FROZEN FOOD

HANDLING AND MERCHANDISING

Revised 2009

Prepared by the

FROZEN FOOD ROUNDTABLE

2000 Corporate Ridge, Suite 1000

McLean, Virginia 22102

Endorsed and Subscribed to by:

Air-Conditioning, Heating and Refrigeration Institute
2111 Wilson Blvd, Suite 500
Arlington, VA 22201
Telephone: (703) 524-8800
Fax: (703) 528-3816
Web site: www.ahrinet.org

American Association of Meat Processors
One Meating Place
Elizabethtown, PA 17022
Telephone: (717) 367-1168
Fax: (717) 367-9096
Web site: www.aamp.com

American Frozen Food Institute
2000 Corporate Ridge, Suite 1000
McLean, VA 22102
Telephone: (703) 821-0770
Fax: (703) 821-1350
Web site: www.affi.com

Food Marketing Institute
2345 Crystal Dr., Suite 800
Arlington, VA 22202
Telephone: (202) 452-8444
Fax: (202) 429-4519
Web site: www.fmi.org

Frozen Potato Products Institute
2000 Corporate Ridge, Suite 1000
McLean, VA 22102
Telephone: (703) 821-0770
Fax: (703) 821-1350
Web site: www.affi.com

Global Cold Chain Alliance
1500 King St., Suite 201
Alexandria, VA 22314 USA
Telephone: (703) 373-4300
Fax: (703) 373-4301
Web site: www.gcca.org

Grocery Manufacturers Association
1350 I (Eye) St., NW, Suite 300
Washington, DC 20005
Telephone: (202) 639-5900
Fax: (202) 639-5932
Web site: www.gmaonline.org

International Association of Refrigerated Warehouses
1500 King St., Suite 201
Alexandria, VA 22314 USA
Telephone: (703) 373-4300
Fax: (703) 373-4301
Web site: www.iarw.org

International Dairy Foods Association
1250 H St., NW, Suite 900
Washington, D.C. 20005
Telephone: (202) 737-4332
Fax: (202) 331-7820
Web site: www.idfa.org

International Institute of Ammonia Refrigeration
1110 North Glebe Rd.
Arlington, VA 22201
Telephone: (703) 312-4200
Web site: www.iiar.org

International Refrigerated Transportation Association, Inc.
1500 King St., Suite 201
Alexandria, VA 22314 USA
Telephone: (703) 373-4300
Fax: (703) 373-4301
Web site: www.irta.org

National Chicken Council
1015 15th St, NW, Suite 930
Washington, DC 20005-2622
Telephone: (202) 296-2622
Fax: (202) 293-4005
Web site: www.nationalchickencouncil.com

National Fisheries Institute
7918 Jones Branch Dr, Suite 700
McLean, VA 22102
Telephone: (703) 752-8880
Fax: (703) 752-7583
Web site: www.aboutseafood.com

National Frozen Pizza Institute
2000 Corporate Ridge, Suite 1000
McLean, VA 22102
Telephone: (703) 821-0770
Fax: (703) 821-1350
Web site: www.affi.com

National Restaurant Association
1200 17th St., NW
Washington, D.C. 20036
Telephone: (202) 331-5900 or (800) 424-5156
Fax: (202) 331-2429
Web site: www.restaurant.org

World Food Logistics Organization
1500 King St., Suite 201
Alexandria, Virginia 22314 USA
Telephone: (703) 373-4300
Fax: (703) 373-4301
Web site: www.wflo.org

Statement of Purpose

The frozen food industry is committed to providing consumers safe, wholesome, high quality food products. Proper handling and storage of frozen foods throughout distribution are essential to maintaining food safety and quality. The following recommended practices for the handling and merchandising of pre-packaged frozen foods have been developed by the trade associations listed [at the end of this section?] to guide the industry – throughout the food chain – and assist consumers in proper product handling and storage. They reflect the extensive scientific, technical and practical experience of the industry's experts, and are designed to help maintain the quality of frozen foods.

Generally speaking, pathogenic organisms will not grow in frozen foods maintained at recommended temperatures. Because the recommended handling practices are intended to focus strictly on maintaining high product quality product distribution and storage, this document does not incorporate food safety systems such as Hazard Analysis and Critical Control Point (HACCP) programs and other programs that are relied upon by food processors in manufacturing safe foods. Information about the use of HACCP and other food safety systems may be obtained by contacting any of the endorsing organizations.

These recommended practices supersede the 1999 edition published by the Frozen Food Roundtable. It reflects extensive research, new technologies, new product development, more recent experience, and changes in government regulation, as well as encompassing advances made in frozen food handling and merchandising.

The following factors must be included in any plan for producing quality frozen foods:

- High intrinsic quality of raw materials used in the product.
- Correct processing and packaging of the product.
- Rotation of inventory throughout the "Cold Chain," utilizing FIFO ("First In - First Out").
- Maintenance of uniform, sufficiently cold temperatures; maintaining 0°F (-18°C). (Some products such as ice cream and frozen snacks, require temperatures of -10°F (-23°C) or colder. (Product-specific temperature information may be obtained from organizations which specialize in that commodity.)

The trade associations that have developed these recommended practices, leaders in the large and evolving frozen food industry, have done so to promote the dissemination of sound, up-to-date practices for the care and handling of frozen foods. **The recommended practices are intended as guidelines, not standards or requirements. Every company must determine which practices are most effective and appropriate for the products that it manufactures and/or distributes. The recommended practices are not intended as and should not substitute for legal advice. Companies should consult their own legal counsel to ensure compliance with applicable laws and regulations. The organizations that have developed these voluntary guidelines do not warrant that they will ensure that the products their members manufacture and/or distribute are safe, wholesome, or correctly labeled, and they expressly disclaim any such warranties.**

The quality of frozen foods in the consumer's kitchen is dependent on the product's handling by each and every person who is part of the distribution chain. Each individual should be familiar with the various

aspects of frozen food handling and consider the guidelines set forth in this document. Maintenance of food safety and quality requires understanding the need for proper product handling.

Disclaimer:

This guidance may not identify all hazards that need to be controlled and it is the responsibility of the company to identify all hazards that are reasonably likely to occur, as well as any new or emerging problems.

Editor's note: All URL's and Web site addresses are current as of August 2009.

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I. FROZEN FOOD FREEZING AND PACKAGING

a. Foods for Freezing

1. Quick freezing does not improve original quality, hence, only sound and wholesome raw materials at an optimum level of maturity and freshness should be frozen.

2. Freezing should be performed with appropriate equipment in such a way as to minimize physical and biochemical changes. With most products this is best achieved by ensuring that the product passes through the temperature range of maximum crystallization [for most products +30°F to +23°F (-1°C to -5°C)] quickly.

3. On exit from the freezing apparatus, the product should be minimally exposed to humidity and warm temperatures, be moved into a cold warehouse as quickly as practical and then allowed an adequate dwell time for temperature equilibration.

4. Product should leave the warehouse at 0°F (-18°C) or lower promptly, and retain that temperature upon reaching the primary warehouse.

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b. Packaging and Identification of Frozen Food

1. Packaging and outer cases for frozen foods should be of good quality in order to prevent contamination, ensure the integrity of the product during normal transit and storage and minimize dehydration.

2. Package coding should be adequate for effective identification and to facilitate compliance with the Public Health Security and Bioterrorism Preparedness and Response Act of 2002 (the BT Act). For more information on the BT Act, see: http://www.fda.gov/RegulatoryInformation/Legislation/ucm148797.htm

3. Outer case coding is essential to enable proper stock rotation of individual cases. Frozen food processors should apply a readily understandable rotation symbol to every shipping case. An example of such a symbol is illustrated in **Appendix A**. This can be preprinted on shipping cases, leaving the number to be applied at the moment of packaging, if necessary. It may also be printed on an adhesive label or applied to the case at the moment of packing. Ideally, it should appear on two or three sides of the shipping case and be visible when the cases are stacked on pallets.

4. Phrases such as "Store at 0°F (-18°C) or colder" should appear on outer cases.

5. Lot, pallet or unit load identity is useful in enabling such loads to be properly rotated while the identity of the load is maintained. Pallets with mixed production codes should be marked accordingly.

II. PRIMARY COLD STORAGE

a. Cold Storage Facility Equipment

1. Each warehouse should be of adequate capacity and be equipped with suitable mechanical refrigeration to provide for, under anticipated conditions of outside temperature and peak loading, maintaining a reasonably steady air temperature of 0°F (-18°C) or colder, in all cold storage areas in which frozen foods are stored.

2. Each storage area should be equipped with two or more accurate and calibrated temperature measuring devices and at least one continuous recording device, installed to reflect the correct average air temperature. Temperatures of each area should be recorded and dated each day. A file of such temperatures should be maintained for a period of at least two years. A member of management should review the continuous recording record within one business day of its completion to ensure proper temperatures have been maintained at all times.

3. It is recommended that refrigeration equipment installations include an audible or visual alarm system that will activate when refrigeration failure occurs. This alarm mechanism enhances rapid response to frozen food exposure to adverse storage temperature. Telephone, email, text messaging or other appropriate communication systems should be used to immediately notify responsible parties if temperature deviations occur outside of normal business operating hours (e.g., nights, weekends, and holidays.)

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b. Cold Storage Facility Handling Procedures

1. The warehouse operator should record the product temperature of each lot of frozen food received and should accept custody only in accordance with good commercial practice. See **Appendices B and D** for information on types of thermometers and methods for measuring temperatures of product. The operator should retain lot arrival temperature records for a period of at least one year.

2. During receipt or storage, if frozen food product temperatures are found to be +10°F (-12°C) or warmer, and/or product cases are damaged or badly soiled, the warehouseman should immediately notify the owner or consignee and request instructions for special handling. Corrective action procedures could include rejecting the shipment or applying temperature recovery procedures that may consist of any available method for effectively lowering temperatures, such as blast freezing, placing product in low temperature areas with air circulation, and proper use of dunnage or separators in stacking.

3. Before a shipment of frozen food is accepted for storage, it should be code marked for effective identification.

4. Frozen food should be promptly moved through non-refrigerated loading and unloading areas to minimize exposure to humidity, elevated temperatures or other adverse conditions.

5. During defrosting cycles, product should be effectively covered or removed from beneath areas of accumulated frost. This should be conducted in a manner that does not raise the temperature of the product.

6. Frozen foods going into separate staging areas for order assembly should be moved out promptly unless the staging area is maintained at a reasonably uniform temperature of 0°F (-18°C) or colder.

7. As many operations as practical (casing, palletizing, etc.) should be carried out in cold storage area or refrigerated processing room to reduce the heat gain and associated quality deterioration, energy and dollar losses resulting from the exposure of frozen product to ambient temperatures.

8. To permit air circulation, sufficient space must be allowed between stacks and walls. If slipsheets are employed, the bottom unit load should be spaced from the floor of the cold warehouse by a pallet or other means.

9. Delivery vehicles should be sealed. If the seals are numbered, those numbers should match any seal numbers recorded on the Bill of Lading (BOL) or other delivery documents.

10. Facilities should have a written protocol to deal with maintenance of proper temperatures in the event of an electrical power outage.

II. TRANSPORTATION

1. The cargo areas of all vehicles used to transport frozen food, e.g., trucks, trailers or containers, railcars, ships and aircrafts, should be:

a) clean and free from dirt, debris, odors, or any substances that could contaminate the food;

b) constructed, insulated and equipped with adequate refrigeration capacity and air delivery system to continuously maintain product temperature of 0°F (-18°C) or colder. Refer to *Refrigerated Transportation Foundation (RTF) Classification System* guidelines and the American Trucking Association's (ATA) *Technology and Maintenance Council (TMC) Recommended Practices Manual RP 717A and 718a* guidelines referenced in **Appendix E** for suggested equipment requirements;

c) equipped with tight fitting doors and suitable closures for drain holes to prevent air leakage;

d) pre-cooled to 0°F prior to loading. The object of pre-cooling is to establish a gradient across the insulation: from 0°F (-18°C) on the inner surface to the temperature of the outer skin; and

e) equipped with an appropriate temperature monitoring device, a temperature recorder, and where appropriate time/temperature indicators to accurately measure the air temperature inside the cargo area of the vehicle. The dial or reading element of the device should be mounted in a readily visible location that can be conveniently read from outside the cargo area.

2. The thermostat on the vehicle's refrigeration unit should be set to maintain a return air temperature of 0°F (-18°C) or colder.

3. Proper airflow or air circulation must be maintained on all six sides of the load. This 0°F (-18°C), or colder, envelope around and through the load is a function of the vehicle's air delivery system and proper loading of vehicle. Refer to RTF and TMC guidelines in **Appendix E**.

4. Shipper, consignor or warehouseman should not tender to a carrier any container which has been damaged or defaced to the extent that the frozen product is in unsalable condition.

5. Carrier should have a written procedure/protocol to follow in the event of a loss of refrigeration during transport. See **Appendix F** for recommendations.

IV. RETAIL STORAGE AND HANDLING

a. Storage on Retail Premises

1. Frozen food storage facilities should maintain a steady product temperature of 0°F (-18°C) or colder. In addition, they should be of sufficient size to provide for proper inventory control, stock rotation and circulation of air around the frozen foods.
2. Frozen food storage facilities should have sufficient circulation of refrigerated air. Cases of frozen foods should be on a pallet or other means of providing adequate air circulation between the bottom case and the floor. To permit air circulation, sufficient space should be allowed between stacks and walls.

3. Frozen food storage facilities should be equipped with an adequate number of accurate and calibrated thermometer(s) (accurate to ±2°F) and temperature recording devices, which are easily read and situated to measure and record representative air temperatures. Glass thermometers should not be used.

4. Frozen food storage facilities should be defrosted, cleaned and free of dirt and debris, as necessary, to maintain refrigeration efficiency and to reduce the possibility of food contaminants.

5. It is recommended that new refrigeration equipment installation include an audible or visual alarm system that will activate when refrigeration failure occurs. This alarm

mechanism enhances rapid response to frozen food exposure to adverse storage temperature. Telephone, email, text messaging or other appropriate communication systems should be used to immediately notify responsible parties if temperature deviations occur outside of normal business operating hours (e.g., nights, weekends, and holidays.)

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b. Retail Display Equipment

1. Display cases should be capable of maintaining a product temperature of 0°F (-18°C) or colder except during defrost cycles and brief periods of loading. Technical specifications for display cases are available from equipment manufacturers.

2. Display cases should be located away from drafts, direct sun, and heat producing equipment or any other factor (i.e., humidity) likely to reduce their performance.

3. Display cases should be equipped with an accurate and calibrated numerically scaled indicating thermometer (accurate to ±2°F). Thermometer should be located in one or more places so as to register the representative air temperature of the unit. The thermometer scale should be located where it can be easily read.

4. The display case should have a properly marked load limit line located on the cabinet wall.

5. In order to provide air circulation, display cases should be provided with a sufficient number of dividers, separators and grids. 6. The display case should be defrosted, cleaned and sanitized when necessary, to assure efficient operation and reduce the possibility of contaminants. It should consistently be kept clean of debris, signs and tags which could restrict or deflect refrigerated air flow, or contaminate product.

7. Air outside the display case should not exceed 75°F and 55% R.H.

8. The display case should be emptied and cleaned/sanitized at least once each quarter according to an established written standard sanitation operating procedure. Records of this activity should be maintained.

9. It is recommended that new refrigeration equipment installations include an audible or visual alarm system that will activate when refrigeration failure occurs. This alarm mechanism enhances rapid response to frozen food exposure to adverse storage temperature. Telephone, email, text messaging or other appropriate communication systems should be used to notify responsible parties if temperature deviations occur outside of normal business operating hours (e.g., nights, weekends, and holidays.

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c. Retailer Handling Practices

1. Frozen food should be delivered in a frozen condition, preferably at 0°F (-18°C) or colder. Frozen food which is warmer than +10°F (-12°C) should be rejected by the department or store manager or, if accepted, examined for acceptable quality prior to being offered for sale. See **Appendix D** for recommended method of measuring temperature.

2. Once unloaded, frozen food should be moved immediately into cold storage or into the retail display case. This is essential to avoid delays which allow frozen food to be subjected to ambient temperatures that may raise the temperature of the product, before stocking into cold storage or display case.

3. Rotate inventory on a "first-in - first-out" (FIFO) basis. Any cases not bearing rotation coding instructions should be dated on receipt.

4. When loading frozen food into the display cabinet, proper inventory rotations should be followed. New products should be placed below the existing stock or at the back, in the case of vertical display shelves.

5. Frozen food should not be placed outside the designated load limit line. Care should be taken not to block air flow.

6. Frozen food display cabinets are designed only to maintain the temperature of already frozen food. Non-frozen food should not be placed in a display cabinet containing frozen food.

7. Retailers should determine manufacturers' recommendations for correct management of frozen food display cases in the event of electrical power failure of any degree. Store personnel should be aware of maintenance requirements, sanitation procedures and emergency actions in the event of equipment failure or product loss. See **Appendix F** for recommendations.

8. If case dividers are used, they should have sufficient holes or slots to allow air to flow freely throughout the case.

9. The thawing of frozen foods for sale at refrigerator temperature should only be done in a refrigerator at a temperature not warmer than 41°F (5°C).

V. FOODSERVICE STORAGE AND HANDLING

a. Product Receipt and Storage in Foodservice Installations

1. Sufficient and conveniently located storage facilities capable of maintaining all frozen foods at a reasonably uniform product temperature of 0°F (-18°C) or colder, should be

provided. These facilities should be of sufficient size to permit proper storage, including stock rotation and inventory control.

2. Product temperatures should be measured upon receipt. Refer to **Appendix D** for method. Frozen food that is warmer than +10°F (-12°C) should be rejected by the receiving department or store manager or, if accepted, examined for acceptable quality prior to being offered for sale. See **Appendix D** for recommended method of measuring temperature.

3. On receipt, promptly move all frozen foods to storage at 0°F (-18°C) or colder.

4. It is recommended that frozen food storage facilities include an audible or visual alarm system that will activate when refrigeration failure occurs. This alarm mechanism improves response time when frozen food is exposed to adverse storage temperature. Telephone, email, text messaging or other appropriate communication systems should be used to notify responsible parties if temperature deviations occur outside of normal business operating hours (e.g., nights, weekends, and holidays.)

5. Rotate inventory on a "first-in / first-out" (FIFO) basis. Any cases not bearing rotation coding instructions should be dated on receipt and the supplier notified to prevent future occurrences.

6. Frozen food storage facilities should have sufficient circulation of refrigerated air. Cases of frozen food should be stored off of the floor by a pallet or other means. To permit air circulation, sufficient space should be allowed between stacks and walls.

7. All frozen food storage facilities should be equipped with an accurate and calibrated numerically scaled indicating and/or recording thermometer accurate to within ±2°F. The sensing element should be located where it will measure the air temperature in the warmest part of each facility. The scale should be easily readable. Foodservice personnel should check thermometer readings frequently.

8. All foods should be well wrapped or sealed before placing them in storage.

9. Frozen food storage facilities should be defrosted, cleaned and free of dirt and debris, as necessary, to maintain refrigeration efficiency and to reduce the possibility of food contamination. Product should be protected during defrosting from melting ice. If necessary, contents should be removed to another freezer during defrosting.

10. Minimize the introduction of warm humid air into the freezer by limiting the number of times the freezer is opened.

11. There should be a written protocol describing the measures to be taken in the event of product temperature exceeding critical limits.

12. Facilities should have written protocols to deal with maintaining temperature in the event of an electrical power failure.

b. Frozen Food Handling in Foodservice Installations

1. Remove from freezer storage only the amount of food required for immediate use.

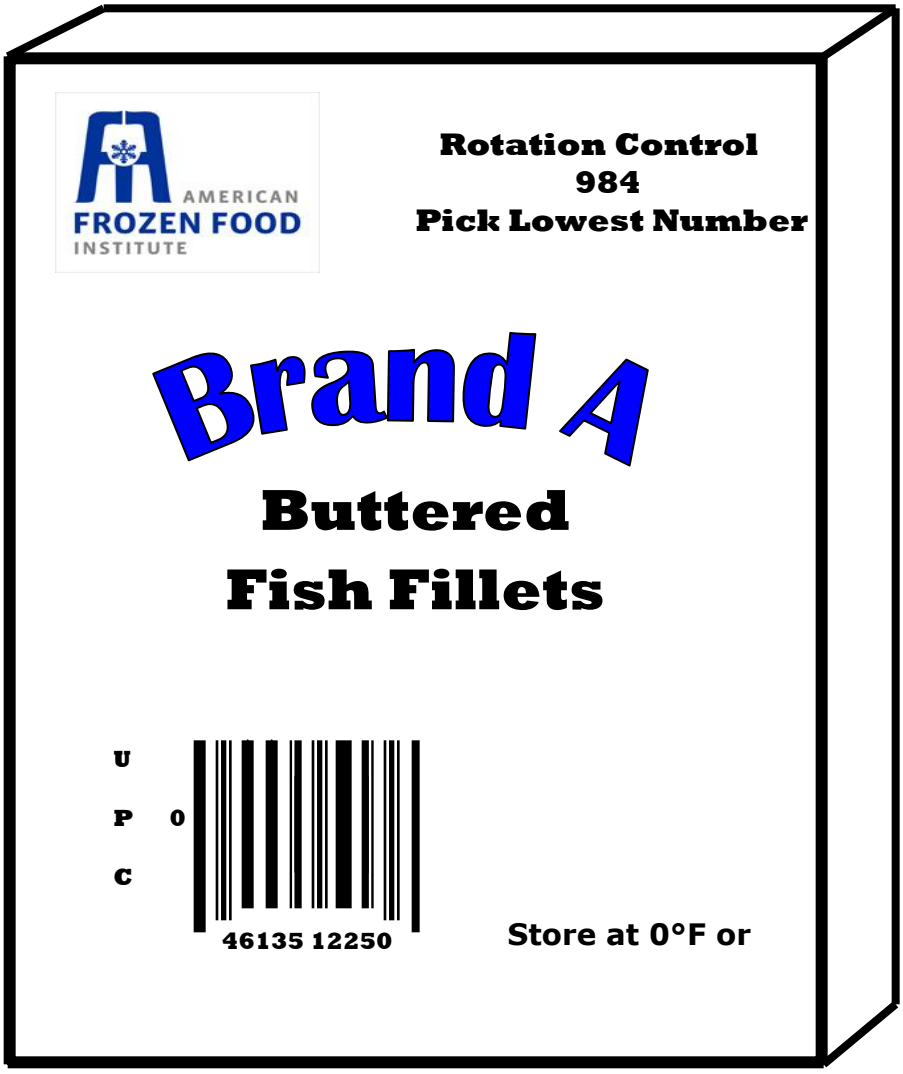
2. Frozen foods should be thawed only:

    - according to manufacturer's instructions;
    - in a refrigerator at a temperature not warmer than 41°F (5°C);
    - under potable quality running water at a temperature not warmer than +70°F (+21°C) [Refer to **Food Code 3-501.13 B (3) and (4**) for thawing time specifications. For potable quality water standards see U.S. Environmental Protection Agency Drinking Water Standards at www.epa.gov/safewater/index.html]; or
    - in a microwave oven or in conventional cooking equipment, in which case the thawing and cooking process should be continuous:

3. Thawed products should be promptly prepared for service or placed in refrigerated storage at less than 41°F.

APPENDIX A

SHIPPING CASE CODE SYMBOL



APPENDIX B

TYPES OF TEMPERATURE MEASURING DEVICES

Many methods have been developed for measuring temperature. Most rely on measuring a physical property that varies with temperature. Because accurate temperature measurement is critical for ensuring production, storage, and transportation of a safe and high-quality food product, many different types of temperature measurement devices have been developed to address specific needs. Cost, durability, accuracy, and speed of readout are variables to be considered when choosing the type of temperature measuring device to be used.

An array of temperature measuring devices are available that are suited for any number of temperature ranges, measuring environments or durability requirements.

Bimetallic Thermometers

Bimetallic thermometers are the most inexpensive, but slowest speed temperature monitoring devices often used in the food industry. A coil in the probe is made of two different metals with differing rates of expansion that are bonded together. The coil, connected to the temperature indicator, contracts as the temperature drops. To properly use such a thermometer, the probe or stem should be inserted in product until the temperature-sensing region is completely immersed. An indentation on the stem indicates the end of the temperature-sensing region. Typically, the thermometer senses temperature from its tip up to the stem for 2 to 2 1/2 inches. The indicated temperature is an average of the contact temperature along the length of the sensing section. An "instant-read" bimetallic-coil thermometer is available and these take up to 20 seconds to record a final temperature. Bi-metal thermometers are sensitive to physical stress such as torque on the stem, or shock from being dropped on the floor. These stresses can affect the tension of the bimetal coil and may necessitate calibration of the thermometer before reuse. While more expensive than the dial thermometers, the digital, instant-read thermometers are widely used in the food and meat industry because of their high sensitivity and easy to read display. Bimetallic thermometers should be National Sanitation Federation (NSF) listed and conform to American National Standard Institute's (ANSI) *Standard 51: Food Equipment Materials*.

Thermistor Thermometers

Thermistor-style thermometers use a resistor (a ceramic semiconductor bonded in the tip with temperature-sensitive epoxy) to measure temperature. The temperature sensors measure current and convert it to temperature. As temperature changes, the semiconductor resistance also changes. The probe diameter is approximately 1/8 inch thick and it takes about 10 seconds to register a temperature on the digital display. The indicated temperature of a thermistor type temperature device is based on the reading taken at the tip where the semiconductor is located. Typically, these devices do not have temperature adjustment capability, thus a correction factor must be determined when they are calibrated.

Thermocouple Thermometers

Capable of digitally displaying a final reading in seconds, a thermocouple is the fastest and most costly thermometer. Thermocouples are made of two dissimilar metals, joined to produce a voltage when the measured temperature deviates from the reference temperature. The type of metals selected determines the thermocouple's application temperature, measuring environment, required service life, accuracy, and cost. The tip of a thermocouple is interchangeable depending on use. Thermocouples measure temperature at the junction of two fine wires located in the tip of the probe. They respond rapidly, so the temperature can easily be taken in several locations.

There are hundreds of thermocouple designs, many tailored to a specific measurement need. Thermocouple thermometers have been standardized for use worldwide. Specifications include letter coding, color coding, voltage/temperature tables, and operational limits. Consideration should be given to using a commercial calibration service provided by the thermocouple manufacturer or from an NIST calibration laboratory. Again, NSF listing is important to ensure conformity with *ANSI/NSF Standard 51*.

Infrared Radiation Thermometers

Infrared radiation thermometers collect radiated infrared energy emitted from the surface of an object which means they only measure surface temperature. The detector converts the emitted radiation into a temperature reading and displays the temperature almost immediately. Most infrared thermometers have a range of 10 feet and respond within a half second. The easiest of all thermometers to use and read, all that is involved is to point the sensor at the desired object, press a button, and read the temperature.

Users of infrared thermometers should remain aware that:

- the stated range may be 10 feet, but more accurate readings are achieved the closer the sensor is to the target object;
- readings only reveal surface temperatures;
- emissivity, which is an object's ability to absorb or release energy, may affect the reading. Reflective surfaces, such as metal, will show temperatures lower than the actual.

Most infrared thermometers may be adjusted by using a reference thermometer to take a temperature reading of the surface in question.

NIST Thermometer

The National Institute of Standards and Technology (NIST), an agency within the U. S. Department of Commerce, provides certification and calibration for thermometers and other precision instruments. The "NIST" label on a thermometer means the instrument has been certified and will maintain accuracy within specified limits, for at least one year. Each year, an NIST thermometer must be recertified to assure accuracy. This is a service usually provided by the manufacturer of the thermometer or an NIST calibration laboratory. An NIST thermometer is typically utilized as a standard to check and calibrate other thermometers against at a non-specific temperature (*i.e.*, not ice water or boiling water).

Temperature Data Loggers

While a data logger is technically any device used to store data, most instrument manufacturers consider it a stand-alone device capable of reading various types of electrical signals and storing the data in internal memory for later computer downloading. The advantage of temperature data loggers is that they can operate independently of a computer, unlike many other types of data acquisition devices. Temperature data loggers record temperature over time and are available in various shapes and sizes. The range includes simple economical single channel fixed function loggers to more powerful programmable devices capable of handling hundreds of inputs.

Temperature loggers, desirable for inclusion with a frozen load, should be accurate within the range of $\pm$ 2 °F, and time accuracy should not vary by more than 3% of total monitoring duration.

All transit temperature loggers presently in use for transport temperature monitoring record at least 2,000 pairs of time and temperature observations. These readings are automatically produced by the logic circuitry of the device in combination with the clock function. The readings produced are "real time," meaning that they are related to exact calendar and clock times, rather than *elapsed* time since initiation of the recording episode.

Useful in pinpointing the time and extent of temperature abuse to a frozen load in transit, a temperature logger can assist in establishing the location, probable cause of the high temperature event, and where corrective action might be required. Providing the advantage of long term convenient data storage, ready statistical analysis, and rapid transmission of information, they can be of help in establishing liability in cases of transport loss/damage disputes.

There is the possible need of multiple devices to accurately monitor loads on transport trucks. During the transportation phase, frozen commodities are often broken into smaller lots and may be placed in several locations within the truck or van. If there is a single logger in a load, the monitoring function must stop during redistribution. Since temperature abuse may occur after the breakup and re-distribution of shipments, monitoring may be not available when it is needed most.

Logger devices are now available for *per pallet* application. High volume production of solid state temperature sensing chips combined with "remote read and write" capabilities will extend temperature monitoring for the entire cold chain. Some of these technologies have the capability to record arrival at a particular location by sending a specific signal to these specialized loggers by radio frequency -- this is the electronic portal -- now commonly used in the distribution of durable consumer goods.

These technologies are very desirable for protection of frozen commodities in extended transport, storage, and re-distribution.

Thermometer Calibration vs. Check

Whether monitoring temperatures at receiving, throughout production or final product storage and distribution, thermometer calibration is essential. The validation, verification reassessment section of the Hazard Analysis and Critical Control Point (HACCP) system

stated in the *Code of Federal Regulations (9 CFR §417.4)* specifies that instruments used for monitoring critical control points must be calibrated.

It should be clarified that many times temperature measuring devices are checked for accuracy, but not always calibrated. Calibration is the process of standardizing a temperature monitoring instrument to ensure that it will measure within a specific temperature range in which the instrument is designed to operate. Accuracy of a thermometer is its ability to measure temperature correctly without error. While not regulated, it is strongly recommended that a thermometer be within ±2°F (±0.5°C) of the actual temperature to be considered an accurate device. Thermometers should not be used if it cannot be physically calibrated and the accuracy of the unit exceeds ±2°F (±0.5°C).

APPENDIX C

THERMOMETER CALIBRATION

Note: The following calibration procedures are used primarily for bi-metallic thermometers. Calibration may not be needed or possible for some thermocouple, thermistor and infrared thermometers. Refer to the manufacturer's instructions.

New thermometers should be calibrated prior to first use. Because they play such a critical role in ensuring the safety and quality of frozen food products, it is also recommended that thermometers be calibrated whenever they are dropped or when going from one temperature extreme to another.

Thermometers should be sanitized before each use. Most thermometer devices could be cleaned and sanitized by washing it in hot, soapy water, rinsed thoroughly, and wiped dry. A sanitation solution is also recommended when thermometers will come in contact with food products. Allow the thermometer to sit in a sanitizing solution for about two minutes. Then use hot water to rinse the thermometer.

If thermometers can be calibrated there are multiple methods that could be used. One of the most common methods is the use of ice water and boiling water as follows:

Low Temperature Calibration

Calibration of the thermometer should be checked at 32 °F, the freezing temperature of water. A freely draining, melting ice bath may be used for medium at 32 °F. It is important that the probe of the thermometer not be allowed to rest on the bottom of the container of freezing water. Allow the thermometer to remain in the water bath for one minute before taking the reading. It is best to compare the reading of the "test" thermometer with the reading of a mercury-in-glass thermometer that is of known accuracy. The accuracy of the thermometer device should be in the range of $\pm$ 2 °F (±0.5°C). If the thermometer is not accurate at 32 °F, adjust accordingly or properly dispose of the thermometer.

High Temperature Calibration

Calibration of the thermometer should be checked at 212 °F, the boiling temperature of water at sea level. Boiling water is used for medium at 212 °F. Water boils at a simmer; it need not be a rolling boil. It is important that the probe of the thermometer not be allowed to rest on the bottom of the container of boiling water. Allow the thermometer to remain in the water bath for a minute before taking the reading. It is best to compare the reading of the "test" thermometer with the reading of a mercury-in-glass thermometer that is of known accuracy. The accuracy of the thermometer device should be in the range of $\pm$ 2 °F (±0.5°C). If the thermometer is not accurate at 212 °F, adjust accordingly or properly dispose of the thermometer.

It is important to recognize that the boiling point of water changes with altitude.

Many documents recommend that if thermometers are used on a continual basis, they should be checked at least once a day or before use and calibrated when necessary. Furthermore, it is recommended that thermometers also be calibrated whenever the thermometer is dropped. Checking/calibrating thermometers is not a regulated activity, but assurance of food safety dictates vigilance in the care and working accuracy of this important piece of equipment.

Many food manufacturers use previous historical documentation to support their check/calibration frequency. Take for example, if a food manufacturer has a year's worth of thermometer check data that is documented on a log, they may review this data to determine a frequency. If no thermometer check deviations are found, then the food manufacturer may make the determination to reduce their check of their thermometers from daily to weekly.

References

For more information regarding the thermometers, the proper technique used to check the accuracy of thermometers, and thermometer calibration, the following references are available:

Flores, N.C. and Boyle, E.A. 2000. Thermometer Calibration Guide (MF-2439). Kansas State University. Manhattan, KS. Publications from Kansas State University are available on the World Wide Web at: www.oznet.ksu.edu.

Flores, N.C. and Boyle, E.A. 2000. Thermometer Calibration Guide (MF-2440). Kansas State University. Manhattan, KS. Publications from Kansas State University are available on the World Wide Web at: www.oznet.ksu.edu.

Kenner, K. 2007. Selection and Maintenance of Temperature Measurement Devices (FS-25-W). Purdue University. West Lafayette, IN. Publications from Purdue University are available on the World Wide Web at: www.purdue.edu.

Brand names appearing in this publication are for identification purposes only. No endorsement is intended, nor is criticism implied of others not mentioned.

APPENDIX D

TEMPERATURE MEASUREMENT:

1. General Information

Choose a reliable, accurate (±2°) thermometer with a short response time (time required to reach a steady reading). Refer to **Appendix C** for information regarding thermometer calibration.

Mercury-in-glass or alcohol-in-glass thermometers should be avoided, both because of the hazard presented by glass and because such thermometers have a long response time.

Reliable and accurate digital thermometers are available with either a flat blade or needle probes. Bi-metal dial thermometers, which can be easily calibrated, are also suitable.

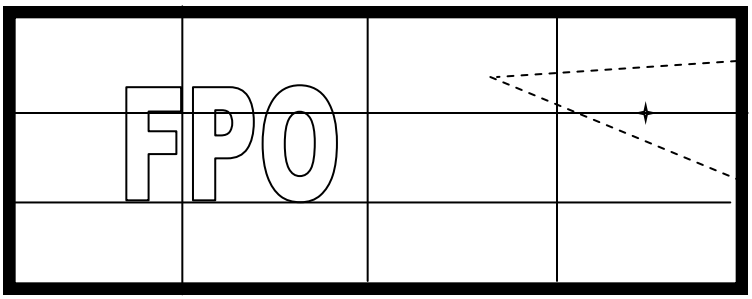
An unpackaged IQF product exiting from a freezing tunnel is best measured by tightly packing a previously pre-cooled flask with the product so the entire measuring surface of the thermometer probe will be in direct contact with the product. The temperature should be recorded when a steady reading is reached. Tested products should be immediately discarded.

2. Non-Destructive Approach with Closed Packages

Select 7 cases of frozen foods. Stack any 3 of the 7 on the floor area of the natural cold environment for the lot being sampled. Cut the sidewall of the top case (number 3 of the stack) at either end with a sharp knife as shown in *Figures A, B* and *C* for different kinds of frozen foods.

Bend the cut tab outward. Insert the probe of the temperature measurement device at about the center of the first stack of packages and between the first and second layers of packages so that the entire sensing element is in firm contact with package walls. Stack the other 4 cases on top of the case containing the probe.

Read and record the temperature observed when the instrument reading stabilizes. This is generally 5 minutes, or less, for most thermometers. Close and tape the cut sidewall areas of the case.



1. Cut case sidewall.

2. Bend cut tab.

FIGURE A: Side view, case of 24 solid packed products

For solid pack products such as frozen spinach, cut the sidewall of the case at either end (dotted line) and insert the probe at the approximate center of first stack and between first and second layers of packages so that the entire sensing element is in firm contact with package walls. For poly bags, insert the probe in the same direction as the length of the bag and deep enough for firm contact between bags

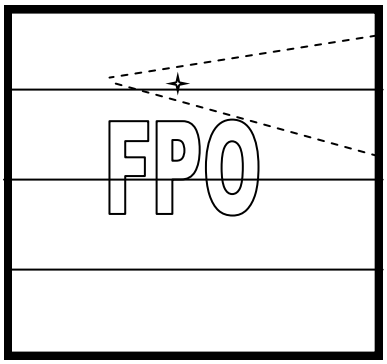


FIGURE B: End View, case of 24 frozen fruit products turned on side.

For products such as frozen fruits in paperboard packages with metal ends, turn the case on its side to give an end view as above. Cut the sidewall of the case as shown and follow the same procedure as in *Figure A.*

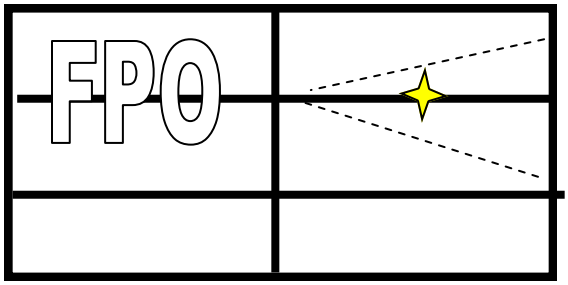


FIGURE C: Side View, case of 6 frozen 8 inch fruit pies

For products such as frozen 8" fruit pies, with air space between the edge of the pie and wall of the individual carton, cut any side of the case as shown and follow the procedure as in *Figure A.*

Not all packages or packing materials are suitable for this type of measurement. Irregularly shaped packs where good thermal contact is not possible, packaging materials that act as an insulator and products in cartons or bubble packs where large air spaces exist are all examples where a between-pack temperature measurement may not provide an

accurate reading of the product temperature. In such instances it may be necessary to proceed directly to a destructive temperature measurement.

The operator or authorized officer conducting the test should ensure that all cases of frozen food products opened for inspection are re-sealed and appropriately labeled or marked with the date and time of the inspection, the name of the inspector who opened it and, where appropriate, the name of the food authority.

3. Destructive Approach with Open Packages

Non-destructive, between-pack temperature measurement may not provide an accurate reading of the product temperature of frozen food packed in:

- irregularly shaped containers where good thermal contact is not possible,
- packaging materials that act as an insulator and
- cartons or bubble packs where large air spaces exist.

WHENEVER there is doubt about product temperatures measured without opening (destroying) packages, the procedure shown in *Figures D and E* should be used. This procedure is also recommended for products packed in cans, because the bead rim of a can does not allow for firm contact of the probe in the sidewall surface.

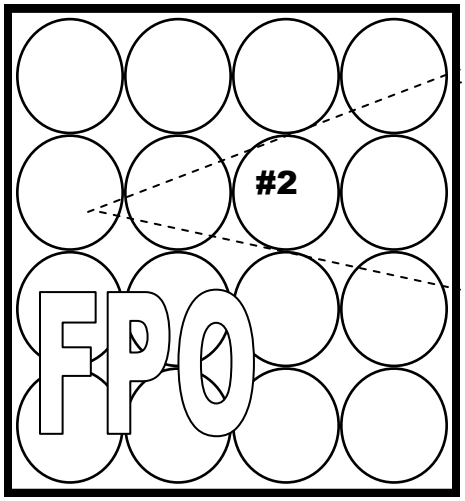


FIGURE D

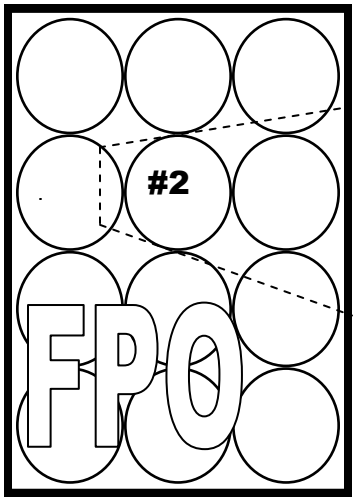


FIGURE E

Before recording a temperature, pre-cool the probe by inserting it between two packets of frozen food and waiting until a steady reading is reached. For products such as frozen concentrated juice, soups, and items packaged in cans, cut the cover of case as shown. A pre-cooled, sharp instrument - such as an ice pick or a drill bit for boring- can be used to punch a hole through the cut portion of packaging wall and into the central area of the #2 can. Insert the probe so that the entire sensing element is in the central portion of the #2

can and record a steady temperature. **Discard the opened/punctured container and replace with a non-compromised container from a case reserved for this purpose.**

The operator or authorized officer conducting the test should ensure that all cases of frozen food products opened for inspection are re-sealed and appropriately labeled or marked with the date and time of the inspection, the name of the inspector who opened it and, where appropriate, the name of the food authority.

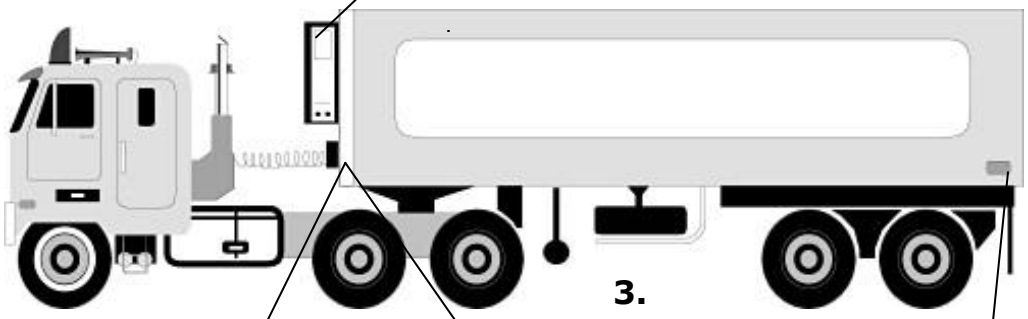
APPENDIX E

TRANSPORT SPECIFICATIONS

2.

Refrigeration Capacity

The cooling capacity of the temperature control unit at 35°F and 0°F box temperature shall be determined (and certified) in accordance with the Air Conditioning and Refrigeration Institute (ARI) Standard 1110 for Mechanical Transport Refrigeration units, last revision, by the manufacturer of the temperature control unit.



3.

1.

"Heat Transfer Characteristics"

The overall heat transmission rate (UA) of the vehicle shall be determined (and certified) in accordance with Truck Trailer Manufactures Association Recommended Practice #38 (Method for Heat Transmission of Refrigerated Vehicles) latest revision, including all corrections necessary for air leakage and mean wall temperature. The overall heat transmission rate determined from the procedure shall be expressed in BTU/hr.°F. The vehicle manufacturer shall affix a certification plate or decal (featured below) on the vehicle lower roadside front.

Combined Equipment Identification

Using the known vehicle UA factor and the capacities of the temperature control unit, the trailer manufacturer or installing agent determines if the temperature control unit has the necessary capacity to rate the vehicles combination as C65, C35, F, or DF and calculates the 'Excess Cooling Capacity." This data is then permanently affixed on the previously installed "Combined Equipment Identification" plates (front and back). The fleet operator or owner of the vehicle completes the air distribution classification by verifying which, in each of the five categories applies and affixing proper codes to the "Combined Equipment Identification" plates (see figures below).

_____
Vehicle manufacturer's name

THERMAL PERFORMANCE
This structure is certified in accordance with Truck Trailer Manufacturer Association Recommended Practice No. 38—(latest revision) and Refrigerated Transportation Foundation method for Classification of controlled temperature Vehicles

No. _____(latest revision)

V.I.N._____

Date of Certification _____

Heat transmission Rate _____Btu/hr-°F

Floor Airflow Area_____in²

AIR DISTRIBUTION CLASSIFICATION

Vehicle Specification Code

BULKHEAD
Solid (Pressure) S
Lattice L
None N

AIR DELIVERY SYSTEM
Yes Y
No N

FLOOR
High H
Med. M
Low L
Flat F

REAR DOORS
High H
Medium M
Low L
Flat F

SIDEWALLS
Non-Flat (Ribbed) - R
Flat F

COMBINED EQUIPMENT IDENTIFICATION PLATE

DATE _____

VEHICLE RATING: *C65* *C35* *F* *DF*
BULKHEAD: S L N
CHUTE: Y N
FLOOR F L M H
DOOR LINING F L M H
SIDE LINING F R

REFRIGERATED TRANSPORTATION FOUNDATION
Equipment Classified by: _____
Date of Classification: _____
Vehicle V.I.N.:_____
Temperature Control Unit Model Number: ____

VEHICLE RATING
BULKHEAD
CHUTE
FLOOR
DOOR LINING
SIDE LINING

EXCESS COOLING CAPACITY_____%

Information from RP 718A, *TMC Recommended Practice* provided courtesy of Technology & Maintenance Council (TMC) of the American Trucking Association.

APPENDIX E

TRANSPORT SPECIFICATIONS

The Critical Airflow Chain

"The key to good temperature management"

Of all things that must be done right when transporting refrigerated commodities, AIRFLOW IS THE MOST IMPORTANT. The loaded product cannot be protected if the airflow chain is broken or strangled. Good airflow requires sufficient space around the load to allow temperature controlled air to freely reach SIX SIDES of the load. Air must travel over the top, down the rear, back underneath and up over the front to cover four of six load surfaces. About 10 to 20 percent of the air should be "bled off" to wash down the sides of the load.

1.

RETURN AIR BULKHEAD

A front wall bulkhead must be provided on every load. The bulkhead shall provide a minimum of 140 square inches return airflow area, be positioned a minimum of 3 inches out from the front wall and up to a minimum of 6 inches from the bottom of the floor.

2.

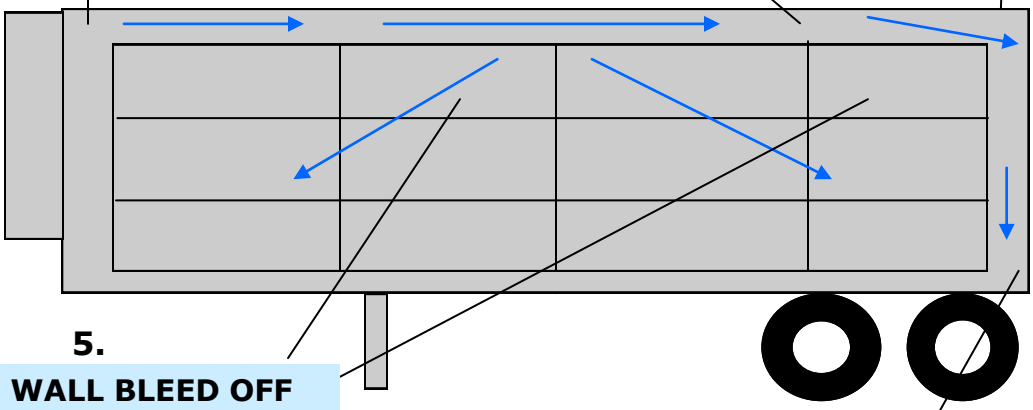
TOP AIR DELIVERY

All trailers should have a RED LINE for maximum load height and air chutes for proper air distribution.

3.

HIGH AIRFLOW REAR DOORS

Ensure adequate airflow between doors and load with 2 to 3 inch ribbed back doors.



5.

SIDE WALL BLEED OFF

Up to 20 percent of the top airflow should bleed off down the walls. This can be accomplished with ribbed side walls or by slipping 1.0 to 2.0 inch spacers between the load and the walls.

4.

HIGH AIRFLOW ALONG FLOORS

Allow adequate air return under the load using:
A. Four Way pallets,
B. Duct T-floor, or
C. Duct Flooring without pallets

Information from RP 718A, *TMC Recommended Practice* provided courtesy of Technology & Maintenance Council (TMC) of the American Trucking Association.

APPENDIX F

EMERGENCY PROCEDURES

In the event of power outages or similar threats to the temperature integrity of frozen foods, some suggested means of minimizing loss and damage include:

- Have a crisis management plan for such situations. Keeping the necessary supplies on hand and pre-assigning specific emergency duties will lessen the chaos of the emergency.
- Keep freezer and refrigerator doors closed as much as possible, to guard against heat transfer.
- Ideally, there should be an external thermometer gauge used to periodically monitor air temperature inside storage unit.
- Stack frozen foods tightly to take advantage of "self-cooling"; however, keep frozen raw meats, poultry, and seafoods on the bottom of the stack so that in the event of some thawing, raw products are less likely to contaminate other foods.
- When possible, keep foods containing allergens on the bottom stack so that in the event of some thawing, allergenic products are less likely to contaminate non-allergenic ones. The list of common allergens covered by the Food Allergy Labeling and Consumer Protection Act (FALCPA), in the United States, often nicknamed the “big eight,” includes crustacean shellfish, eggs, fish, milk, peanuts, soybeans, tree nuts, and wheat.
- Give careful consideration to using dry ice to keep foods frozen. DRY ICE CAN CAUSE A BUILDUP OF CARBON DIOXIDE GAS, AND CAN CREATE SERIOUS ASPHYXIATION HAZARDS! Use appropriate gloves or tools to avoid contact with skin.
- Once power or refrigeration service is restored, ensure proper temperature was maintained by checking the temperature of the product in warmest area of storage. Examine frozen foods closely for signs of thawing, such as softness or distortion, or for signs of re-freezing, such as distortion or ice crystal formation. Contact the manufacturer or distributor immediately for advice about the specific products.
- Have a written protocol to follow in circumstances where product temperature has exceeded critical limits.