to 5 lb green weight, spaced on 6 in. centers on the sausage sticks. This spacing avoids contact between the sausage which would otherwise cause mold and allows sufficient space for air circulation and uniform evaporation of moisture from the product.

The equipment for producing the required room conditions consist in general of a spray type dehumidifier or spray type unit cooler in which the air is cooled by passing through a liquid spray circulated over refrigerating coils inside the conditioning equipment.

In some installations water or salt (NaCl) brine is cooled by refrigeration in a separate cooling system, from which it is pumped to the dehumidifier sprays and returned for further cooling.

There is also available equipment employing a hygroscopic liquid which is sprayed in the dehumidifier through which the air is circulated. The moisture condensed from the air in the hygroscopic liquid is evaporated from this liquid in a regenerator.

Treatment of the dehumidifier liquid is advisable to maintain a pH which will minimize corrosion.

In accordance with seasonal requirements, this air then passes through a heating coil for reheating the air to the proper temperature prior to introduction to the dry room.

A blower type fan of suitable characteristics to overcome resistance through the conditioning equipment and duct system provides the means for maintaining the proper air circulation requirements.

In this type of installation it is very important that the means for introducing and returning the air be given careful consideration. The air supply duct system should be located at the floor of the dry room, arranged to introduce the proper air volume in a horizontal direction, close to the floor to each individual row of sausage racks with a total length of blow not to exceed 30 ft.

The air return duct system should be located at the ceiling of the dry room and should include branch ducts extending centrally the full length of the sausage racks, over alternate rows of racks. The branch ducts should contain uniformly spaced return air openings located in top of same for returning the air to the conditioning equipment so that the air circulation throughout the dry room will be uniformly distributed in a vertical direction through the sausage. The branch ducts should be located so that a space of approximately 2 in. is maintained between the ceiling and the top of the branch duct. Excessive air circulation is to be avoided.

Room Dimensions: Fig. 8

40 ft 2 in. × 33 ft 6 in. × 11 ft 6 in.
Floor space = 1350 sq ft
Volume = 15,600 cu ft
Outdoor wall area—980 sq ft
Partition wall area—770 sq ft

Hanging Capacity:

No. of racks—12
Length of racks—27 ft
No. of rails high—5
Spacing of sticks—2 per ft of rail
No. of pieces of sausage per stick—7
Average weight per sausage—4 lb
12 × 27 × 5 × 2 × 7 × 4 = 90,720 lb of product
Say 90,000 lb green weight hanging capacity
Loading per day—1500 lb

Outdoor Conditions Assumed (Summer):

95 F db; 75 F wb; 39% rh; 37.8 H; 66 F dp; 96 gr per lb

Dry Room Conditions Desired:

55 F db; 50 F wb; 70% rh; 20.2 H; 46 F dp; 46 gr per lb

Sensible Heat Calculations

Walls (2 in. insul.)—980 × (95 − 55) × 0.10	= 3920 Btuh
Partition (4 in. insul.)—770 × (95 − 55) × 0.067	= 2060 Btuh
Floor & Ceiling—2700 × (55 − 55) × 0.10	= none
Infiltration—0.5 × 15,600 × (95 − 55) × 0.243 × 0.075	= 5700 Btuh
Lights 600 watts × 3.415	= 2050 Btuh
Motors 5 hp × 2546	= 12,730 Btuh
Product 1500 × 0.8 sp ht × (95 − 55)/24	= 2000 Btuh
Total Sensible Heat	= 28,460 Btuh

Latent Heat Calculations

Product 90,000 × 0.30 × 1000/(60 × 24) = 18,720 Btuh
18,720 × 7000/(60 × 1000) = 2184 gr/min
Infiltration 0.5 × 15,600 × 0.075 × (37.8 − 20.2) = 10,300
(10,300 − 5700) × 7000/(60 × 1000) = 537 gr/min

Total grains of moisture = 272. gr/min

Assume 12 air changes per hour empty room volume 15,600 × (12/60) × 0.075 = 234 lb air per min (2721/234) = 11.2 gr per lb of air to be absorbed. 46 − 11.2 = 34.8 gr per lb in supply air. (39 F dp) 39 F dp, 90% rh, 41.3 F db, 40.3 F wb, 15.3 H, gr per lb. Sensible heat gain 28,460/(234 × 0.243 × 60) = 8.3 F db. Latent heat product only = 18,720/(234 × 0.243 × 60) = 5.5 F deg. Temperature drop due to evaporative cooling. 8.7 F − 5.5 F = 3.2 F deg net temperature rise in room. 55 F db − 3.2 F = 51.8 F db supply air at 39 F dp (34.8 gr).

Refrigerating Load = 234 × (20.2 − 15.3) × 60 = 68,800 Btuh
Reheat Load = 234 × (17.6 − 15.3) × 60 = 32,300 Btuh
Room Load = 234 × (20.2 − 17.6) × 60 = 36,500 Btuh

LARD CHILLING

In federally inspected plants the USDA Meat Inspection Division designates the types of pork fats which, when rendered, are classified as lard. Other pork fats, when rendered, are designated as *rendered pork fats*. The rendering process requires considerable heat and the subsequent temperature of the lard at which refrigeration is to be applied may be as high as 120 F. The following data for refrigeration requirements may be used for either type of product.

The requirements of the Meat Inspection Division are good sanitation through all phases of handling. The use of copper or copperbearing alloys where they come in contact with lard should be avoided because minute traces of copper lower the stability of lard.

Specific gravity of lard varies from about 0.99 at 0 F to 0.88 at 160 F. Specific gravity at 70 F is about 0.93. Heat of solidification of lard is approximately 48 Btu per lb. Melting begins at −35 to −40 F and ends at 110 to 115 F. The point of half fusion is in the neighborhood of 40 F. Specific heat of lard in the completely solid form varies from 0.28 Btu per F per lb at −110 F to 0.34 at −40 F. Specific heat in the liquid state varies from 0.50 at 110 F to 0.52 at 212 F.

Refrigeration is employed in the production of lard so that the final product will have smooth texture and firm consistency. The finest possible crystal structure is desired.

Calculation for chilling 1000 lb of lard per hr are:

Initial temperature	120 F
Final temperature	80 F
Heat of solidification	48 Btu per lb
Specific heat	0.50 Btu per (lb)(F deg)

$$\text{\% solidification at final temperature} = \frac{\text{Temp at which melting ends} - \text{final temp}}{\text{Temp at which melting ends} - \text{temp at which melting begins}} \times 100 = \frac{115-80}{115-(-40)} \times 100$$

$$= (35/155)(100) = 22.6\%$$

Latent heat of solidification:

$$(22.6/100) \times 48 = 10.8 \text{ Btu per lb}$$

Sensible heat removed

$$0.50 \times (120 - 80) = 20 \text{ Btu per lb}$$

Total heat removed:

$$(20 + 10.8) \times 1000 = 30{,}800 \text{ Btu per hr}$$

$$30{,}800/12{,}000 = 2.57 \text{ tons net refrigeration}$$

Assuming 15 percent loss, due to radiation and other causes in process, the required refrigeration for application to chill 1000 lb lard per hr would be 1.15 × 2.57 = 2.96 tons.

Filtered lard at 120 F can be chilled and plasticized in a compact internal swept surface chilling unit. This is the modern method and the one generally used. Units are available using either ammonia or halogenated hydrocarbons. A refrigerating capacity should be provided equivalent to about three tons per 1000 lb of lard handled per hour for the product only and additional refrigeration provided for the requirements of heat equivalent to the work done by the internal swept surface chilling equipment.

In the operation of this type of chilling equipment, it is essential to maintain the refrigerant free of oil and other impurities so that the heat transfer surface will not have a film of oil on it to act as insulation and cut down the capacity of the unit. Some installations of such equipment are provided with oil traps connected to the liquid refrigerant leg on the floor below to provide drainage space to accumulate the oil drained from the refrigerant space of the unit.

The safety requirements for this type of chilling equipment are quite amply described in the latest revision of the *American Standard Safety Code for Mechanical Refrigeration* B9. It must be kept in mind that such units are pressure vessels and as such require safety valves properly installed and properly maintained.

The recommended storage temperature for packaged refined lard is 31 to 33 F. The storage temperature required for prime steam lard in metal containers is 40 F or below. These conditions are recommended for up to a 6 month storage period. If lard is to be kept in storage for a year or more, 0 F is recommended.

HIDE CURING

Hides represent one of the greatest values of any of the cattle by-products. Great care is taken in all of the operations involved, from the purchase of live cattle to the delivery of the cured hides. The hide is subject to decomposition from bacterial action immediately after the organs of the animal stop functioning. Experience has shown that the best method of stopping this bacterial action is through prompt handling to curing. Curing, as defined by Dr. De Beukelaer of the American Meat Institute Foundation, is the transformation which places the hide in a condition to resist bacterial decomposition. This is accomplished by the replacement of natural moisture in the hide with concentrated brine. Some moisture is lost in this operation. The reduction in the weight of the hide in curing is mainly based on this moisture loss and is commonly referred to as shrink. Blood solids removed from the surface of the hide are also a contributing factor in hide shrinkage.

Hide shrink may vary between 12 and 18 percent. Normal expectancy is as follows:

Native Bull	16 to 18%	Light Cow	14 to 17%
Native Steer	13 to 18%	Calf & Kip	12 to 15%

The weight of a hide from an animal will vary throughout the year. For example, the hair on the hide is usually short during the late summer and fall, then grows longer during the winter. For a yearly average, it will be satisfactory to assume the green hide is approximately 6½ to 7½ percent of the live animal weight. Hides from fattened steers will be in the lower bracket, while the hide will be of higher percentage with lean cattle.

Moisture in hides of the same weight will vary because of conditions on the killing floor, but more noticeably, the moisture content of green hides will vary considerably from that of cured hides. For this reason, it is desirable to calculate the specific heat for each condition. Siebel's formula for specific heat above freezing should be used:

$$s = \frac{a + 0.2b}{100} = 0.008a + 0.20,$$

in which s is the specific heat above freezing of a substance containing a percent of water, b percent of solids and 0.2 is the assumed specific heat of the solid matter.

$$s\ (\text{green}) = 0.008 \times 69 + 0.20 = 0.752$$
$$s\ (\text{cured}) = 0.008 \times 46 + 0.20 = 0.568$$