SECTION 1: SCOPE

This code recommends proper packaging and transport of fresh fruit and vegetables in order to maintain produce quality during transportation and marketing.

SECTION 2: DEFINITIONS

For purposes of this Standard, the following definitions shall apply:

2.1 perishable

food that is of such type or in such a condition that it may spoil.

2.2 dunnage

inexpensive or waste material used to load and secure cargo during transportation.

2.3 fiberboard

type of engineered wood product that is made out of wood fibers.

2.4 wire bound

food containers made from wood which are usually stapled with wires at the girth and wood cleats.

2.5 slip sheet

thin pallet-sized sheets made of plastic, heavy laminated kraft paperboard, or corrugated fiberboard used in commercial shipping and often used to replace traditional wooden pallets.

SECTION 3: DESIGN, CONDITION AND LOADING METHOD OF TRANPORT EQUIPMENT

3.1 MODE OF TRANSPORTATION AND TYPE OF EQUIPMENT

The following factors should be considered in selection of transport and type of equipment:

a) destination;
b) value of the produce;

c) degree of produce perishability
d) amount of produce to be transported;
e) recommended storage temperature and relative humidity;
f) outside temperature conditions at origin and destination points;
g) time in transit to reach the destination by air, land, or ocean transport;
h) freight rates negotiated with the carriers; a
i) quality of transportation service.

3.2 The reliability and quality of transportation service provided by different carriers should be carefully considered along with the rates charged.

3.3 High volume produce with short storage life should be transported in refrigerated trailers and van. After transit, there must be enough remaining produce life for marketing. Minimal handling reduces exposure and damage of the produce.

3.4 High-value and highly perishable produce can bear freighted.

3.5 Prior to transit, the service provider must ensure proper storage conditions to maintain the quality of the products.

3.6 During transport, the service providers should implement an accurate monitoring of temperature and relative humidity.

3.7 Long distance transportation through tropical and frigid climates requires rugged well-designed equipment to withstand the transit environment and protect the produce. Desirable features in refrigerated trailers up to 14.6 m (48 ft.) long and van containers up to 12 m (40 ft.) long include for example:

a) 42000 kJ/h (40000 BTU/h) refrigeration capacity at 38^{O}C (100^{O}F) ambient, 2^{O}C (36^{O}F) return air temperature;
b) a continuously operating high capacity evaporator blower for more even produce temperatures and higher relative humidities;
c) a solid return air bulkhead at the front of the trailer to ensure air circulation throughout the load;
d) vertical ribs on the rear door to assist in air circulation;
e) adequate insulation and provisions for heating, when used in regions where weather conditions so demand due to the nature of the produce;
f) deep floor grooves or channels, from 50 to 75 mm (2 to 3 mm) in depth to provide an adequate cross-sectional area for air circulation under loads placed directly on the floor;
g) supply-air temperature sensing of the operation of the refrigeration unit to reduce produce chilling and freezing injury;
h) provisions for ventilation to prevent ethylene or carbon dioxide buildup;
i) air-ride suspension to reduce the amount of shock and vibration transferred to the shipping containers and the produce inside; and

j) modern containers in which cold air leaves the front part of the container, but the air flow circulates from below (close to the floor) toward the back, then rising to the upper part of the container.

3.8 Most carriers check their transport equipment before presenting it to the shipper for loading. The condition of the equipment is critical to maintaining the quality of the produce. Therefore, the shipper also should check the equipment to ensure it is in good working order and meets the needs of the produce. Carriers provide guidance on checking and operating the refrigeration systems.

3.9 All transportation equipment should be checked for:

a) cleanliness - the load compartment should be regularly cleaned for example by steam cleaning;
b) damage to walls, floors, doors, ceilings should be in good condition; and
c) temperature control - refrigerated units should be recently calibrated and supply continuous air circulation for uniform produce temperatures.

3.10 Shippers should insist on clean equipment. A load of produce can be ruined by:

a) smell from previous deliveries or incompatible loads;
b) toxic chemical residues;
c) insects nesting in the equipment;
d) decaying remains of agricultural produce; and
e) debris blocking drain openings or air circulation channels along the floor.

3.11 Shippers should insist on well-maintained equipment and check for the following:

a) damage to walls, ceilings, or floors which can let in the outside heat, cold, moisture, dirt, and insects;
b) operation and condition of doors, ventilation openings, and seals; and
c) provisions for load locking and bracing.

3.12 For refrigerated trailers and van containers, the following additional checks are important:

a) with the doors closed, have someone inside the cargo area check for light-- door gaskets must seal. A smoke generator also can be used to detect leaks;
b) the refrigeration unit should cycle from high to low speed when the desired temperature is reached and then back to high speed;
c) determine the location of the sensing element which controls the discharge air temperature. If it measures return air temperature, the thermostat may have to be set- higher to avoid chilling injury or freezing injury of the produce;
d) a solid return air bulkhead should be installed at the front of the trailer;
e) a heating device should be available for transportation in areas with the extreme cold weather; and

f) equipment with a top air delivery system should have a fabric air chute or metal ceiling duct in good condition.

3.13 Produce requiring refrigeration should be thoroughly precooled, if necessary, prior to loading into transportation equipment. Produce temperatures should be taken with an appropriate thermometer and recorded on the bill of lading for future reference. The load compartment in the equipment also should be precooled to the recommended transport or storage temperature for the produce. It is advisable that the loading area should be enclosed and if available, the loading dock doorway area should be equipped with doorway air seals.

3.14 Proper loading practices are critical to maintaining temperature and relative humidity, protecting the produce from impact and vibration forces in transit, and preventing insects from entering the load. Special care must be taken when shipping mixed loads. The produce must be compatible.

3.15 Basic loading methods include:

a) bulk loading, by machine or hand, of unpackaged commodities;
b) hand loading individual shipping containers, with or without pallets; and
c) unit loading of palletized or slip-sheet loads of containers with pallet jacks or forklifts.

3.16 Inadequate provisions for air circulation will ruin a load, even in well-designed transportation equipment. When possible, shipping containers should be kept off shallow floors and away from flat sidewalls by using pallets, racks, and dunnage. Adequate head space between the upper row of cartons and the top of the container should be allowed; this may be done by taping or gluing the upper row of cartons or by using appropriately designed packages for this purpose. Room for air circulation must be provided under, around and through the load to protect the produce from:

a) heat gain from the outside air during hot weather;
b) heat generated by the produce through respiration;
c) accumulation of ethylene from ripening of the produce;
d) heat loss to the outside air during extremely cold weather; and
e) chilling injury or freezing injury during operation of the refrigeration unit.

3.17 Shippers using refrigerated transport equipment should follow the carrier's recommendations on loading of the equipment's load compartment to avoid chilling injury or freezing injury to the produce. Discharge air may be colder than the set-point temperature if the refrigeration system operates on return air temperature sensing.

3.18 Loads should be secured with one or more of the following materials to prevent the effects of vibrations and impact damage in transport and handling:

a) aluminum or wood load locks;
b) paperboard or fiberboard honeycomb fillers;

c) wood blocking and nailing strips;
d) inflatable craft paper air bags;
e) cargo nets and straps; and
f) wood load gates constructed of 25 mm x 100 mm (1 x 4 in) material.

3.19 If available all loads should have a small air temperature recorder placed between packages in the area where the warmest temperatures occur. Recorder companies recommend placement on top of the load, near a sidewall, one-third of the way in from the rear doors, away from any direct discharge of refrigerated air. Rail cars should have two or three recorders. In loads with top-ice or humidity above 95%, the recorders should be waterproof or enclosed in a plastic bag.

3.19.1 Shippers and receivers must follow the temperature recorder company's instructions on documenting the load, starting the recorder, reading the results, and returning it for calibration and certification if necessary. These steps are essential for settling claims over temperature management during transportation.

3.20 Similar sized shipping containers should be loaded together in mixed loads for increased stability. Heavier shipping containers of produce should be loaded first, distributed evenly across the floor of the trailer or container. Lighter shipping containers can then be placed against or on top of the heavier produce. Load lock and secure stacks of different sized shipping containers. To facilitate inspection of mixed loads at ports of entry, a representative sample of each commodity should be available near the door. This can minimize the unloading of cargo for examination.

3.21 Never load fruit, vegetables, or other food products with cargoes that provide any risk of contamination through the transfer of odor or toxic chemical residues. The longer the transit time, the higher the risks in transporting mixed loads of agricultural produce. Therefore it is essential that guidelines be followed as much as possible to maintain quality in distant markets.

3.22 Modified atmospheres of reduced oxygen and elevated carbon dioxide and nitrogen are provided to trailers and containers after loading is completed. The trailers and containers must be equipped with channels at the doorway for a plastic film curtain and gas ports for the application of the treatment.

3.23 The refrigeration unit, walls, ceiling, floor, and doors must adequately seal the inside of the cargo area from outside air. Otherwise, the modified atmosphere will quickly dissipate. Warning labels must be applied to the equipment to warn that the atmosphere is not life supporting and that the cargo area must be properly ventilated before personnel enters to unload the cargo.

SECTION 4: PACKAGING TO MAINTAIN PRODUCE QUALITY DURING TRANSPORTATION AND MARKETING

4.1 Packaging must withstand:

a) rough handling during loading and unloading;
b) compression from the overhead weight of other containers;
c) impact and vibration during transportation; and
d) high humidity during precooling, transit, and storage.

4.2 Packaging materials are chosen on the basis of needs of the produce, packing method, precooling method, strength, cost, availability, buyer specifications, and freight rates. Importers, buyers, and packaging manufacturers provide valuable recommendations. Materials used include:

a) paperboard or fiberboard bins, boxes (glued, stapled, interlocking), lugs, trays, flats, dividers or partitions, and slip sheets;
b) wood bins, crates (wire bound, nailed), baskets, trays, lugs, pallets;
c) paper bags, sleeves, wraps, liners, pads, excelsior, and labels;
d) plastic bins, boxes, trays, bags (mesh, solid), containers, sleeves, film wraps, liners, dividers, and slip sheets; and
e) foam boxes, trays, lugs, sleeves, liners, dividers, and pads.

4.3 Bins, boxes, crates, trays, lugs, baskets, and bags are considered shipping containers. Baskets, however, are difficult to handle in mixed loads of rectangular boxes. Bags provide limited produce protection. The fiberboard type box is a widely used container. Styles include for example:

a) one-piece slotted box with glued, stapled, or self-locking flaps;
b) two-piece half slotted box with a cover;
c) two-piece half slotted box with a full telescoping cover, providing strong walls and corners;
d) three-piece Bliss-style box featuring stapled or glued ends providing strong corners;
e) one-piece box with full telescoping cover;
f) two-piece, die-cut style box with full telescoping cover; and
g) one-piece box with wire or fiberboard tabs or hardboard end inserts and plastic end caps, providing stacking strength and alignment.

4.3.1 Fiberboard boxes for produce which are packed wet or with ice must be wax-impregnated or coated with water resistant material. The compression strength of untreated fiberboard can be reduced more than one half in conditions of 90% relative humidity. In addition to maintaining box strength, wax helps to reduce the loss of moisture from the produce to the fiberboard. All glued boxes should be made with a water resistant adhesive.

4.3.2 The majority of fiberboard boxes and wood crates are designed to be stacked top to bottom. Compression strength and produce protection are sacrificed when boxes or crates are stacked on their ends or sides. Misaligned boxes can lose up to 50% of their top to bottom compression strength.

4.4 Various materials are added to shipping containers to provide additional strength and produce protection. Dividers or partitions and double or triple

thickness sides and ends in fiberboard boxes provide additional compression strength and reduce produce damage.

4.4.1 Pads, wraps, and sleeves and excelsior also reduce bruising. Pads also are used to provide moisture as with asparagus; provide chemical treatment to reduce decay as with sulfur dioxide pads for grapes, and absorb ethylene as with potassium permanganate pads in boxes of bananas and flowers.

4.4.2 Plastic film liners or bags are used to retain moisture. Perforated plastic is used for most produce to allow the exchange of gases and avoid excessive humidity. Solid plastic is used to seal the produce and provide for modified atmosphere by reducing the amount of oxygen available for respiration and ripening. For example, this is done for bananas, strawberries, tomatoes and citrus fruits.

4.5 Packing methods include:

a) **field packing:** produce is placed in fiberboard boxes, plastic crates or wood crates during harvesting. Some produce is wrapped. The filled containers are then taken to a precooling facility to have the field heat removed where possible;
b) **shed packing**: produce is processed or packed indoors or under cover at a central location. The produce is brought from the field to the packing shed in bulk in field crates, bins, or trucks. If available, the produce should be precooled either before or after they are placed in shipping containers according to the nature of the produce; and
c) **repacking**: produce is taken out of one container, re-graded, and placed in another. This is often done to make smaller containers for the retailer or consumer packages.

4.5.1 Types of packs include:

a) **volume fill**: produce is placed by hand or machine into the container until the desired capacity, weight, or count is reached;
b) **tray or cell pack**: produce is placed in molded trays or cells which provide separation and reduced bruising;
c) **place pack**: produce is carefully placed in the container. This provides reduced bruising and a pleasing appearance;
d) **consumer pack or prepack**: relatively small amounts of produce are packaged, weighted, and labeled for retail sale;
e) **film or shrink wrap**: each fruit or vegetable is individually wrapped and sealed in film to reduce moisture loss and decay. The film may be treated with authorized fungicides or other chemicals; and
f) **modified atmosphere**: individual consumer packs, shipping containers, or pallet loads of containers are sealed with plastic film or bags. The oxygen level is reduced and the carbon dioxide level is increased. This reduces produce respiration and slows the ripening process.

4.6 Shipping containers must be sized and filled correctly. Containers which are

very wide and weight more than 23 kg (50 lb.), for example, encourage rougher handling, produce damage, and container failure. Overfilling causes produce bruising and excessive bulging of the sides of the container, which leads to decreased compression strength and container failure. Under-filling also causes produce damage. The produce is bruised as it moves around inside the shipping container during transport and handling.

4.6.1 Due to a large number of different container sizes in use, box standards are desirable.

Standardized containers:

a) utilize, with other containers, the maximum surface of the pallet with no overhang and little under hang;
b) provide unit loads and stable mixed pallet loads; and
c) reduce transportation and marketing costs.

4.7 A large number of shippers have switched from handling individual shipping containers to unit loads on pallets. Most distribution centers are set up to store palletized loads in three tier racks.

4.7.1 Unit loads provide for:

a) reduced handling of individual shipping containers;
b) less damage to the containers and the produce inside;
c) faster loading and unloading of transportation equipment; and
d) more efficient distribution center operations.

4.7.2 Unit loads may include, for example, some of the following features:

a) standard wood pallets or slip sheets such as; 1200 x 1000 mm (48 x 40 in), 800 x 1000 mm, 800 x 1200 mm, 1000 x 1200 mm;
b) fiberboard, plastic or wire vertical interlocking tabs between boxes;
c) boxes with holes for air circulation, which align when the boxes are stacked squarely on top of one another, corner to corner;
d) glue between boxes to resist horizontal slipping;
e) plastic netting around the pallet load of boxes;
f) fiberboard, plastic, or metal cornerboards; and
g) plastic or metal strapping around the cornerboards and boxes.

4.8 Wood pallets must be strong enough to allow storage under load. Provisions for forklift and pallet jack handling are necessary. The design of the bottom of the pallet should not block air circulation.

4.8.1 Pallets must have an adequate number of top deck boards to support fiberboard boxes. Otherwise the boxes may collapse between deck boards from the overhead weight of the other containers, crush the produce, and cause the entire load to lean or fall off the pallet. A sheet of fiberboard with holes for air circulation can be used to distribute air across the pallet.

4.8.2 Boxes must not overhang the edges of the pallets. Overhang can reduce the strength of fiberboard boxes by one-third. This condition also can lead to collapse of the entire load, crushing of the produce, and make loading, unloading, and storage in racks difficult. On the other hand, boxes which utilize less than 90% of the pallet surface and do not align with the pallet edge can shift in transit.

4.8.3 Pallet loads of shipping containers which are not strapped or netted should have at least the top three layers of containers cross-stacked to provide stability. Some shippers use film wrap, tape, or glue on the top layers in addition to cross-stacking. The containers must be strong enough to be cross-stacked without collapsing. Film wrap should not be used on shipping containers of produce that need ventilation.

4.9 Slip sheets are used by some shippers because they cost less than pallets. They also eliminate the cost of transporting and returning pallets. A special forklift is needed to transfer slip sheet loads to and from the pallets at the shipper's and receiver's distribution center. If a receiver does not have the proper handling equipment, the packages are unloaded by hand onto pallets for placement in storage. Shipping containers on slip sheets are cross-stacked, film wrapped, or otherwise unitized with corner boards and strapping.

4.9.1 Slip sheets made of fiberboard or plastic must be strong enough to be clamped and pulled onto the forklift tines or plate for lifting while fully loaded. Fiberboard slip sheets should be wax impregnated when used in wet conditions. Slip sheets used in transportation equipment should have holes for air circulation under the load. The use of slip sheets in refrigerated transportation equipment with shallow floor channels is not recommended due to the need for adequate air circulation under the load.

SECTION 5: PRECOOLING PRACTICES

5.1 If available, the removal of field heat by the process of precooling to a recommended storage temperature and relative humidity is suggested to maintain the quality of fruits, and vegetables. The quality of most produce will rapidly deteriorate if field heat is not removed before loading into transportation equipment.

5.2 Refrigerated transportation equipment is designed to maintain temperature and should not be used to remove field heat from produce packed in shipping containers. The refrigeration units also are not capable of raising or controlling the relative humidity.

5.3 Precooling extends produce life by reducing:

a) field heat;
b) the rate of respiration and heat generated by the produce;
c) the rate of ripening;

d) the loss of moisture (shriveling and wilting);
e) the production of ethylene (ripening gas generated by the produce); and
f) the spread of decay.

5.4 The success of precooling is dependent on:

a) time between harvest and precooling;
b) type of shipping container if produce is packed beforehand;
c) initial produce temperature;
d) velocity or amount of cold air, water, or ice provided;
e) final produce temperature;
f) sanitation of the precooling air or water to reduce decay organisms; and
g) maintenance of the recommended temperature after precooling.

5.5 Precooling**,** where it is used, should occur as soon as possible after harvest. For most produce, harvesting should be done in early morning hours to minimize field heat and the refrigeration load on precooling equipment. Harvested produce should be protected from the sun with covering until they are placed in the precooling facility.

5.6 Many products are field or shed packed and then precooled. Wire bound wood or nailed crates or wax impregnated fiberboard boxes are used for packed produce that is precooled with water or ice after packing. Precooling of produce packed in shipping containers and stacked in unitized pallet loads is especially important as air circulation around and through the packaging may be limited during transportation and storage.

5.7 The choice of precooling method depends on the nature, value, and quality of the produce as well as the cost of labor, equipment, and materials. Precooling methods include:

a) **room cooling:** stacking containers of produce in a refrigerated room. Some produce is misted or sprayed with water during room cooling;
b) **forced air cooling or wet pressure cooling:** drawing air through stacks of containers of produce in a refrigerated room. For some produce, water is added to the air;
c) **hydrocooling**: flushing produce in bulk tanks, bins, or shipping containers with a large quantity of ice water;
d) **vacuum cooling**: removing heat from produce packed in shipping containers by drawing a vacuum in a chamber;
e) **hydrovacuum cooling**: adding moisture to produce packed in shipping containers before or during the vacuum process, to speed the removal of heat; and
f) **package-icing**: injecting slush or crushed ice into each shipping container of produce. Some operations use bulk containers.

5.8 Since most produce is sensitive to chilling injury, care must be taken not to precool or store the produce below the recommended temperature. Often the visible

effects of chilling injury are delayed until the produce is offered for retail sale. These effects include failure to ripen properly, pitting, decay, watery breakdown, and discoloration in fruits and vegetables.

5.9 All produce is sensitive to decay. Precooling equipment and water should be sanitized continuously, for example, with a hypochlorite solution to eliminate decay producing organisms. Care also must be taken not to allow produce to warm up after precooling. Condensation on cool produce surfaces at higher air temperatures also spreads decay.

5.10 The method of transportation, condition of the transport equipment, loading method, and transit and storage practices affect the success of precooling. If the recommended temperature and relative humidity are not maintained after precooling, produce quality will deteriorate.

REFERENCES:

Codex Recommended International Code of Practice – General Principles of Food Hygiene (CAC/RCP 1-1969, Rev. 4- 2003).

Recommended International Code of Practice for Packaging and Transport of Fresh Fruits and Vegetables (CAC/RCP 44-1995).

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