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EAST AFRICAN STANDARD

The handling of chilled and frozen foods

EAST AFRICAN COMMUNITY

Draft for comments only — Not to be cited as East African Standard

Foreword

Development of the East African Standards has been necessitated by the need for harmonizing requirements governing quality of products and services in East Africa. It is envisaged that through harmonized standardization, trade barriers which are encountered when goods and services are exchanged within the Community will be removed.

In order to meet the above objectives, the EAC Partner States have enacted an East African Standardization, Quality Assurance, Metrology and Test Act, 2006 (EAC SQMT Act, 2006) to make provisions for ensuring standardization, quality assurance, metrology and testing of products produced or originating in a third country and traded in the Community in order to facilitate industrial development and trade as well as helping to protect the health and safety of society and the environment in the Community.

East African Standards are formulated in accordance with the procedures established by the East African Standards Committee. The East African Standards Committee is established under the provisions of Article 4 of the EAC SQMT Act, 2006. The Committee is composed of representatives of the National Standards Bodies in Partner States, together with the representatives from the private sectors and consumer organizations. Draft East African Standards are circulated to stakeholders through the National Standards Bodies in the Partner States. The comments received are discussed and incorporated before finalization of standards, in accordance with the procedures of the Community.

Article 15(1) of the EAC SQMT Act, 2006 provides that "Within six months of the declaration of an East African Standard, the Partner States shall adopt, without deviation from the approved text of the standard, the East African Standard as a national standard and withdraw any existing national standard with similar scope and purpose".

East African Standards are subject to review, to keep pace with technological advances. Users of the East African Standards are therefore expected to ensure that they always have the latest versions of the standards they are implementing.

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Introduction

Food is chilled or frozen for two reasons, namely to maintain its fresh quality for as long as possible and to contribute to its safety for human consumption. The first is primarily a matter of good merchandising. The fresher food appears and tastes, the better it will sell. The safety of food, however, is a different matter, for it is possible for food to appear wholesome and to taste and smell reasonably fresh and yet to be highly dangerous.

Food which supports bacterial multiplication at ordinary temperatures, causing deterioration in the process, is called perishable food and all such food, unless sterilized and packed in hermetically sealed containers, contains some bacteria and will be further contaminated by bacteria from its surroundings.

The bacteria that multiply in food can be of the following two types:

- a) pathogenic or disease causing; and
- b) non-pathogenic or harmless from the disease point of view, but destructive from the commercial aspect.

The pathogenic bacteria that multiply in food can cause food poisoning or spread intestinal disease such as typhoid, cholera, and gastro-enteritis, while the non-pathogenic bacteria, although harmless to man, cause food spoilage. Spoilage bacteria and enzymes impart an abnormal odour and taste to food and cause it to become discoloured and also lower its nutritional value. This, however, is not always the case with pathogenic bacteria, which may not cause any discoloration or impart any abnormal taste or odour to food.

For their multiplication bacteria require certain favourable conditions such as moisture, warmth, and the presence or absence of oxygen, as well as food material. Temperature is a very important factor because most bacteria multiply at temperatures between 10-65 °C, the optimum being 37°C. However, some can still multiply at a retarded rate at temperatures down to -10°C. Below -10 °C many bacteria and spores remain viable but do not multiply, while above 65°C vegetative (i.e. growing) bacteria die off while spores can survive at 100°C.

By depriving bacteria of their required temperature needs through chilling or freezing, we prevent or at least retard their multiplication and the food will remain in an acceptable condition for a longer period and its safety for human consumption is ensured. The lower the temperature at which food is stored, the longer it will keep. Food frozen to a temperature of -18 °C or below and kept at that temperature will not deteriorate bacteriologically although it will slowly lose quality in other ways e.g. as a result of enzymic activity, but food stored at average refrigeration temperatures between 0°C and -10°C, even when properly handled, will gradually deteriorate microbiologically, as well as more rapidly in other ways. For this reason it is important that food should be stored and sold in strict rotation and stocks regularly inspected for signs of spoilage.

There are a number of contributory factors responsible for the contamination of food with harmful bacteria. One of the main factors is the incorrect manner in which food is stored. The unhygienic handling of food is another factor contributing to its contamination with harmful bacteria. Incorrect methods of preparation and processing likewise greatly reduce its quality.

This code of practice is designed to contribute to the safety and quality of all chilled and frozen foods, whether manufactured, sold, bought, or stored by the user.

In the preparation of this East African Standard, the following sources were consulted extensively:

SANS 10156:2007, *The handling of chilled and frozen foods*

CAC/RCP 52:2003(Rev. 4:2008), *Code of practice for fish and fishery products*

Codex Alimentarius website: http://www.codexalimentarius.net/mrls/vetdrugs/jsp/vetd_q-e.jsp

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USDA Foreign Agricultural Service website: <http://www.mrlatabase.com>

USDA Agricultural Marketing Service website: <http://www.ams.usda.gov/AMSV1.0/Standards>

European Union: http://ec.europa.eu/enterprise/sectors/pharmaceuticals/veterinary-use/maximum-residue-limits/index_en.htm

Assistance derived from these sources is hereby acknowledged.

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The handling of chilled and frozen foods

1 Scope

This code of practice contains recommendations for the hygienic manufacture, storage, and transportation of chilled and frozen foods, and for their hygienic handling in retail and catering establishments.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

CAC/GL 21, *Principles for the establishment and application of microbiological criteria for foods*

CAC/RCP 1, *Recommended international code of practice — General principles of food hygiene*

CAC/GL 30, *Principles and guidelines for the conduct of microbiological risk assessment*

CAC/GL 31, *Guidelines for the sensory evaluation of fish and shellfish in laboratories*

CAC/GL 48, *Model certificate for fish and fishery products*

CAC/RCP 52:2003(Rev. 4:2008), *Code of practice for fish and fishery products*

CAC/GL 53, *Guidelines on the judgement of equivalence of sanitary measures associated with food inspection and certification systems*

EAS 38, *Labelling of prepackaged foods — Specification*

3 Definitions

For the purpose of this standard the following definitions shall apply:

chill room

an insulated and refrigerated room specifically designed for the storage of foods at temperatures not lower than -1°C , and that has sufficient refrigeration capacity to maintain the desired storage temperature, and may also have sufficient refrigeration capacity to cool the foods placed in it to that temperature, or to absorb the heat of respiration of fruits and vegetables, or to perform both these functions

NOTE It is most important for the user of a chill room to ascertain whether the room is intended as a holding room only or whether it is capable of cooling the product or absorbing heat of respiration, or doing both.

chilled food

food stored above the freezing point of the specific food and at the relevant particular temperature recommended in 8.17

cold room

an insulated and refrigerated room specifically designed for the storage of frozen foods, and that has sufficient refrigeration capacity to maintain a temperature of -18°C or lower when filled with products that have already been frozen to that temperature

NOTE A cold room is not normally designed to freeze products but should have sufficient refrigeration capacity to reduce the temperature of a mass of frozen food equivalent to approximately 30 % of the fully loaded room from -15°C to -18°C in 24 h.

effective material

a material that is capable of performing the required function(s) and that contains no substance

known to be toxic to human beings, or capable of imparting any taste or odour to the product or of staining it, and that, in the case of an elastomeric or a plastics material, is based on a polymer of a grade and quality recommended by the polymer manufacturer as being suitable for the specific purpose(s)

freezer

a room or equipment specifically designed to lower the temperature of a food product through the zone of maximum crystallization (for most products between -1 °C and -5 °C) in the period of time acceptable for that particular product

frozen food

food that has been preserved by the freezing process and that is stored in a hard-frozen state

order make-up room

the area or space within a warehouse used for the purpose of organizing frozen food into individual consignment lots for delivery rounds

outer container

the box, carton, or case into which packages (with or without wrappers) are packed for storage and distribution

package

the immediate tray, dish, casserole, carton, plastics pouch, or other package in which the product is packed and in which it is chilled or frozen or both, stored, distributed, and (where appropriate) used

practical storage life

the period of frozen storage after manufacture, processing, or harvesting and freezing (or chilling) of an initially high quality product, during which the organoleptic quality remains suitable for consumption or for the process intended

quick-frozen food

food brought through the critical temperature zone -1 °C to -5 °C in a period not exceeding 4 hours and not removed from the freezer until the product has reached a condition which will ensure, at the thermal centre after thermal stabilization, a temperature of -18 °C or lower, i.e., the required storage temperature

thermal centre

the point within the package or piece of food which has the highest temperature at the end of the freezing process

thermal stabilization

the natural process by which the whole mass of a product attains a uniform temperature under adiabatic conditions

vegetative bacteria

bacteria that are in the non-spore phase, i.e., actively growing bacteria

4 Conditions in the factory

4.1 General

The relevant requirements and regulations of the current relevant national legislation (see foreword) are mandatory. Compulsory standards and the relevant requirements of local authorities must be complied with. Further, all the recommendations given in 4.2 to 4.7 (inclusive) should be observed in the preparation of foods that are chilled or frozen.

4.2 Construction of, and conditions in, the factory

- a) Ensure that the roof is weatherproof and dustproof, and that ceilings where present are smooth, washable, and impervious to moisture.
- b) Provide measures to keep out birds, bats, flying insects, and rodents.
- c) Construct the floors of material impervious to water and resistant to degradation and provide them with covered wall to floor junctions and a surface finish that permits proper cleaning. Ensure that the floors are adequately graded (1 in 50, min.) and drained to external gullies connected to

sewers or drains that are kept in good condition and repair, and with strainers in place. Where necessary, provide duck-boards of impervious material for workers. Keep the floor and the drainage channels clear during production periods. Construct drainage channels with rounded edges and smooth inner surfaces and wide enough to allow effective cleaning. Where possible, locate them out of the way of floor traffic. Cover those sections traversing traffic lanes with removable grids. Clean floors and drainage channels thoroughly at the close of each day's operations. Keep drainage channels free from installations that obstruct flow and impede cleaning. Do not lay loose plates, boards, or covers other than duck-boards upon a floor.

- d) Ensure that the inside surfaces of the walls of processing rooms are impervious to water and are provided with a smooth, light-coloured washable finish to ceiling height. Cover wall-to-wall junctions. Do not use face brick finishes. Slope window sills downwards to the inside at an angle of at least 45°. Where cleanliness demands it, thoroughly wash the inside surfaces of the walls immediately after each shift.
- e) Ensure that litter, waste, and overflow are removed regularly and that all such waste material is suitably stored and disposed of, without delay, in an efficient and hygienic manner.
- f) Provide general illumination that permits efficient operation during the manufacture of the product, and that complies with the requirements of the current relevant national legislation (see foreword).
- g) Provide ventilation that will effectively remove excess heat and steam and prevent the formation of condensate. If necessary, augment natural ventilation by mechanical means.
- h) Take adequate measures to inhibit mould growth and to prevent dust, dirt, flaking paint, and other loose or extraneous material being present in the processing areas, in the storage, cold storage, refrigeration, and freezing rooms, and in other areas where food is handled. When mould and fungi constitute a problem,
 - 1) treat the affected areas with a fungicide registered under the current relevant national legislation (see foreword), and approved by the manufacturer of the equipment, and
 - 2) if necessary, brush with a hard broom or a suitable brush.
- i) Ensure that an adequate system of insect control keeps the factory free from flies and other insects, taking care that the product is not contaminated with insecticide. Where insect traps are used, clean and sterilize the traps regularly and suitably dispose of the contents.
- j) Ensure that chemicals used for inhibiting mould growth and controlling insect pests are registered for use in food factories.
- k) Ensure that all buildings and rooms in which raw materials and ingredients are prepared and stored are of rodent-proof construction.
- l) Apply pesticides in accordance with the manufacturer's recommendations and ensure that insecticides and rodenticides are not used while processing is in operation, and that they are at no time into contact with raw materials, wrappers, packages, outer containers, or the product. Keep working surfaces free from insecticidal and rodenticidal residues. Store insecticides, rodenticides, detergents, and disinfectants separately in a safe place that is away from foodstuffs and raw materials.
- m) Ensure that no factory chimney, smoke room, smoke generator, smoke duct, or motor exhaust emits smoke or fumes in a quantity or in a manner that is offensive, or injurious or dangerous to health, or that causes contamination at any stage in the preparation of the product, Ensure compliance with the requirements of the current relevant national legislation (see foreword).
- n) Provide, at least at the entry points to the preparation and processing areas of the factory, an adequate number of wash-basins, the water supply to which is operated by means other than

the user's hands or elbows, and an adequate supply of hot and cold running water or clean warm water at a temperature suitable for the washing of hands, soap or detergent solution, nail brushes, and disposable towels or hot air dryers. Limit the number of entry points to the preparation and processing areas and exercise strict control to ensure that all employees handling food wash their hands every time they enter these areas.

- o) Do not allow animals in any part of the factory.
- p) Ensure that no person handles cooked products after handling raw materials before he has thoroughly washed, cleaned, and disinfected his hands.
- q) Ensure that cooked and raw products do not come into contact with each other and that cooked products are not handled on the same surfaces as raw products unless such surfaces have been thoroughly disinfected between processes.
- r) Ensure that areas in which cooking or any other heat process is carried out are either separate from all areas in which chilled or frozen food products are handled, processed, or stored, or are not used simultaneously for hot and cold operations.
- s) Do not allow operations that are detrimental to the manufacture of the product to take place in the factory or the surrounding area under its jurisdiction. Maintain the premises and factory grounds in a clean and sanitary condition.

4.3 Equipment

- a) Where required, provide facilities for the freezing of the product conveniently near the food processing and packaging departments. Provide ample refrigeration and freezer storage convenient to processing and freezing facilities, except where the frozen product is immediately removed from the establishment.
- b) Ensure that all plant, equipment, and utensils coming into contact with the product are of smooth-surfaced effective material (preferably an intrinsically corrosion-resistant, non-absorbent material) and so designed and installed as to permit thorough cleaning and disinfection. Do not recess equipment into the floor unless acceptable means for drainage and cleaning are provided. Do not use materials detrimental to the product or which are likely to contaminate it (e.g. copper, lead, lead alloys, and zinc) in the construction of equipment coming into direct contact with either raw or unprotected foods at any stage of production. Ensure that
 - 1) table frames are of an intrinsically corrosion-resistant metal or have been so treated as to render them resistant to corrosion;
 - 2) table tops are of an intrinsically corrosion-resistant metal (or other corrosion-resistant material), are such as to allow rapid and effective drainage, and are free from cracks, crevices, and open or raised joints;
 - 3) all joints in tables are watertight and smooth;
 - 4) cutting boards and blocks are of a solid, smooth, tough, hygienic material such as nylon (but not wood) and are of such size and shape as to facilitate thorough cleaning and disinfection;
 - 5) conveyor belts are of stainless steel or have smooth impermeable surfaces that also so cover the edges of the belts that no canvas or other base material is exposed.
- c) Maintain the plant and all equipment and utensils in a state of good repair and cleanliness. Provide suitable cleaning and disinfecting materials, hot and cold running water, steam, hose-piping, brushes, and other materials and equipment necessary for the cleaning of the plant and utensils. Wash and clean the entire manufacturing and processing plant, including utensils, after each production run, at the end of operations and, if necessary, again before commencing operations. Provide a scullery for the purpose of cleaning utensils and loose equipment.

Disinfect the entire system at the end of operations and, immediately before the recommencement of operations, rinse the plant and utensils with potable water (see 4.7.1).

- d) Regularly (relative to the operation being conducted and the volume of production), after cleaning the plant, equipment, and utensils at the end of operations, take swabs for microbiological counts on all surfaces of the plant and equipment that come into contact with the product. After sampling 5 areas each 100 cm² in extent on each surface, the total viable bacteria count for the surface (after incubation of test samples at 37 °C for 48 h and expressed as count per 10 cm² of surface area) should not exceed 15.
- e) Do not stack containers holding food materials directly on the floor or one upon the other unless they are specifically constructed for this type of stacking and the outer surfaces are scrupulously clean. Ensure that containers are not overfilled, and that the contents are adequately protected.
- f) Ensure that all utensils and equipment coming into direct contact with the product are of sound design and that they are, when not in use, cleaned and stored under acceptable hygienic conditions and are disinfected before reuse. Hot water disinfectors of sound construction and in good working order should be used for the disinfection (by total immersion) of saws, knives, steels, and other deboning or meat cutting equipment. Keep the disinfectors in good working order and in a clean, hygienic condition.
- g) Do not permit employees to remove utensils used in the preparation of the product from the factory except for repair or replacement.

4.4 Raw materials: storage and preparation facilities

Quality control of raw materials and of products during processing is essential to ensure a high quality product having good keeping properties. The following measures are recommended:

- a) Ensure that only sound raw material is received at the plant, and store products requiring to be held in a chilled or frozen state at the relevant temperatures and humidities recommended in 8.17. Note that fresh fish should be well iced (or frozen) if not, then to be processed immediately.
- b) Ensure that storage areas for raw materials and areas where preparatory operations such as washing and peeling of fruit and vegetables are carried out, are separated from the areas in which food (which is to be chilled or frozen) is made up, processed, and packaged, or that such operations are not carried out concurrently. Prepare meat products in accordance with the requirements of the current relevant national legislation (see foreword).
- c) Ensure that the tolerances for trace metals in foods specified in the current relevant national legislation (see foreword) regulations are not exceeded.

4.5 Waste disposal

Provide in a place convenient to the various preparation and processing areas a separate waste storage area or room and/or other suitable facility (e.g. a hopper or chute) for storing inedible materials, such as fruit and vegetable trimmings and bones, pending removal from the premises. If applicable, construct the waste storage room of an impervious material and of such size as to permit the proper storage of filled and empty metal or other substantially non-absorbent refuse containers and their lids, and, where necessary, equip it with an effective power-driven exhaust ventilation system, hot and cold water outlets, and adequate floor drainage connected to a sewer. Locate the discharge from the exhaust system well away from fresh air inlets. Thoroughly wash the inside of the waste hopper and/or the walls and floor of the waste storage room with water and a suitable disinfectant every day. Ensure compliance with the regulations under the current relevant national legislation (see foreword), which prohibits the pollution of water supplies.

4.6 Packaging and labelling materials

Where used, store packaging and labelling materials in a separate enclosed space convenient to the packaging areas. Do not store in the product processing areas packaging and labelling materials

other than those small quantities of such supplies as are necessary for maintaining continuity of operations.

4.7 Water and ice

4.7.1 General

Ensure that the factory is supplied with and uses clean potable water that is free from suspended matter and substances that are deleterious to the product or injurious to health, and that has been so treated (by flocculation, filtration, chlorination, or any other acceptable process) as to ensure compliance with the bacteriological requirements of EAS 12.

4.7.2 Chlorination of water

4.7.2.1 Water for use in the product

All water used in the manufacture of the product must contain at least 0.5 mg/l of free residual chlorine at the point of use (but note the exceptions below) and must, where necessary, be continuously chlorinated to this level. However, where chlorinated water affects the product detrimentally in any way, dechlorinate such water immediately before use, or use other satisfactory disinfecting procedures.

4.7.2.2 Ice

Preferably manufacture ice on the premises from clean potable water. Whether it is manufactured on the premises or not, handle ice in a hygienic manner.

Ensure that water derived from ice immediately after its manufacture (melted under aseptic conditions at a temperature not exceeding 10 °C) complies with the recommended bacteriological standard of EAS 12.

4.7.2.3 Water for cleaning

Water used for cleaning plant and equipment should comply with the recommended bacteriological standard of EAS 12.

4.7.2.4 Water used for the disinfection of plant and equipment

Water used for the disinfection of plant and equipment after cleaning should contain a minimum of 20 mg/l of free residual chlorine or, alternatively, such other disinfecting substances as will ensure disinfection of the cleaned plant and equipment.

5 Hygiene for employees engaged in the manufacture of the product

5.1 General

- a) Do not allow any person who is suffering from or is a carrier of any communicable disease (notably diarrhoea) or who is suffering from an infected wound, sore, or any condition causing a discharge of pus or serum from any part of the body
 - 1) to be engaged in the preparation, processing, handling, or transportation of the product;
 - 2) to work in any part of the factory where the product is prepared, processed, handled, or transported; or
 - 3) to work in any part of the factory in a capacity in which there is a likelihood of his/her contaminating the product with pathogenic organisms.
- b) Ensure that the responsible officer appointed by the factory manager files for ready reference each medical certificate submitted to him by an employee.

- c) Do not allow any person who is suffering from any cut or injury to prepare, process, handle, or transport chilled or frozen foods unless and until the cut or injury has been so treated and dressed as to prevent any possible contamination of the food.
- d) Keep the manual handling of foodstuffs down to a minimum.

5.2 Do not allow workers' personal effects or their food in the preparation, processing, packing, and storage areas of the factory. Do not permit containers used in the manufacture of the product to be used for eating and drinking purposes; provide disposable cups for drinking purposes and refuse bins for the disposal of the used cups.

5.3 Prohibit eating, spitting, and the use of chewing gum and tobacco (in any form) within the preparation, processing, packing, and storage areas of the factory.

5.4 Ensure that

- a) all employees are issued regularly with clean, light-coloured protective clothing and clean, washable or disposable headgear that completely covers their hair, and that these items are worn at all times while the employees are engaged in the handling and packaging of food;
- b) employees carrying carcasses wear clean, light-coloured waterproof capes and headgear that covers their hair completely;
- c) waterproof protective clothing is made of a plastics material or rubber, or other non-absorbent, impervious material;
- d) overalls completely cover the personal clothing of the employees;
- e) sleeves do not extend below the elbow except when acceptably covered by plastics sleevelets or when protective clothing with long sleeves is worn in freezers and chillers;
- f) all protective clothing is of acceptable design (with the top pockets on the inside of the garment) and kept in good repair and does not constitute a source of contamination of the product;
- g) protective clothing is not stored in workrooms and, when not in use, is kept in lockers in change-rooms and is not removed from the premises except for laundering under acceptable conditions; and
- h) waterproof protective clothing is cleaned at the time of removal and hung on hooks or pegs at exits from preparation and processing areas during work intervals and visits to sanitary conveniences.

5.5 Ensure that

- a) employees engaged in the preparation and handling of foods keep their fingernails short and clean and wash their hands with liquid soap and water or in a detergent solution and disinfectant before commencing work and after each absence from the factory processing area (disinfectant creams may be used);
- b) fingernails are free from varnish and lacquer; and
- c) employees handling raw materials and the unprotected product do not wear any jewellery.

5.6 Comfort facilities

Provide, in accordance with the requirements of the current relevant national legislation (see foreword), adequate facilities in respect of dressing-rooms, shower-baths, wash-basins (the water supply of which is operated by means other than the user's hands or elbows), and water-closets.

Provide for the use of employees an ample supply of hot and cold running water, clean disposable towels or hot-air dryers, nailbrushes, toilet-paper and soap or a suitable detergent solution. Where lockers are used, place them on legs of length at least 250 mm. Alternatively, in place of lockers institute in a special room, a controlled clothes-basket system for the storage of workers' clothes. Do not allow the tops of lockers to be used as shelves.

Take steps to prevent and dispel offensive odours in the comfort facilities. Provide adequate seating accommodation for the use of employees in their rest periods.

6 Preparation and processing of chilled and frozen foods

6.1 General recommendations

6.1.1 Cooling

Ensure that fans, blowers, and air-cooling systems do not move air from raw materials or other sources of contamination into processing rooms.

6.1.2 Raw materials

Introduce only adequately cleaned and prepared raw materials into areas where foods are cooked and subsequently handled in processing operations.

6.1.3 Operations planning

Plan preparatory operations in such a manner that the expeditious handling of consecutive packages in the packaging line will prevent contamination, loss of quality, and spoilage.

6.1.4 Raw meat

Carry out the deboning of red meat carcasses and the cutting up of raw meat in working areas of which the temperature does not exceed 10 °C. The air velocity and the relative humidity of the air in deboning rooms require careful control in order to make the temperature bearable. Hot deboning of meat may be carried out.

6.1.5 Batter and breading materials

When batter, egg wash, or milk is an ingredient, maintain it at a product temperature not exceeding 5 °C when not in use in a machine. Discard batter remaining in machines and equipment at clean-up time. Discard breading materials that have come into contact with batter and that have been removed by screening.

6.1.6 Food and food ingredients capable of supporting rapid bacterial growth

a) Stocks, gravies, and sauces

During the processing cycle maintain, but for not longer than 6 h, stocks, gravies, and sauces at a temperature above 70 °C or, within 2 h following preparation, incorporate into the finished product or chill to 5 °C or lower (but do not retain for longer than 24 h at this temperature). For storage, freeze and reduce the temperature to -18 °C or lower, as rapidly as possible.

b) Cooked food

- 1) Preferably chill or incorporate into the finished product within 2 h of preparation.
- 2) If the cooked food is to be retained for 1-8 h after preparation, chill at an air temperature of 5 °C or lower within 30 min following preparation.
- 3) If the cooked food has been comminuted or sliced, is a liquid, or is to be retained for longer than 8 h, so chill within 30 min following preparation that its internal temperature

will be 5 °C or lower within 2 h of the start of chilling.

- 4) If the cooked food is in the form of large solid food components, such as those that must be cooled before slicing, chill at an air temperature of 5 °C or lower.

6.1.7 Thawing

If a frozen product is to be thawed prior to cooking, do not continue the thawing process for longer than is necessary to obtain the degree of separation or softening required, and do not allow the temperature of the product to exceed 5 °C. If not processed further immediately, store it as recommended in 8.17, but for not longer than 6 h before cooking.

Frozen products (contained in plastics bags, if possible), may be thawed in running water at a temperature not exceeding 20 °C, or in still or moving air at a temperature not exceeding 20 °C. Use a drip pan to avoid mess. The vacuum thawing method in which the frozen product is placed in a vacuum chamber and rapidly heated by steam at a temperature of 20 °C may also be utilized. Withdraw only sufficient stocks from the cold store to ensure a steady work flow.

6.1.3 Operations planning

Plan preparatory operations in such a manner that the expeditious handling of consecutive packages in the packaging line will prevent contamination, loss of quality, and spoilage.

6.1.4 Raw meat

Carry out the deboning of red meat carcasses and the cutting up of raw meat in working areas of which the temperature does not exceed 10°C. The air velocity and the relative humidity of the air in deboning rooms require careful control in order to make the temperature bearable. Hot deboning of meat may be carried out.

6.1.5 Batter and breadng materials

When batter, egg wash, or milk is an ingredient, maintain it at a product temperature not exceeding 5 °C when not in use in a machine. Discard batter remaining in machines and equipment at clean-up time. Discard breadng materials that have come into contact with batter and that have been removed by screening.

6.1.6 Food and food ingredients capable of supporting rapid bacterial growth

- a) Stocks, gravies, and sauces

During the processing cycle maintain, but for not longer than 6 h, stocks, gravies, and sauces at a temperature above 70°C or, within 2 h following preparation, incorporate into the finished product or chill to 5 °C or lower (but do not retain for longer than 24 h at this temperature). For storage, freeze and reduce the temperature to -18°C or lower, as rapidly as possible.

- b) Cooked food

- 1) Preferably chill or incorporate into the finished product within 2 h of preparation.
- 2) If the cooked food is to be retained for 1-8 h after preparation, chill at an air temperature of 5 °C or lower within 30 min following preparation.
- 3) If the cooked food has been comminuted or sliced, is a liquid, or is to be retained for longer than 8 h, so chill within 30 min following preparation that its internal temperature will be 5 °C or lower within 2 h of the start of chilling.
- 4) If the cooked food is in the form of large solid food components, such as those that must be cooled before slicing, chill at an air temperature of 5 °C or lower.

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6.1.7 Thawing

If a frozen product is to be thawed prior to cooking, do not continue the thawing process for longer than is necessary to obtain the degree of separation or softening required, and do not allow the temperature of the product to exceed 5°C. If not processed further immediately, store it as recommended in 8.17, but for not longer than 6 h before cooking.

Frozen products (contained in plastics bags, if possible), may be thawed in running water at a temperature not exceeding 20°C, or in still or moving air at a temperature not exceeding 20°C. Use a drip pan to avoid mess. The vacuum thawing method in which the frozen product is placed in a vacuum chamber and rapidly heated by steam at a temperature of 20°C may also be utilized. Withdraw only sufficient stocks from the cold store to ensure a steady work flow.

6.1.8 Fruit and vegetables

Clean, wash, peel (when necessary), and trim fresh fruit and vegetables in such a way as to remove all defective and undesirable material. Take the necessary precautions to prevent loss of nutrients, discoloration, and other deterioration of the product during these operations. Wash, prepare, and cook (where necessary) vegetables containing vitamin C or which have a high sugar content as soon as possible. Do not thaw frozen prepared vegetables before cooking (except that surface thawing to facilitate easy removal from the container is permissible).

6.2 Frozen foods

6.2.1 General

The recommendations given in 6.2.2-6.2.4 are additional to those given in 6.1.

6.2.2 Freezers

Ensure that freezers operate effectively and are maintained in a clean hygienic condition. Equip airblast freezers, both batch and continuous, with automatic temperature recorders that have sufficient sensing elements to monitor adequately the overall air temperature inside the freezers. Ensure that all recorders are calibrated correctly on installation, and recalibrated annually (or more frequently if necessary). All freezers should also be equipped with external temperature indicators. Keep a record of the temperatures of the freezing facilities available for inspection.

6.2.3 Freezing

Freeze products by recognized commercial methods ensuring that the products are so protected that dehydration and discoloration will not occur during the freezing and storage cycle (see the relevant regulations and compulsory standards under the current relevant national legislation (see foreword) respectively). If cold air is used as the freezing medium, so arrange the product by staggering the individual items or by employing dunnage, spacers, or other suitable methods, as to permit satisfactory circulation of cold air around the product. Do not stack products directly on the floor or directly against the walls of freezers. Circulate the air by a positive method; natural air circulation is not satisfactory. Freeze packaged items in a manner that will result in a minimum amount of bulging and other distortion. Leave the product in the freezer for long enough to ensure that the core temperature after thermal stabilization is -18 °C or lower.

6.2.4 Transfer to cold room

Ensure that a core temperature of -18 °C or lower is maintained by transferring the frozen product to the cold room as soon as possible after removal from the freezer.

6.3 Pre-cooked frozen food

6.3.1 General

The recommendations given in 6.1 and 6.2 apply also to pre-cooked frozen food, but note that

- a) the recommendations given in 6.3.5 replace those given in 6.1.6(a); and
- b) significant changes in cooking procedures and recipes are necessary for the production of pre-cooked frozen food of high nutritional value and good palatability; adhere strictly to these modifications.

6.3.2 Fresh and frozen uncooked products

Cook in a continuous operation whenever possible and in the shortest time commensurate with the attainment of a condition that will ensure a firm but tender texture, good flavour, and natural colour in the end product after it is frozen and then reheated to the serving temperature. Pack and commence freezing the product within 2 h of its being cooked.

6.3.3 Cooked meat

Do not retain for longer than 1 h in the warm state between cooking and placing in the freezer. If further delay occurs, protect the product properly from exposure to the surrounding atmosphere and cool it promptly to a temperature of 5 °C or below. In no event permit the retention period to exceed 6 h in the case of sliced meat, and 24 h in the case of unsliced meat.

6.3.4 Pre-cooling of joints and meats that require slicing

There is necessarily more bacterial risk involved in pre-cooling than if the food were frozen immediately and it is important that the cooling be carried out under controlled conditions.

Cool the meat as rapidly as possible to the temperature best suited for slicing. Ideally the initial rate of cooling should be to 20 °C within 2 h. After slicing, meat which is at a temperature higher than 5 °C should be cooled to 5 °C or lower as soon as possible. Since the smaller the joint or the thinner the roll of meat the more rapidly will heat be lost, the cooking of smaller joints and thinner rolls of meat is to be preferred.

6.3.5 Pie fillings, stock, gravies, sauces, and other similar materials capable of supporting rapid bacterial growth

- a) Maintain pie fillings, stock, sauces, gravies, and similar materials that are capable of supporting rapid bacterial growth at a temperature above 70 °C for a period not exceeding 6 h, or cool them to 5 °C or lower within 2 h. Do not retain them for longer than 24 h (18 h for pie fillings) at 5 °C or lower.
- b) For storage, freeze them and reduce the temperature to -18 °C or lower as rapidly as possible. Store broth frozen to -18 °C for a period not exceeding 30 d from the date of processing. If a longer storage period is required, the product temperature should be lowered to -25 °C.
- c) In the cases of sauces and gravies to be used for filling at temperatures in the range 60-70 °C, withdraw smaller batches from the hot main batch, prevent condensate formation on the covers of containers during cooling to filling temperature, and discard any such material that is not used within 1 h. Alternatively, cool sauces and gravies rapidly and uniformly to a temperature not in excess of 10 °C within 2 h; or to 20 °C or lower within 1 h provided they are used and the final product is placed in the freezer within 2 h of the time the product reaches 20 °C.

7 Packing and marking

7.1 Materials

Use only new, clean, sound, effective materials that do not impair the freezing process and that are resistant to light, air, and moisture, and that do not discolour the product or are themselves not discoloured by contact with the product.

7.2 Packages

Pack the product in clean, sound, non-toxic packages. The requirements of and regulations under the current relevant national legislation (see foreword) are mandatory.

7.3 Outer containers

It is recommended that outer (bulk) containers be clean, neat, and of rigid construction, and of sufficient strength to withstand the storage and distribution operations. Only packages of the same type and size, bearing the same date of packing, should be packed together in an outer container.

7.4 Marking

NOTE For the applicable regulations governing the grading, packing, and marking of frozen fruit and frozen vegetables for local sale and for export, see the relevant national legislation (see foreword).

7.4.1 Packages

It is recommended that the following information be printed on each package:

- a) Directions for use that,
 - 1) in the case of chilled food (e.g. open-pack meats), include the following statement (completed for temperature): "Maintain at the recommended storage temperature (.. °C) or lower until required for use", and
 - 2) in the case of frozen food, state: "Maintain in a hard-frozen state at or below -18 °C until required for use";
- b) the date of packing in code or in clear, and/or, in the case of perishable chilled products, the date by which the product should be purchased.

7.4.2 Outer containers

It is recommended that the information listed in 7.4.1, with the exception of the directions for use other than storage instructions, should also be printed on the outer container.

8 Storage

8.1 Vehicles

It is recommended that refrigerated vehicles, as described in section 9, or insulated pre-cooled vehicles be used for transportation of the product if the time interval between removal from the chilling or freezing plant and delivery to chill or deep-freeze stores is likely to lead to a rise in the product temperature to an unacceptable level.

8.2 Cold storage chambers

a) Frozen foods

It must be clearly understood that industrial cold storage chambers for frozen foods are normally designed not for the freezing or chilling of foods but for holding bulk supplies of frozen foods at their correct storage temperature, and frozen products should not be placed in storage chambers unless the products are already within 3 °C of the required storage temperature.

b) Chilled foods

The industrial cooling down of perishable foodstuffs may be carried out either in the storage room, if it is specifically designed for this purpose, or in a special pre-cooling chamber.

8.3 Temperature

Operate cold stores in such a way that at extreme outside temperatures and under peak load conditions the relevant constant product temperature recommended in 8.17 is maintained.

8.4 Thermometer

Equip each storage room with a temperature measuring device that is easily readable from the outside. Locate the sensing elements of thermometers and other temperature measuring and recording devices in positions likely to provide a representative indication of the average storage condition, and not in the direct blast of refrigerated air or near entrance doors.

8.5 Stacking

a) Air circulation

Where air circulation is used it is essential to ensure that it is efficient. Place the product on pallets, racks, or skids in such a manner as to allow clearances of at least 80 mm between it and the floor of the storage room, at least 100 mm between it and the walls, and at least 250 mm between it and the ceiling.

b) Jacketed storerooms

In jacketed cold stores, the product may be stacked up to the ceiling and hard against the walls.

c) Honeycomb stacking

If separate chilling facilities are not available, use honeycomb stacking for cheese, butter, and margarine until the product has reached the recommended temperature, after which it may be block stacked.

8.6 Meat products

Hang unpackaged meat, other than frozen meat, on hooks and allow adequate circulation of air around the meat. Put open-pack meat products into trays and store them on slatted pallets or purpose-built slatted shelves in such a way that there is no contact between the base of a pallet or shelf and the food stored beneath. Store frozen meat on pallets or purpose-built shelves in the same way.

8.7 Fish

Store frozen fish in suitable wrappers or in the glazed state.

NOTE For the compulsory standard specification for frozen fish, frozen marine molluscs, and frozen fish and frozen marine mollusc products see SANS 585.

8.8 Cross-tainting

Adopt adequate measures to ensure that cross-tainting of foods does not take place (see Tables 14 and 15).

8.9 Defrosting

Ensure efficient operation of the refrigeration and freezing plant by regular defrosting to keep the evaporator in each chamber free from ice accumulation. Where automatic defrosting has been installed, check at regular intervals to ensure that defrosting does occur. Carry out the defrosting in strict compliance with the instructions of the supplier of the equipment.

8.10 Temperature readings

It is recommended that cold stores be fitted with temperature recorders. If not, then take temperature readings three times a day (morning, afternoon, and evening) to ensure that the correct temperature is being maintained. Keep a record of the daily temperature readings and carefully file them for reference purposes against the possibility of complaints regarding any particular consignment.

Outside each chamber, install warning devices (visual or sound or both) that draw attention to any rise in temperature above the recommended levels. Give clear and concise instructions (verbal and in writing) to all members of the staff, including night watchmen, regarding the action they must take in case of emergency.

8.11 Temperatures of consignments

The operator of a storage room should not accept delivery of a consignment of chilled food if the internal product temperature is 3 °C or more above the recommended storage temperature, or of frozen food if the internal temperature is 5 °C or more above the recommended temperature. If chilled foods are received at more than 2 °C below the recommended temperature, the operator should ensure that textural damage has not been incurred before accepting delivery. Those frozen foods destined for repackaging in smaller units may, however, be thawed to a point at which individual items may be separated, in accordance with good hygienic practice, for such purposes. Delivery temperatures for fruit could be acceptable up to 10 °C above the recommended temperatures provided that the cold store, has the necessary refrigeration capacity to reduce the product temperature to the optimum carrying temperature within 24 h.

8.12 Sampling

Lay down sampling methods by agreement between the seller and the purchaser.

8.13 Hygiene

Ensure that the equipment, floors, walls, and ceilings of cold stores are maintained in a hygienic condition.

8.14 Warm-up room

In addition to comfort facilities in accordance with 4.6, it is desirable to provide a warm-up room for the use of personnel working in cold stores.

8.15 Order make-up rooms

Maintain order make-up rooms at a temperature not exceeding 7 °C in the case of chilled food, and -7 °C in the case of frozen food. Do not use order make-up rooms for storage.

8.16 Stock rotation

Employ a system of controlled stock rotation. First in, first out, should be the basic principle.

8.17 Recommended storage conditions for chilled and frozen foods

8.17.1 Notes on the storage of fruits and dehydrated vegetables

a) Harvesting

Ensure that the fruit is harvested at the correct stage of maturity. Fruits are divided into two groups (see table 1), one group that is capable of ripening after harvesting (climacteric group marked with a (c) in table 1) and a second group that can only ripen on the tree or vine (non-climacteric group marked with an (n) in table 1). In order to ensure the optimum storage period, the (c) group fruits should be full-grown, firm but not eating-ripe when placed in the cold store while the (n) group should always be eating-ripe.

b) Soundness

Store only fruits that are free from bruises and mechanical injuries.

c) Seasonal effects

Keeping quality varies from season to season. The cold storage supervisor should regularly check the condition of the fruit by periodically removing small samples and allowing them to

remain at ambient temperature to evaluate the shelf-life of the fruit.

d) **Highest freezing point**

The highest freezing point is dependent on the total soluble solids content of the product. This varies according to the stage of ripeness of the fruit or vegetable and also varies from season to season.

e) **Utilization of knowledge regarding highest freezing point**

Air delivery temperatures for pre-cooling of fruit and vegetables for chilled storage should be not lower than the highest freezing point for the specific product being pre-cooled. In cases where the minimum air delivery temperature is equal to the highest freezing point of the fruit or vegetable, the air delivery should be applied for only short periods of time, e.g. 3 h during every 12 h of pre-cooling.

f) **Short term storage**

A holding temperature of 7.2-10 °C is a compromise temperature for a few days storage for most fruits with the exception of berry fruits (excluding grapes) and figs.

g) **Long term storage**

The storage life of a fruit is dependent on cultivar post-harvest treatments, where relevant, and cold storage practice. The more important factors affecting those fruits that are stored for long periods are the following:

1) **Apples**

The softer varieties such as Jonathan and Golden Delicious maintain good keeping quality for 4-5 months; Starking and Rome Beauty for 5-6 months; and Granny Smith and York Imperial for 7 months.

Treat all apples stored for longer than 4 months with a fungicide registered for use in South Africa. Both thiabendazole and benonyl are very effective.

Treat Starking, Rome Beauty, Granny Smith, and other scald-susceptible cultivars with an anti-oxidant against darkening of the skin surface (superficial scald).

2) **Citrus**

Subject citrus fruits to the same fungicide treatment with benonyl or thiabendazole as apples.

3) **Grapes**

Retain grapes in an atmosphere containing 8 mg/L of sulfur dioxide or fumigate with sulfur dioxide gas (0.25 % (v/v) for 20 min) every 8-10 d. Other fruits suffer physiological injury from exposure to sulfur dioxide gas.

4) **Pears**

Bon Chretien pears have a storage life of 2-3 months provided rapid pre-cooling is practiced and a steady temperature of -0.5 °C is maintained. Beurre Bose and Beurre Hardy pears store well for 4 months. Doyenne du Comice, a very high quality pear, stores well for 5 months and also has the ability to be kept in a sound ripe condition for a further 3 weeks after storage.

Packham's Triumph, Winter Nellis, and Forelle cultivars may be stored for 7 months. Apply fungicides to all pears that are cold-stored and anti-oxidants to the Packham's

Triumph, Winter Nellis and Beurre Hardy cultivars.

5) **Peaches**

Clingstone peaches may be held for processing for 4 weeks, the resultant processed product being equal to peaches processed ex harvest.

6) **Plums**

The storage of plums is a very complex matter. Many of the cultivars cannot stand up to storage at -0.5 °C for longer than 10 d. Storage life may be extended to 3 weeks by utilization of dual storage. Store Santa Rosa, Gaviota, and Methley at -0.5 °C for 10 d then at 7.2 °C for 14-21 d, and Kelsey and Red Ace at -0.5 °C for 10 d and then at 10°C for 14-21 d. Golden King and Sun Gold may be held at -0,5 °C for 28-35 d.

h) **Dried fruits and vegetables**

Dried fruit should be stored at temperatures in the range 0.0-5.5 °C and at a relative humidity of 55-60 %. A higher relative humidity, namely up to 80 %, is still suitable for dried apricots, peaches, and apples, but not for figs and raisins, as these dried products develop sugar spots at relative humidities exceeding 60 %. Dried fruit may be held for up to one year at 0 °C and for 6 months at 4.5-5.5 °C.

Dehydrated vegetables, because of their very low moisture contents, store well at reasonable ambient temperatures. The pack should be moistureproof. Under these conditions dehydrated vegetables retain their condition well for one year at 21°C.

8.17.2 Chilled fruits

See Table 1.

Table 1 — Fruits (chilled)

1	2	3	4	5
Fruit and group *	Optimum storage temp., °C	Preferred relative humidity, %	Approximate length of storage life+	Highest freezing point, °C
Apples (c).....	-0,5	90 – 95	4 to 7 m	-1,5
Apricots (c).....	-0,5	95 min.	2 to 4 w	-1,1
Avocadoes (c)....	5,5	90 – 95	4 to 5 w	-0,3
Bananas (c).....	13,5	90 – 95	2 to 3 w	-0,8
Dates (n).....	0,0 max.	75	6 to 12 m	-15,7
Figs, fresh (n).....	-0,5	85 – 90	7 to 10 d	-1,1
Grapefruit (n).....	11,0	90 – 95	8 to 10 w	-2,0
Grapes, Vinefera (n)..	-0,5	90 – 95	2 to 5 m	-2,1
Guavas (n).....	7,0	90 – 95	8 to 10 d	-
Lemons (n).....	11,0	85 – 90	2 to 3 m	-2,5
Litchis (n).....	0,0	90 – 95	3 to 4 w	-
Loganberries (n)....	-0,5	90 – 95	2 to 3 d	-1,3
Mangoes (c).....	12,5	85 – 90	2 to 3 w	-0,9
Melons				
Hales, best type (c) ..	4,5	85 – 90	14 d	-1,2
Honeydew (c) ...	13,0 to 18,0	85	1,5 to 3 m	-0,9
Nectarines (c).....	-0,5	90 – 95	3 to 4 w	-0,9
Olives (n).....	7,0 to 10,0	85 – 90	4 to 6 w	-1,4
Oranges (n)	4,5	90 – 95	6 to 12 w	-1,3
Pawpaws (c).....	7,2	85 – 90	1 to 2 w	-0,9
Peaches				
Cling (c).....	-0,5	90 – 95	2 w	-
Freestone (c).....	-0,5	90 – 95	2 to 4 w	-0,9
Pears (c).....	-0,5	90 – 95	2 to 7 m	-1,6
Persimmons, Japanese (c)	-0,5	90 – 95	3 to 6 w	-2,2
Pineapples (n).....	8,5	90 – 95	4 to 5 w	-1,1
Plums and prunes (c)..	‡	90 – 95	3 to 6 w	-0,8
Quinces (c).....	-0,5	90 – 95	4 to 6 w	-2,0
Raspberries (n)	-0,5	90 – 95	3 to 4 d	-1,1
Strawberries (n)	-0,5	90 – 95	4 to 8 d	-0,8
Tangerines (n)	4,5	85 – 90	2 to 4 w	-1,1
Watermelons (n)	2,0 to 4,5	85 – 90	2 to 3 w	-
Youngberries (n)	-0,5	90 – 95	2 to 3 d	-
*(c) = climacteric group (see 8.17.1(a)).				
(n) = non-climacteric group (see 8.17.1(a)).				
+d = days				
m = months				
w = weeks				
‡ Dual storage (see 8.17.1(g)(6)).				

8.17.3 Frozen fruit products

See Table 2.

Table 2 — Fruit products (frozen)

1	2	3	4
Product	Storage life (months) at storage temperatures of		
	-18 °C	-25 °C	-30 °C
Fruit juices, citrus, and other fruit concentrates	24	>24	>24
Peaches, apricots, or cherries in sugar	12	18	>24
Peaches in sugar and ascorbic acid ..	18	24	24
Raspberries, strawberries, and booyenberries: in sugar	18	>24	>24
without sugar.....	12	18	24

8.17.4 Chilled vegetables

See Table 3.

NOTE Store only vegetables that are free from bruises and mechanical damage.

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Table 3 — Vegetables (chilled)

1	2	3	4	5	6
Vegetable	Optimum storage temp., °C	Preferred relative humidity, %	Approx. length of storage life*	Highest freezing point+, °C	Remarks
Artichokes, globe	-0,5	90 – 95	1 m	-1,2	Pre-cool rapidly after harvesting and pack in perforated polyethylene bags
Artichokes, Jerusalem..	-0,5	90 – 95	2 to 5 m	-	
Asparagus.....	0,0 to 2,2	95	2 to 3 w	-0,5	Use 2,2 °C for storage periods exceeding 10 days
Beans, green..	7,2	90 – 95	10 d	-0,7	Pick with 2,5 mm long stems and pre-cool very rapidly
Beetroot (bunch)	0,0	90 – 95	10 to 14 d	-1,5	
Beetroot (topped)	0,0	90 – 95	1 to 3 m	-1,5	
Broccoli	0,0	90 – 95	10 to 21 d	-1,0	Pre-cool rapidly; high air circulation and high relative humidity important
Brussels sprouts	0,0	90 – 95	3 to 6 w	-1,0	Pack in perforated film bags
Cabbage	0,0	85 – 90	2 to 4 m	-0,5	
Carrots (bunch)	0,0	90 – 95	2 w	-1,0	Avoid storing with any fruit that gives off ethylene. Pack in bags with perforated polyethylene liners
Carrots (topped).....	0,0	90 – 95	3 to 4 m	-1,0	
Cauliflower	0,0	90 – 95	2 to 3 w	-1,0	Sensitive to temperatures below 0 °C. Pack heads down
Celery	0,0	90 – 95	2 to 3 m	-0,5	High relative humidity is important
Corn (sweet)	0,0	90 – 95	4 to 8 d	-0,6	Pre-cool rapidly once harvested
Cucumber	7,2 to 10,0	90 – 95	10 to 14 d	-0,5	Is very subject to chilling injury
Egg plant	8,0 to 10,0	90 – 95	10 to 14 d	-0,5	Is very subject to chilling injury below 8 °C
Endive	0,0	90 – 95	2 to 3 w	-0,6	Very high relative humidity is essential
Horse-radish	-0,5	90 – 95	10 to 12 m	-	Is liable to taint other products in same store
Leek	0,0	90 – 95	1 to 3 m	-0,7	High carbon dioxide concentration checks yellowing
Lettuce	0,0	95	2 to 3 w	-0,2	Pre-cool rapidly and maintain temperature accurately at 0 °C Avoid storing with any fruit that gives off ethylene
Mushrooms.....	0,0	90 – 95	3 to 5 d	-0,9	Pre-cool rapidly and use film overwraps
Onions.....	0,0	65 – 70	3 to 5 m	-0,8	Cure adequately before storage
Parsley	0,0	95 min.	1 to 2 m	-1,1	
Parsnips	0,0	90 – 95	2 to 6 m	-0,6	Must be injury free
Peas, green.....	0,0	90 – 95	1 to 2 w	-0,5	Exceptional speed between harvesting and pre-cooling needed
Pepper, chilli, dry.....	0,0 to 10,0	60 – 70	6 m	-	Avoid storing brittle dry chilli peppers
Peppers, green.....	7,0 to 10,0	90 – 95	2 to 4 w	-0,5	Pack in bags with polyethylene liners (150 g/m ²) that ensure long storage
Potatoes	5,5 to 10,0	85 – 90	3 to 5 m	-1,0	Temperature below 5,5 °C results in sugar build-up during storage
Potatoes, new.....	4,5	85 – 90	3 to 4 w	-1,0	Store in dark
Pumpkins	10,0 to 12,5	70 – 75	1 to 3 m	-1,0	Low relative humidity is important
Radishes	0,0	90 – 95	3 to 4 w	-0,7	Topping important; hydro-cool and pack in thin polyethylene bags
Rhubarb	0,0	95	2 to 4 w	-0,9	Top the bunches to ensure adequate air circulation
Spinach	0,0	90 – 95	10 to 14 d	-0,3	Do not wash; icing recommended. Use rapid air circulation
Squashes	12,5 to 18,0	50 – 75	2 to 5 m	-0,8	
Sweet potatoes.....	13,5 to 15,5	85 – 90	2 to 4 m	-1,7	Cure adequately prior to storage
Tomatoes, green.....	12,0 to 13,0	85 – 90	3 to 4 w	-0,5	Very susceptible to chilling injury
Tomatoes, ripe.....	0,0	85 – 90	1 to 2 w	-0,5	Storage quality dependent on cultivar; "Money Maker" has good keeping quality
Turnips	0,0	90 – 95	4 to 5 m	-0,5	Top the bunches; store only sound turnips
*d = days m = months w = weeks					
+ When a dash (-) is used in this column it indicates that no information is available.					

8.17.5 Frozen vegetables

See Table 4.

Table 4 — Vegetables (frozen)

1	2	3	4
Product	Storage life (months) at storage temperatures of		
	-18 °C	-25 °C	-30 °C
Asparagus	15	24	>24
Beans, green	15	24	>24
Beans, Lima	18	>24	>24
Broccoli.....	15	24	>24
Brussels sprouts.....	15	24	>24
Carrots.....	18	>24	>24
Cauliflower.....	18	>24	>24
Corn (sweet).....	12	18	24
Peas	18	>24	>24
Potatoes, French fried	24	>24	>24
Spinach	18	>24	>24

8.17.6 Chilled dairy product and eggs

See Table 5.

Table 5 — Dairy products and eggs (chilled)

1	2	3	4
Product	Storage temp., °C	Preferred relative humidity*, %	Storage life+
Butter (short term storage, i.e. retail and household)	Below 5,0	ns	2 w
Cheese, not pre-packed			
Grated (only hard varieties)	3,0 to 5,0	Below 75	6 to 8 m
Hard varieties (after curing)	3,0 to 5,0	75 – 80	1 to 3 m
Processed	10,0 to 15,0	75 – 80	3 to 6 m
Soft uncured (fresh) varieties	3,0 to 5,0	75 – 80	1 w
Soft varieties (after curing)	3,0 to 5,0	90 – 95	2 to 4 w
Cheese, pre-packed			
Hard varieties (after curing), e.g. Cheddar, Gouda....	3,0 to 5,0	ns	1 to 3 m
Soft uncured (fresh) varieties, e.g. cottage, cream....	3,0 to 5,0	75 – 80	1 w
Soft varieties (after curing), e.g. Camembert, blue vein	3,0 to 5,0	75 – 80	2 to 4 w
Cream			
natural	0,0 to 2,0	ns	7 d
pasteurized.....	2,0 to 7,0	ns	7 d
Eggs			
dried, whole	2,0	min.	6 to 12 m
dried, yolk	2,0	min.	6 to 9 m
in shell, fresh	0,0	88 – 92	4 m
oil processed	0,0	88 – 92	6 m
Margarine			
hard	2,0 to 5,0	ns	6 m
soft.....	2,0 to 5,0	ns	4m
Milk			
buttermilk.....	7,0 max.	ns	7 d
pasteurized.....	7,0 max.	ns	5 d
Yoghurt			
natural	3,0 to 5,0	ns	17 d
pasteurized.....	3,0 to 5,0	ns	3 to 12 m
*ns = not specified. +d = days m = months w = weeks			

8.17.7 Frozen dairy products and eggs

See Table 6.

Table 6 — Dairy products and eggs (frozen)

1	2	3	4	5
Product	Storage life (months) at storage temperatures of			
	-15 °C	-18 °C	-25 °C	-30 °C
Butter (long term storage at factories and agents).....	6 – 9	–	–	–
Eggs, liquid, whole	–	12	18	24
Ice-cream, factory or depot retail or household	–	–	6	–
	–	1	–	–

8.17.9 Frozen meat and poultry

See Table 8.

Table 8 — Meat and poultry (frozen)

1	2	3	4
Product	Storage life (months) at storage temperatures of		
	-18 °C	-25 °C	-30 °C
Beef			
Corned.....	2 – 3	4 – 5	6 – 8
Cuts (wrapped)	4 – 6	6 – 10	10 – 12
Dripping	8 – 10	10 – 12	12 – 18
Fresh carcase	5 – 8	8 – 12	12 – 18
Sausage, mince, and patties.....	2	3	4 – 6
Liver, raw	2	3	4
Mutton			
Carcase	3 – 6	6 – 9	9 – 12
Minced	–	3 – 4	–
Pork			
Cured.....	1 – 2	3 – 4	5 – 6
Fresh	2 – 3	4 – 6	8 – 12
Lard	6 – 8	8 – 10	10 – 12
Sausage, mince, and patties.....	1	2	3
Poultry			
Chicken, cut up	–	9	–
Chicken, livers	–	3	–
Chicken, whole	–	12	–
Duck, whole.....	–	6	–
Goose, whole.....	–	6	–
Turkey, cut up	–	6	–
Turkey, whole	–	12	–
Rabbits	2 – 3	4 – 6	8 – 12
Tongue, fresh.....	2 – 3	4 – 6	8 – 12
Venison.....	5 – 8	8 – 12	12 – 18

8.17.10 Chilled marine products

See Table 9.

Table 9 — Marine products (chilled)

1	2	3	4
Products	Storage temperature, °C	Preferred relative humidity, %	Storage life*
Fish			
Cold smoked.....	0,0 to 2,0	90 – 95	8 to 12 d [‡]
Fresh	0,0 to 2,0	90 – 95	8 to 12 d [‡]
Hot smoked (3 – 5 % salt)	0,0 to 5,0	–	1 to 2 m [§]
Mild cured (5 – 8 % salt in product) ..	–2,0 to 2,0	75 – 95	2 to 6 m [§]
Salted (min. 10 % salt in product).....	0,0 to 10,0	90 – 95	10 to 12 m [§]
Oysters, live in the shell.....	3,0 to 8,0	100	5 to 7 d [‡]
Rock lobster, tails, uncooked.....	0,0 to 2,0	90 – 95	4 to 5 d [‡]
Rock lobster, whole or tails, cooked.	0,0 to 2,0	90 – 95	5 to 7 d [‡]
Shrimps and prawns, unpeeled, in ice	0,0 to 1,0	–	5 to 6 d [‡]
*d = days m = months [‡] From time of catching. [‡] Frozen product thawed and held at 0.0 to 2.0 °C. [§] Mould may be a problem. Microbiological deterioration is retarded only above a 5 % salt content.			

NOTE Fresh fish: storage life. The time given, 8-12 d at 0,0 to 2,0 °C, applies only to freshly caught fish stored in ice, and it should be emphasized that this is the total time after catching. Any storage time indicated for fish at a later stage, e.g. after filleting ashore or delivery to a fishmonger, should take into account the storage time already elapsed. Fish that has been on a trawler for 6 d would, for example, have a maximum further storage life of 6 d. Likewise, when fish is stored un-iced in a chill room or refrigerator cabinet, the temperature is more likely to range from 2 to 5 °C. The storage life at 2 °C and 5 °C of a fish that would keep for 12 d in ice would be 6 d and 4 d respectively.

Cold smoked fish: storage life

The same comments apply as for fresh fish with greater emphasis as the storage life of any cold smoked fish must of necessity already have been shortened by storage prior to processing.

8.17.11 Frozen marine product

See Table 10.

Table 10 — Marine products (frozen)

1	2	3	4
Product	Storage life (months) at storage temperatures of		
	-18 °C	-25 °C	-30 °C
Fish			
Fatty	4	8	12
Flat	10	24	24
Lean	8	18	24
Shellfish			
Langoustines, prawns, and shrimps*	6	12	15
Langoustines, prawns, and shrimps, vacuum packed .	8	18	24
Rock lobster, tails	8	18	24
Molluscs (abalone, oysters, etc.) (shucked and well packed)	4	10	12
Whole lobster, cooked*	6	12	15
Whole lobster, raw.....	4	10	12
* These recommendations are conservative and tentative and subject to review when more information is available.			

8.17.12 Chilled baked goods

See Table 11.

Table 11 — Baked goods (chilled)

1	2	3	4
Product	Storage temperature, °C	Preferred relative humidity, %	Storage life, d
Cake, fresh			
Coffee.....	15,0	80 – 90	5
Layer	2,0	80 – 85	7
Loaf	2,0	80 – 85	10
Doughnuts (cake and yeast).....	15,0	80 – 90	3
Fruitcake, fresh.....	4,0	50 – 60	300
Pies, fruit, fresh.....	2,0	80 – 85	3
Rolls	0,0	80 – 85	21

8.17.13 Frozen baked goods

See Table 12.

Table 12 — Baked goods (frozen)

1	2
Product	Storage life at -18 °C or below*
Bread	
Baked with baking powder.....	3 – 6 m
Yeast, after first leavening	2 – 3 m
Cakes	
Baked (with icing)	3 – 4 m
Baked (without icing)	2 – 6 m
Boston bread	12 m
Date loaf	3 m
Dry cakes.....	8 – 12 m
Fruit	12 m
Pastry and tarts	
Baked with fruit filling and pastry cover	2 – 3 m
Chiffon filling, no crust	2 – 3 m
Unbaked with fruit filling and pastry cover	2 – 3 m
With cream cover.....	1 m
Pastry (short and puff)	6 m
Sandwiches with suitable spread.....	2 – 3 w
Scones, baked.....	3 m
*m = months w = weeks	

8.17.14 Pre-cooked frozen food stored at -18 °C or below

See Table 13, which is applicable to food from large manufacturing units, adequately packaged and frozen by commercial methods.

Table 13 — Pre-cooked frozen food

1	2	3
Product	Storage life (months) at storage temperatures of	
	-18 °C	-25 °C or below
Broth, soup, sauce and skimmed gravy*.....	1	–
Chicken or turkey pies	6 – 8	12
Cooked meat and vegetables	6 – 8	12
Creamed dishes, e.g. creamed poultry	6 – 8	12
Dishes well covered with sauce or gravy*	6 – 8	12
Fish with cheese sauce.....	6 – 8	12
Fish with lemon butter sauce	6 – 8	12
Fried chicken.....	6 – 8	12
Fried chicken dinners.....	6 – 8	12
Fried fish dinner.....	6 – 8	12
Fried fish sticks, scallop or shrimp	6 – 8	12
Meat and fish loaves	6 – 8	12
Meat and fish pies.....	6 – 8	12
Puddings, baked or steamed	12	–
cold.....	12	–
Shrimp creole.....	6 – 8	12
Tuna pie.....	6 – 8	12

*Remove fat from soup, sauce, gravy, and pre-cooked dishes as it rapidly turns rancid in the frozen state.

8.18 Cross-transference of volatiles during chilled cold storage

8.18.1 General

Volatiles given off during metabolic processes of produce, and by packaging material and cold storage construction materials, often have deleterious effects on the keeping quality of the stored product.

8.18.2 Odour contamination from vegetable material

Odours from apples and citrus are readily taken up by eggs, meat and dairy products. Common storage of these commodities should be avoided.

Always store eggs separately.

Potatoes give off earthy flavours and should not be stored together with apples, pears, and other fruit.

All deciduous fruit having the same optimum storage temperature may be stored together. Tables 14 and 15, based on research and practical experience of the Perishable Products Export Control Board, have over the years proved to be a reliable guide as to the products that may be stored together.

8.18.3 Odour contamination from packaging and other materials

Most packaging materials and adhesives that contain formaldehyde-based constituents taint produce readily, and often also cause physiological damage to the product. Thoroughly evaluate all such materials prior to using them for produce packaging. Most disinfectant and preservation materials for wood have serious phytotoxic effects on biological material. In the cold store use only paints that are quick drying and non-odorous, and that have been approved for use in food cold stores.

8.18.4 Ethylene emanations

Ethylene is a ripening hormone. It is produced and given off by most fleshy fruit and vegetables, e.g. apples, avocados, bananas, peaches, pears, plums, melons, and tomatoes, etc. It initiates ripening but this effect is minimal at temperatures below 1.5 °C. Ethylene also has a phytotoxic effect on lettuce, carrots, greens, nursery stocks, and many types of flowers.

Table 14 — Perishables which may, or may not, be stored under chilled conditions in the same space

	Apples	Avocados	Egg fruit	Grapefruit	Grapes	Green beans	Green peppers	Lemons	Litchis	Nectarines	Oranges	Peaches	Pears	Pineapples	Plums	Tangerines	Tomatoes (green)	Tomatoes (ripe)	Vegetables (leaf)	Vegetables (root)
Apples	N	N	N	Y	N	N	N	Y	Y	N	Y	Y	N	N	N	N	N	N	Y	Y
Avocados	N	N	N	N	Y	N	N	N	N	Y	N	N	N	N	Y	N	N	N	N	N
Egg fruit	N	N	N	N	N	Y	N	N	N	N	N	N	Y	N	N	N	N	N	N	N
Grapefruit	N	N	N	N	N	N	Y	N	N	N	N	N	Y	N	N	N	N	Y	N	N
Grapes	Y	N	N	N	N	N	N	Y	Y	N	Y	Y	N	N	N	N	N	N	Y	Y
Green beans	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N
Green peppers	N	N	Y	N	N	N	N	N	N	Y	N	N	Y	N	N	N	N	Y	N	N
Lemons	N	N	N	Y	N	N	N	N	N	N	N	N	Y	N	N	Y	N	N	N	N
Litchis	Y	N	N	N	Y	N	N	N	Y	N	Y	Y	N	N	N	N	N	N	Y	Y
Nectarines	Y	N	N	N	Y	N	N	N	Y	N	Y	Y	N	N	N	N	N	N	Y	Y
Oranges	N	Y	N	N	N	Y	N	N	N	N	N	N	N	N	Y	N	N	N	N	N
Peaches	Y	N	N	N	Y	N	N	N	Y	Y	N	Y	N	N	N	N	N	N	Y	Y
Pears	Y	N	N	N	Y	N	N	N	Y	Y	N	Y	N	N	N	N	N	N	Y	Y
Pineapples	N	N	Y	Y	N	N	Y	Y	N	N	N	N	Y	N	N	N	N	Y	N	N
Plums	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Tangerines	N	Y	N	N	N	Y	N	N	N	N	Y	N	N	N	N	N	N	N	N	N
Tomatoes (green)	N	N	N	Y	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N
Tomatoes (ripe)	N	N	Y	N	N	N	Y	N	N	N	N	N	N	Y	N	N	N	N	N	N
Vegetables (leaf)	Y	N	N	N	Y	N	N	N	Y	Y	N	Y	Y	N	N	N	N	N	N	Y
Vegetables (root)	Y	N	N	N	Y	N	N	N	Y	Y	N	Y	Y	N	N	N	N	N	Y	

N = Cannot be stored in the same space.
Y = Can be stored in the same space.

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Table 15 — Frozen commodities which may, or may not, be stored in the same space

	Beef	Butter	Fish (smoked)	Fish (white)	Fruit and juices	Horsemeat	Mutton	Pineapple chips	Pork	Rock lobster	Vegetables
Beef		Y	N	Y	Y	Y	Y	N	Y	SR	Y
Butter	Y		N	Y	Y	SR	Y	N	Y	SR	Y
Fish (smoked)	N	N		SR	SR	N	N	N	N	N	SR
Fish (white)	Y	Y	SR		Y	Y	Y	N	Y	Y	Y
Fruit and juices	Y	Y	SR	Y		Y	Y	Y	Y	Y	Y
Horsemeat	Y	SR	N	Y	Y		Y	N	Y	SR	Y
Mutton	Y	Y	N	Y	Y	Y		N	Y	SR	Y
Pineapple chips	N	N	N	N	Y	N	N		N	N	Y
Pork	Y	Y	N	Y	Y	Y	Y	N		SR	Y
Rock lobster	SR	SR	N	Y	Y	SR	SR	N	SR		Y
Vegetables	Y	Y	SR	Y	Y	Y	Y	Y	Y	Y	

Y = No danger of cross-taint.
SR = Slight danger of cross-taint.
N = Decided danger of cross-taint.

9 Distribution

9.1 Equipment

It is recommended that vehicles for the transportation of chilled or frozen foods be insulated and be equipped with

- a mechanical or other refrigeration system that is capable of maintaining the recommended product temperature while loaded with chilled or frozen food, and of rapidly returning the vehicle to the recommended temperature when the door is closed again after off-loading operations; and
- a thermometer or other appropriate means of temperature measurement indicating air temperature inside the vehicle, with the dial or reading element of the thermometer mounted outside the vehicle.

9.2 Hygiene

9.2.1 Before cooling, clean and disinfect all interior surfaces of vehicles used to transport chilled or frozen food. Keep the vehicles free from objectionable odours.

9.2.2 Accept for transport only chilled or frozen food securely packed or wrapped in a hygienic manner. Unwrapped products should be transported in accordance with the relevant statutory regulations.

9.3 Handling practices for transport by road

9.3.1 Before loading, pre-cool vehicles to within 5 °C of the storage temperature recommended for the transportation of the product.

9.3.2 Do not accept chilled food or frozen food for transportation if the internal product temperature exceeds the recommended temperature.

9.3.3 Chilled and frozen products should not be stored together in the same compartment of a refrigerated carrier for longer than 4 h unless the chilled product is covered with an insulating blanket.

9.3.4 Where possible, make provision for refrigerated vehicles to back up flush against the loading or off-loading doors or passage entrances so that loading/off-loading will take place in a virtually sealed refrigerated area. Where this is impracticable, use a movable screen over the entrance to the vehicle.

9.3.5 Except in the case of a vehicle of double-walled construction in which refrigerated air circulates between the inner and outer walls of the vehicle, refrigerated food should be loaded into the vehicle in such a manner as to provide free circulation of refrigerated air at the front, rear, top, bottom, and both sides of the load. Do not stack the product in a manner that will impede the airflow.

9.3.6 Keep the mechanical refrigeration system of the vehicle in operation and the doors of the vehicle closed during any period when loading or off-loading are not in operation.

10 Retail outlets

10.1 Equipment

10.1.1 Storage

- a) Equip each storage facility with mechanical refrigeration capacity adequate to maintain, at extreme outside temperatures and under peak loading conditions, the temperatures recommended in 8.17. Maintain at the recommended temperature products that have to be removed from their containers. To protect a product received in bulk and not immediately put into the retail cabinet, the retailer should, wherever possible, have a suitably equipped cold storage room of adequate capacity.
- b) If storage facilities of the cabinet type are used, ensure that each is equipped with a thermometer indicating the interior air temperature at a representative position, and defrost them as often as necessary to maintain the refrigeration efficiency specified.
- c) If storage facilities of the walk-in type are used, the applicable recommendations of Clause 8 apply.

10.1.2 Display cabinets

- a) Do not so site display cabinets that the open display area is subjected to abnormal radiant heat (e.g. is in direct sunlight, under strong artificial light, or in direct line with heaters). Excessive radiant heat may result in the product temperature in the cabinet being more than 6 °C warmer than the air temperature in the cabinet. Do not allow an air current to blow directly into the refrigerated space.
- b) Remove frost on refrigerator coils in the air passage of display cabinets and blow out condenser coils as frequently as is necessary to maintain the refrigeration efficiency specified.
- c) Equip each display cabinet with a thermometer, the sensing element of which is located in an appropriate place in the path of refrigerated air being returned to the coils. The indicating part of the thermometer should be located in a conspicuous place.
- d) Designate the product load line (i.e. the highest level where the temperature specified for the product can be maintained) by a distinctive permanent line on the inside of each display cabinet.
- e) Display, in prominent places above display cabinets, notices to the effect that thawed food should not be refrozen.

- f) Connect display cabinets directly to the electricity supply without the use of plugs or intermediate on/off switches.

10.2 Handling practice

10.2.1 The delivery of chilled or frozen food should not be accepted if the internal product temperature exceeds the temperature recommended in 8.17. In practice, a tolerance of 3 °C would be applicable.

10.2.2 Ensure that chilled or frozen food is transferred immediately from the delivery vehicle to the retail cabinet or storage room. Under no circumstances stack refrigerated food in any place other than the retail cabinet or storage room.

10.2.3 Keep the packaging of the food intact until it is finally sold. The packaging is designed to preserve the quality and hygienic standards of the food set by the manufacturer.

10.2.4 Do not place unwrapped or unfrozen products in the same display cabinet as frozen food. Such products introduce the risks of temperature rise, contamination, and dehydration.

10.2.5 Ensure that new stocks of refrigerated or frozen foods are never loaded on top or in front of old stock. First in, first out, should be the basic principle.

10.2.6 Never load food beyond the load line in display cabinets.

10.2.7 It is recommended that aluminium and/or insulated covers of hygienic construction be installed on open-top retail cabinets during non-selling hours. In this way the practical storage life of food in cabinets may be more than doubled.

10.2.8 Ensure that display cabinets will store retail packages of frozen food at a maximum top layer temperature of –10 °C. Do not permit hot air to flow over the food.

10.2.9 Adopt adequate measures to ensure that cross-tainting of foods does not take place.

10.2.10 Empty and clean display cabinets, refrigerators, and deep freeze cabinets regularly at weekly intervals, timed for when the cabinets are relatively empty. Effectively insulate against heat and condensation food temporarily removed for cleaning of the appliances or place it directly into the receiving store, if available. Wash down the inside walls of the appliances with an effective nontainting, non-toxic detergent or detergent-disinfectant solution, used at the recommended dilution and temperature, and scrub out rails and runners. Scrub and mop the floors of cold chambers and flush the gullies and traps with hot water. Wash the top and outside walls of cabinets as part of the general cleaning.

11 Catering establishments

11.1 Storage

11.1.1 Ensure that the general recommendations in 10.1.1 for the storage of chilled and frozen foods are complied with.

11.1.2 Use a system of controlled stock rotation. First in, first out, should be the basic principle.

11.1.3 Provide appropriate storage for all chilled and frozen food and ensure that it is properly used. Do not keep more food in the kitchen or the larder than is necessary.

11.2 Preparation and cooking of chilled and frozen foods

If a catering establishment is registered as a factory, the recommendations in section 5 are applicable where relevant.

NOTE While not specifically applicable to catering establishments, the general principles embodied in section 5 are recommended as guidance for caterers.

11.3 Hygiene

The relevant recommendations of Clauses 4 and 5 should be followed (with the same reservations as given in 11.2).

12 Measurement of temperature

12.1 Thermometers

Thermocouples, thermistors, and resistance thermometers are all suitable for temperature measurement. They should be of a probe type, and have a temperature range from $-40\text{ }^{\circ}\text{C}$ to $+30\text{ }^{\circ}\text{C}$ with an error margin not exceeding $1\text{ }^{\circ}\text{C}$. The use of ordinary metal-sheathed thermometers may readily result in large errors. Glass thermometers used in contact with food are unsafe.

Discard fruit punctured for the taking of temperatures.

12.2 Calibration

Frequent calibration of thermometers used for foods is necessary. Reference points are $0\text{ }^{\circ}\text{C}$ (melting ice made from distilled water) and $-21.4\text{ }^{\circ}\text{C}$ (eutectic point of a sodium chloride solution).

Alternatively, thermometers may be checked by comparing the temperature reading of the instrument under test with the reading of a thermometer known to be accurate, e.g. a standard thermometer. Both sensors should be held alongside each other in the same ambient temperature zone.

If, after testing, an error greater than $0.5\text{ }^{\circ}\text{C}$ is noted, the calibration of the thermometer being checked should be adjusted until a correct reading is indicated. After adjustment, the thermometer should be rechecked for accuracy.

12.3 Measurement

Temperature measurement techniques must ensure

- a) accurate measurement of temperature at the point of measurement;
- b) selection of sufficient temperature readings to yield a reliable mean temperature and to indicate the temperature variation in the cold store, cabinet, or product (as applicable). Equip each storage room, cabinet, or other storage facility with a temperature measuring device that is easily readable from the outside. Locate sensing elements of thermometers and other temperature measuring devices in accordance with 8.4.

12.4 Cold stores

The following should be monitored where necessary:

- a) air delivery temperature;
- b) return air temperature; and
- c) in cases of doubt only (e. g. temporary breakdown of refrigeration), product temperature.

When checking product temperature, measure it in the centre of the stack, near the door, and near the roof. The number of points at which it should be measured is dependent on the size of the room and the available facilities.

12.5 Frozen products in cold stores

12.5.1 Bulk containers

If outer containers are stacked closely together, e.g. on a pallet, take the temperature readings

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- a) of a container in an outer face of an outer bulk container, and
- b) of a container in the outer face of a bulk container in the centre of the lot.

Insert the thermometer at least 65 mm towards the centre of the product in the test container or up to the centre in smaller packs.

Significant differences between the two readings indicate a temperature gradient in the pallet load and may require the taking of more temperatures if the previous history of the pallet load suggests that the elevated temperatures recorded have been sustained for long enough to cause significant quality loss.

If individual bulk containers are being examined, select a container from at least one layer in from the outside of a bulk container.

12.5.2 Retail packages

a) Reference method

For temperature measurement in the centre of a retail package, make a hole in the frozen product. Heat is generated during the boring operation and heat may also be conducted into the product by the thermometer. Keep the temperature sensing probe at the storage temperature for 2 min before inserting it into the product, and let 1 min elapse between boring the hole and taking the temperature of the frozen commodity.

b) Practical method

The surface temperature of frozen foods can be measured without destroying the product, and the method is sufficiently accurate for routine temperature checks, provided that good contact is achieved when the temperature sensor is inserted between packages or outer containers. When adequate pressure is applied, the temperature measured should normally be within 2 °C of the true product temperature. The temperature sensor should first be pre-cooled by insertion between packages of frozen food, good thermal contact being made. If temperature measurements are to be taken inside a cold store, pre-cooling may be accomplished by allowing the sensor to equalize with the ambient temperature of the cold store.

If packaged frozen food is contained in outer containers, the side wall of the case should be cut and the tab folded outwards. The pre-cooled temperature sensor should then be so inserted between the first and second layers of inner packages that the sensor is in good contact with the packages. To provide pressure and achieve better thermal contact between the sensor and packages, stack additional packages or containers of frozen food on top of the test container.

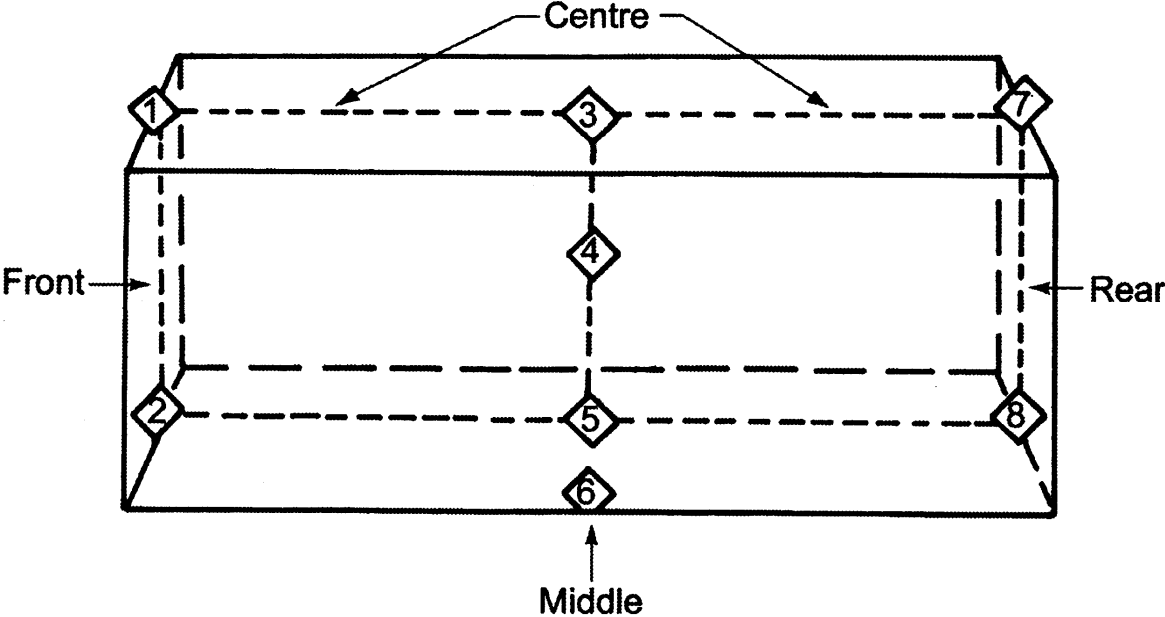
Record the temperature after it has reached a steady value. If several test containers are to be checked, the temperature sensor should not be removed from a test container until the succeeding container is ready for temperature measurements. If packages are not in outer containers (e.g. in retail display cabinets) follow the above procedure (where applicable), ensuring that enough packages are stacked on top of the test package to ensure good thermal contact between sensor and package.

NOTE It is a wise precaution to cover the thermometer in a suitable pure edible oil of British Pharmacopoeia quality to ensure that it will not be frozen into the product. When this precaution is taken, the thermometer may be left in position until a constant temperature is reached.

12.6 Vehicle or transport container units

Take temperature readings in the positions shown in Figure 1.

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- 1. Top, front, centre
- 2. Bottom, front, centre
- 3. Top, middle, centre
- 4. Halfway up, middle, centre
- 5. Bottom, middle, centre
- 6. Bottom, middle, side (next to door if there is a side door)
- 7. Top, rear, centre
- 8. Bottom, rear, centre

Figure 1 — Suggested locations in the transport vehicle from which test packages should be selected

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