

OPEN REFRIGERATED DISPLAY CASES¹

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The use of open refrigerated display cases is a recent development in the field of merchandising food products on a retail level. With each new development comes many questions regarding the operation of the equipment and the ability of the new unit to perform as compared to previous ones. There is no one publication available today which covers the various questions pertaining to the usage and operation of open refrigerated display cases. Several publications were reviewed to obtain the information for this paper. There is a need for cooperation of sanitarians and engineers in the design and operation of display cases. Usually the equipment is properly designed but certain operational procedures are not followed at the retail level which make the units objectionable in some cases. There is very little difference in the operation of open refrigerated display cases as compared to the conventional refrigerated display cases. The main difference is one of procedure in using the equipment.

There is a great amount of waste and spoilage of fruits, vegetables, milk and meat at the retail level. It was recently estimated that 35 percent of the nation's vegetable production is lost between the farmer and the consumer^{1a}. It is generally agreed that the losses of fresh fruits and vegetables at the retail level are from 4 percent to 8 percent^{1b}. In any business the decrease of waste and spoilage accounts for an increase in efficiency with an overall saving to the purchaser and/or increased profits to the producer. The previous data regarding losses and wastage indicate that considerable spoilage occurs at places other than the retail store outlets. Improper handling and marketing practices between the producer and the retail

store are probably a greater problem than the display cases from the standpoint of preventing losses. Also, it is important to note that some of the waste or spoilage that occurs in the retail stores may be due to improper handling and marketing practices used prior to the time the products are received at the store.

The growth of the self-service of meats in particular, has been dependent upon two things: (a) development of suitable package materials; (b) development of equipment for handling products at a uniformly low temperature².

In tests carried out in the Philadelphia area 3.5 percent of the losses of vegetables occurred in stores in the summer where refrigerated display cases were used as compared to 7.6 percent losses where refrigerated units were not used².

CLASSIFICATION OF UNITS

Display cases can be divided into the following types:

- Bin type, angular
- Canopy type
- Magazine feed type
- Multiple deck
- Pigeon hole
- Open-front
- Open-top

Of the various types we are mainly interested in discussing the last two, inasmuch as the former types have been used for many years. They will be used as standard for comparison. Self-service cases include such features as rear loading, one-way vision mirrors, lighting, automatic defrosting equipment, and various methods of maintaining low temperatures.

The units are normally designed to maintain a low temperature product rather than to cool products. A unit would have to have much larger refrigeration capacity in order to cool the product to a low temperature. In later sections of the paper the relationships between lighting, temperature, and humidity on maintaining the quality of the product will be discussed.

The standard refrigerated boxes



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should be designed to maintain temperatures of from 36° to 42° F. In addition, a fairly high humidity of from 70 to 85 percent is required for all cut and uncovered foods³. The high humidities are required in order to avoid dehydration or drying of the product. A uniform movement of air is required in order to maintain uniform temperatures throughout the box. It is best that the air is not blown directly on the products so that excessive drying is prevented.

Open refrigerated display cases are commonly used for fruits and vegetables, milk, meat, and eggs.

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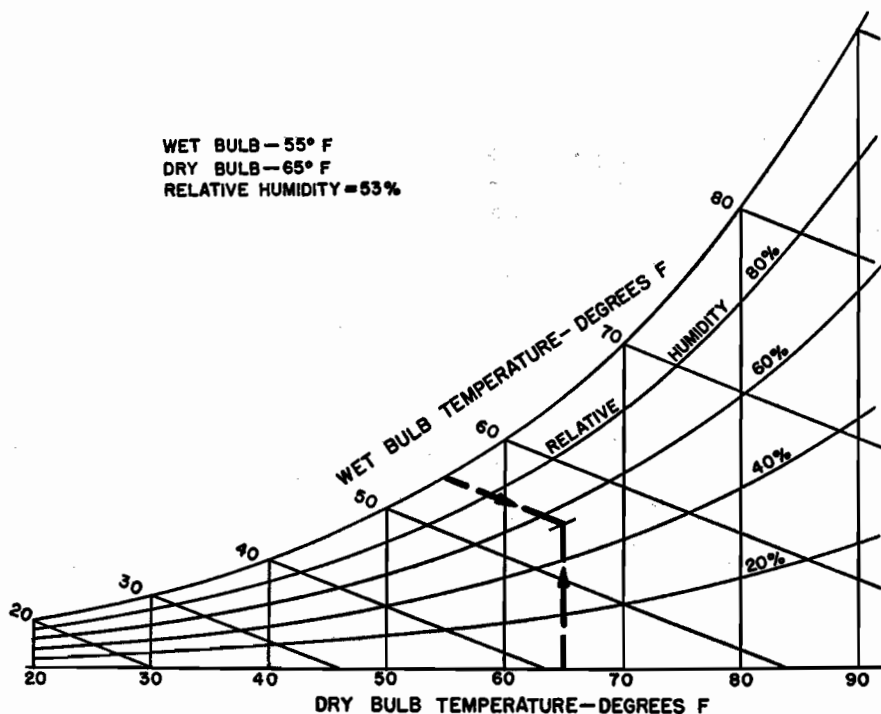


FIG. 1 HUMIDITY OR PSYCHROMETRIC CHART

LOCATION OF UNIT

One of the most important factors to consider is that the open display case should not be placed around fans or drafts. The unit should be kept away from doors. By following these suggestions foreign material will not be blown into the cooler and warm air will be kept out, thus decreasing the refrigeration load and maintaining a lower temperature in the product.

A drain must usually be available for removing water from the unit, particularly during the defrosting period. Some units do not require drain connections because they are equipped with systems of disposing of water by the use of heat from the refrigeration system^{4a}.

TEMPERATURES AND HUMIDITIES

From the standpoint of maintaining the quality of product in the display case, the maintenance of temperature and humidity is probably the most important item. A display unit should be equipped with a thermometer—usually a dial thermometer. A thermometer for checking refrigerated display cases should have scale divisions which are widely spaced and easy to read, probably with a scale that ranges from about 10° to 90° F. There is some variation in the temperature throughout the box. The

bulb of the thermometer should be placed on a level with the highest point to which the product is placed in the case. It is important that the thermometer is not placed close to the cooling coils or cooling plate. If the thermometer has a metal back it should be mounted on a wooden surface or a small piece of wood which will act as an insulator⁵.

The maintenance of the proper recommended humidity is particularly important for unpackaged produce or produce placed in ventilated packages. The relative humidity is measured by a psychrometer. The common psychrometer is composed of two thermometers, one a wet bulb and the other a dry bulb. Water will evaporate from the wet bulb of the thermometer, with the evaporation of water cooling the thermometer thus giving a lower temperature. The amount of temperature depression will depend upon the rate at which water is evaporated from the wet bulb which in turn is dependent upon the moisture in the air. The relative humidity is then obtained from a psychrometric chart (See Figure 1). Instruments are also available for reading the relative

humidity directly. Some commercial companies have placed the information on the psychrometric chart on a simple slide rule to aid in rapidly obtaining the relative humidity without a chart.

a. Vegetable and Fruit Cooler

Considerable work has been done to determine the shelf life of various fresh fruits and vegetables in retail store display cases, by the Division of Handling, Transportation, and Storage of Horticultural Crops of the Agricultural Research Administration, the U.S.D.A.⁶⁻¹².

It is a well-known fact that with refrigeration the respiration rate of packaged produce is much lower than otherwise. At lower temperatures produce requires less oxygen and produces less carbon dioxide, e.g., strawberries respire only about 1/5 as fast at 40° as at 70° F. Apples respire only 1/14 as fast, peaches 1/9 as fast, potatoes 1/2 as fast and sweet corn 1/5 as fast at 40° as at 70° F¹³.

The difficulty of obtaining desirable refrigeration at various points in the refrigerated display cases has been pointed out¹⁴. This was caused mainly by the fact that pre-packaged produce interfered with the circulation of refrigerated air. It was experienced to some extent for the cooling of bulk produce.

Very few stores have adequate refrigerated space in which to store all of their produce. A priority basis is needed for using refrigerated space. Table 1 lists those fruits and vegetables in three groups—those in which refrigeration is essential, those in which refrigeration is desirable, and those in which no refrigeration is desired.

Produce stored and displayed on a false-bottom rack, in a regular refrigerated case did not keep satisfactorily, and should not be recommended.

On a percentage basis the greatest losses of produce in refrigerated display cases were as follows: lima beans, 17; eggplant, 16; pineapple, 16; parsnips, 16; kale, 16; and corn, 16 percent¹.

Vegetables inside the refrigerated zone became chilled and upon chilling moisture is condensed from the room air on the vegetables. There is little exchange of air between the refrigerated box and the room. The warm air normally

TABLE 1—PRIORITY FOR REFRIGERATION SPACE¹

<i>Refrigeration essential</i>		<i>Refrigeration desirable</i>	<i>No refrigeration desired</i>
Apples, summer	Kale	Apples, winter	Bananas
Artichokes	Head lettuce	Avacados	Cucumbers
Asparagus	Limes	Beans, snap	Lemons
Lima beans	Mushrooms	Beets	Onions
Berries	Pears, ripe	Cabbage	Pears, green
Broccoli	Peas	Carrots	Peppers
Brussel sprouts	Pineapples, ripe	Egg plant	Pineapples, green
Cauliflower	Radishes	Grapefruit	Potatoes
Celery	Salad mixes	Oranges	Sweet potatoes
Cherries	Scallions	Parsnips	
Chicory	Spinach	Rhubarb	
Cole slaw	Sweet corn	Tomatoes	
	Tangerines		

ries because it is lighter. In general, the temperature range for open vegetable cases will vary from 35° to 46° F.³

Tests by the U.S.D.A. give the variation of temperatures in a refrigerated box⁶.

b. Milk Cooler

Pasteurized milk, if cooled properly, will keep a long time. In tests at Michigan State College, milk was held at 33° F for two to six weeks without flavor deterioration¹⁵. However, at temperatures higher than 33° F flavor deterioration proceeded quite rapidly.

A survey of 17 states in 37 cities in which nearly 16,000 stores and 24,000 restaurants and dairy bars and 920 roadside stands were contacted, showed that 60 percent of the milk delivered to the stores was above 50° F and 16 percent above 60° F¹⁶. About 55 percent of the milk delivered to the restaurants was above 55° F and 19 percent above 60° F. This information points out one of the important operations which is often neglected in the handling of the products from the processor to the retailer. More attention should be given to maintaining proper temperature before the milk is delivered to the store. In the same survey it was found that over 1/2 of the milk was at least 24 hours old in the display cases. In the same area most cities set a maximum temperature of 50° F.

Other researchers have recommended that milk be stored below 50° F¹⁷. This is particularly important where delivery is every-other-day or three days a week, so that milk will retain its quality

up to four days after pasteurization. Under home-refrigerated conditions at about 40° F, 3- and 4-day old milk tested showed 97 percent had no or slight increase in acidity, while with 5- and 6-day milk, only 64 percent and 55 percent had no or slight increase in acidity. There was also a decided increase in bacteria count with the 5- and 6-day old milk over the 3- and 4-day milk, with the refrigerator temperature varying from 37° to 52° F¹⁷.

In the closed-type dairy cases, temperatures of 36° to 45° F are considered satisfactory³. The same should apply to open display cases inasmuch as milk is enclosed in a moisture-proof carton and the effect of humidity would not apply as for vegetables and fruits which are not packaged.

c. Meat Cooler.

The lowest temperature which can be provided without freezing the meat is desirable. The practical range is from 32° to 34° F. The relative humidity may average as low as 60 percent in mechanically refrigerated self-service cases. Fresh meats are in equilibrium with about 95 percent relative humidity². Meat placed in the refrigerated air stream would normally dry out. Therefore a moisture-proof wrap is required to prevent dehydration of meat. When stored at 40° F, package fresh beef can be kept on display for three days, while at 50° F two days, at 72° F one day, before the color of the product becomes unsatisfactory because of high temperature². It was found that air movement across steak samples for one self-service case under self-service conditions was about 25 ft. per minute¹⁸, in a room of about 70° F and 30 percent

relative humidity. The relative humidity in the box varied from 50 to 71 percent. Temperatures varied up to 5° F from the front to the back of the box, with the highest temperature in the middle. When the meat was not stacked, the upper edge of the steak placed in the display box was 2° to 4° F warmer than the lower surface. On keeping quality tests, much better quality was obtained at 32° F than at 34° or 40° F. In two days at 40° F mold development on the packaged steaks hit the logarithmic spiral, while at 34° F six days were required. Other changes which might be caused or speeded by bacterial growth would be discoloration, slime formation, and off-odor, any of which could render the meat unsalable.

The average inlet air temperature on a commercial meat cooler for one model is 24° to 30° F¹⁹. The meat products should be placed in a ribbon display so that air will be circulated around the product from the refrigeration coil to get as much cooling as possible.

Temperatures for beef, veal, and lamb should be carefully regulated so that the minimum does not fall below 32° F in order to prevent darkening due to slow freezing action⁵.

d. Egg Cooler.

Generally eggs are displayed unrefrigerated or if refrigerated, placed in the same unit in which milk and cheese are stored. In retail stores in New York state, 32 percent of the eggs were refrigerated²⁰. It is generally considered that the proper temperature for egg storage is between 45° and 60° F. At temperatures below 45° F, condensation often occurs on the eggs when they are removed from the refrigerated area, giving an undesirable product. The humidity chart discussed previously can be used to determine if condensation will take place. A special open egg display case has been developed to maintain the proper temperature. The refrigeration for cooling eggs will come from plates extending along the sides of rows of cartoned eggs rather than from the rear of the eggs. Thus, cold air will circulate directly from the coils to the egg cartons, and maintain proper temperature more easily without a variation in temperature

from the bottom to the top of the display case²⁰.

e. *Frozen meats and juices.*

These products require temperatures of from -5° to $+5^{\circ}$ F³. It is important that frozen foods in these cases should be stored low enough to prevent being affected by the higher temperatures which occur in the buffer area at the top of the display space and the room temperature above. Some units have lids which can be closed at night and over weekends.

With rapid air movement over meat about 50 percent of the time, and stored at 0° F, 21 different packaging materials on fresh ground beef were tested²¹. It was found that fresh ground beef quality could be maintained for as long as 14 months and still have good color and no more than 1/2 percent shrink based on weight. A list of the various packaging materials was presented in the report and the value of the material on the basis of surface dehydration given.

PACKAGING RELATIONSHIPS

Much material has been published on the relationship of various materials for packaging meats and vegetables. In fact, an entire monthly periodical entitled *Modern Packaging* is available for those interested. If properly packaged with a material such as MSAT cellophane, bacterial growth will be retarded if the refrigeration unit holds the product in the display case at a temperature of from 34° to 40° F. Color deterioration is a major problem encountered with packaged meats²².

LIGHTING

Oftentimes, discoloration of meat is attributed to lighting when the actual difficulty might be because of too low a temperature. Fresh meats should not be maintained below 32° and smoked meat should be kept at 38° to 40° F for best color retention²³.

Also, discoloration of meat might be caused by darkening of the surface due to dehydration which usually can be corrected by using a higher humidity around the meats. This can be accomplished by lowering the velocity of the air.

If the light on the meat is of great intensity or of long duration, the meat will fade quite rapidly. The light changes the color pigment. If the light intensity is

above 35 footcandles^{4b}, fading of meat may take place in commercial units. The footcandle light intensity can be measured by an exposure meter similar to or the same as a meter used in photography. It was formerly thought that the effect of ultraviolet light caused meat, particularly pork, to become rancid and therefore the fluorescent lights which contain a greater amount of ultraviolet light were less desirable. However, it has been found that the fading of color was due to light intensity and exposure time regardless of whether an incandescent lamp or fluorescent lamp was used, as long as the intensities of the two lights were the same^{24, 25}. An intensity of 60 footcandles for one hour was the minimum exposure which caused fading²⁵. It was also found that display in the frozen state did not alter the susceptibility to fading with different lights.

GENERAL HANDLING AND DISPLAY

It is important to emphasize again that the product should be delivered to the store in good and cooled condition before it is placed on display. For example, many city ordinances require that milk be 50° F or less when sold. It would also be important that the milk be delivered to the store at 50° F and at all steps in the delivery operation the product be held below this temperature. It would seem that sanitarians should be aware of this fact because they might penalize the retail outlet for improper handling before the retail store even received the product.

Most boxes have directions or marks regarding the amount of produce that should be placed in the display case. This is actually about 9 inches above the floor. Users of refrigerating equipment should not be permitted to place more product in the display case than recommended by the manufacturer. To do this, permits too high temperatures in the top layer of product with resulting spoilage. Bacterial action is considerably higher in improperly refrigerated products.

Tests have been conducted in which vegetables have been sprinkled four times daily as compared to non-sprinkled lots. Sprinkling with tap water four times daily had no cooling effect

on the product but it kept it attractive longer and reduced moisture loss⁶.

Burlap covers for placing over the produce in the refrigerated display case are available. Prior to placing the cover over the produce, the latter should be sprayed with water and then the cover should be saturated with water⁴. This procedure keeps the product moist throughout the night and should increase the shelf life of the product.

MAINTENANCE, OPERATION, HEALTH REQUIREMENTS

With the first display boxes which had a closed glass front defrosting was not a particular problem because the cooling coil was operated at a temperature slightly above freezing. However, with the open front refrigeration equipment the necessity of using small coils because of limited space, it is necessary to operate the cooling coil at a temperature below freezing in order to maintain the proper temperature in the freezing or cooling compartment. When the cooling coil is operated below freezing, ice accumulates on that coil. The cooling coils become inefficient as an ice layer builds up on them. The following methods may be used for defrosting: (a) manual, (b) timers, (c) electrical means, (d) hot gas, (e) auxiliary heat, and (f) a timer with pressure reset.

SUMMARY

Although the open refrigerated display cases have been introduced recently they have been designed so that when properly used, food products will be adequately preserved. The principles which apply in the operation of the closed refrigerated display cases apply in almost every respect to the open cases. The amount of loss at the retail level can be reduced considerably by use of refrigerated cases. The open refrigerated display case cut the losses in one-half as compared with no refrigeration of vegetable products.

The unit should be placed where there will not be a draft. The temperature and humidity should be adjusted according to the recommendations for various products. By using the proper package material the importance of relative humidity control, especially for meat, is decreased. The intensity of light in footcandles, not the kind

of light source, that is, fluorescent or incandescent, is the criterium for determining whether or not meat will be discolored.

Sanitarians must be aware of the fact that although produce in the display case may be spoiled, it may have been caused by improper handling prior to delivery at the retail outlet. Retail men have an interest in getting a good product. Company recommendations should be followed regarding the amount of produce and placement of produce in the open display case. By using proper methods the material will be maintained at the proper temperature and humidity in an open unit and will be attractive so that maximum customer appeal will be obtained.

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THIRD REPORT OF THE
RESOLUTIONS COMMITTEE
of the
Association of Food and Drug
Officials of the United States
May 21, 1954

RESOLUTION X

WHEREAS, The Association of Food and Drug Officials of the United States assembled in annual convention, Des Moines, Iowa, May 20, 1954, has carefully studied and evaluated House Bill 8368, entitled "A Bill to Amend the Agricultural Marketing Act of 1937, so as to Remove Domestic Trade Barriers Affecting Milk and Milk Products", introduced by Hon. August H. Andresen, referred to the Committee on Agriculture,

WHEREAS, It is believed that the authors of this bill, while concerned with the remedies which they sought, failed to recognize the untoward effect that the principle employed would have in depriving all states of their traditional, inherent and rightful authority in ordering their own affairs and in promoting and protecting the health and welfare of their people;

WHEREAS, It is considered apparent that the principle of this bill is wrong, that it would serve no constructive purpose in promoting the sale of milk nor in promoting the principles of public health.

THEREFORE, BE IT RESOLVED, That because of the defective nature of this Bill, both in principle and detail, this Association is not only unalterably opposed to its passage as law, but also is opposed to this principle in legislation.

(Signed) E. W. Constable
(Chairman)

J. H. McCutchen
Sarah Dugan

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