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INTERNATIONAL FOOD STANDARDS

CODE OF PRACTICE FOR FISH AND FISHERY PRODUCTS



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A fisherman is shown from the waist up, standing in shallow, greenish water. He is wearing a dark t-shirt with a logo that says 'LOCAL CREW 2005' and a blue cloth around his waist. He is holding a fishing net with both hands, and water is splashing around him. In the foreground, there is a purple and yellow patterned bucket. The background shows a line of green trees under a clear blue sky. The entire image is overlaid with a faint, white, circular grid pattern.

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Foreword



The Codex Alimentarius, “the food code”, has a fundamental role in protecting consumers all around the world and ensuring fair practices in food trade. The *Code of Practice for Fish and Fishery Products* is the essential reference point for technical guidance on the harvesting, processing, transport and sale of fish and fishery products.

Aquaculture in general plays a crucial role in global food security and together with fisheries plays a significant and growing role in providing food, nutrition and employment in all parts of the world, thereby contributing to the Goals of the 2030 Agenda for Sustainable Development. Fisheries and aquaculture offer ample opportunities to reduce hunger and improve nutrition, alleviate poverty, generate economic growth, and ensure better use of natural resources. Aquaculture is the fastest-growing food sector and has the potential to produce the fish needed to help meet the demands of a growing population. Importantly, fish accounts for 17 percent of the global population’s intake of animal protein.

This updated version of the text introduces valuable additional information on how to minimize the risk of histamine build-up in fish and fishery products through technical guidance for the control of histamine formation at key steps in the food chain from harvesting to processing. This guidance will be relevant for both small and large-scale operators.

As demands for production increase, while limiting food waste or loss, the fisheries sector will continue to face environmental challenges and will be required to adopt policy and management practices that are able to harness technical developments and innovation to ensure business development and trade. Both for countries where fishing or aquaculture is already the backbone of the community and in regions where population growth will require policy makers and regulators to explore new opportunities in food systems, practical Codex texts such as this code of practice can ensure that products that are sold on national or international markets meet the requirements of international standards, protecting health and facilitating trade.

Bjørn Røthe Knudtsen

Chairperson, Codex Committee on Fish and Fishery Products
Regional Director, The Norwegian Food Safety Authority

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Introduction



The present Code of Practice for Fish and Fishery Products was developed by the *Codex Committee on Fish and Fishery Products* by merging the individual codes and adding new sections. Those codes were primarily of a technological nature, offering general advice on the production, storage and handling of fish and fishery products on board fishing vessels and on shore. The present Code also deals with the distribution and retail display of fish and fishery products.

The combined Code was further modified to incorporate the Hazard Analysis Critical Control Point (HACCP)¹ approach described in the *General Principles of Food Hygiene* (CXC 1-1969), Annex: “Hazard Analysis and Critical Control Point (HACCP) system and guidelines for its application”. The Code describes a prerequisite programme covering technological guidelines and the essential requirements of hygiene in the production of fish, shellfish and their products that are safe for human consumption, and otherwise meets the requirements of the appropriate Codex product standards. The Code also contains guidance on the use of HACCP, which is recommended to ensure the hygienic production of fish and fishery products to meet health and safety requirements.

Within the Code, a systematic approach similar to that of HACCP has been applied to essential quality, composition and labelling provisions of the appropriate Codex product standards. Throughout the Code, this is referred to as “defect action point (DAP) analysis”. However, DAP analysis is optional.

The Codex Committee on Fish and Fishery Products recommended at its twentieth Session that defects of a commercial nature, such as workmanship defects, which had been removed from Codex fish product standards, be transferred to the appropriate Codex Code of Practice for optional use between buyers and sellers during commercial transactions.

This Code will assist all those engaged in the handling and production of fish and fishery products, or concerned with their storage, distribution, export, import and sale, in attaining safe and wholesome products that can be sold on national or international markets and meet the requirements of Codex standards.

How to use this Code

The aim of this Code is to provide user-friendly background information and guidance for the development of fish and shellfish process management systems that would incorporate good manufacturing practice (GMP) as well as the application of HACCP in countries where such measures have not yet been developed. In addition, it could be used in the training of fishers and employees in the fish and shellfish processing industries.

The practical application of this *international* Code in the context of *national* fisheries may require some modifications and amendments to take into account specific local conditions and consumer requirements. In that sense, the present Code is not intended to replace the advice or guidance of trained and experienced technologists regarding the complex technological and hygienic problems unique to a specific geographical area or fishery; in fact, this Code is intended to be used as a supplement in such instances.

The Code is divided into separate though interrelated sections, which can be consulted as appropriate in the course of setting up an HACCP or DAP programme:

- (a) **Section 2 Definitions**
Being acquainted with the definitions is important and will aid the overall understanding of the Code.
- (b) **Section 3 Prerequisite programme**
Before HACCP or a similar approach can properly be applied to a process, it is important that a solid foundation of good hygienic practice be in place. Section 3 covers the minimum requirements for a facility prior to the application of hazard and defect analyses.
- (c) **Section 4 General considerations for the handling of fresh fish, shellfish and other aquatic invertebrate**
Section 4 provides an overview of the potential hazards and defects that may have to be considered when building up an HACCP or DAP plan. This is not intended to be an exhaustive list but is designed to help an HACCP or DAP team to think about what hazards or defects should be considered in fresh fish, shellfish and other aquatic invertebrates, after which it is then up to the team to determine the significance of any particular hazard or defect in relation to the process.
- (d) **Section 5 Hazard Analysis and Critical Control Point (HACCP) and defect action point (DAP) analysis**
Only when the groundwork in Section 3 has been completed satisfactorily should the application of the principles outlined in Section 5 be considered. This Section uses the processing of a canned tuna product as an example to illustrate how the principles of HACCP should be applied to a process.
- (e) **Section 6 and 7 Aquaculture production and Live and raw bivalve molluscs**
These Sections deal with pre-harvest and primary production of fish, crustaceans and molluscan shellfish not caught in the wild.

Although potential hazards and/or defects are listed for most steps in Sections 6–21, it should be noted that this is only for guidance and the consideration of other hazards and/or defects may be appropriate. Moreover, the format of these sections has been designed for maximum “ease of use”, meaning that potential hazards and/or defects are listed only where they may be introduced into a product or where they are controlled, rather than repeated at all intervening processing steps.

In addition, it must be stressed that hazards and defects, and their subsequent control or action points, are product- and line-specific and, therefore, a full critical analysis based on Section 5 must be completed for each individual operation.

- (f) **Section 9 Processing of fresh, frozen and minced fish**
This Section forms the foundation for most of the subsequent processing sections. It deals with the major process steps in the handling of raw fish through to cold storage and gives guidance and examples on the sort of hazards and defects to expect at each step. This Section should be used as the basis for all the other processing operations (Sections 10–19, which give additional guidance specific to the appropriate product sector).
- (g) **Section 10 - 20 Processing of specific fish and shellfish products**
Processors operating in particular sectors will need to consult the appropriate section to find additional information specific to that sector.
- (h) **Section 21 - 22 Transportation and Retail**
cover general transportation and retail issues. Transportation and retail apply to most, if not all sections on the processing of specific products. They should be granted the same level of care as the other processing steps.





1

Scope

This Code applies to the growing, harvesting, handling, production, processing, storage, transportation and retail of fish, shellfish and aquatic invertebrates and products thereof from marine and freshwater sources that are intended for human consumption.



2

Definitions



2.1 General definitions

Biotoxins

Poisonous substances naturally present in fish and fishery products or accumulated by the animals feeding on toxin-producing algae or in water containing toxins produced by such organisms.

Chilling

The process of cooling fish and shellfish to a temperature approaching that of melting ice.

Clean water

Water from any source where harmful microbiological contamination, substances and/or toxic plankton are not present in such quantities that may affect the safety of fish, shellfish and their products intended for human consumption.

Cleaning

The removal of soil, food residues, dirt, grease or other objectionable matter.

Contaminant

Any biological or chemical agent, foreign matter or other substances not intentionally added to food that may compromise food safety or suitability.

Contamination

The introduction or occurrence of a contaminant in fish, shellfish or their products.

Control measure

Any action or activity that can be used to prevent or eliminate a food safety hazard or reduce it to an acceptable level. For the purposes of this Code, a control measure is also applied to a defect.

Corrective action

Any action to be taken when the results of monitoring at the CCP indicate a loss of control. For the purposes of this Code, this also applies to DAPs.

Critical control point (CCP)²

A step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

Critical limit

A criterion that separates acceptability from unacceptability. For the purposes of this Code, this also applies to DAPs.

Decision tree

A sequence of questions applied to each process step with an identified hazard to identify which process steps are CCPs. For the purposes of this Code, this also applies to DAPs.

² Refer to Annex II for a comprehensive list of the acronyms used in this Code.

Decomposition

The deterioration of fish, shellfish and their products including texture breakdown and causing a persistent and distinct objectionable odour or flavour.

Defect

A condition found in a product that fails to meet essential quality, composition and/or labelling provisions of the appropriate Codex product standards.

Defect action point (DAP)

A step at which control can be applied and a quality (non-safety) defect can be prevented, eliminated or reduced to an acceptable level, or a fraud risk eliminated.

Disinfection

The reduction by means of chemical agents and/or physical methods in the number of microorganisms in the environment to a level that does not compromise food safety or suitability.

Dressed

That portion of fish remaining after heading and gutting.

Facility

Any premises where fish or fishery products are prepared, processed, chilled, frozen, packaged or stored. For the purposes of this Code, premises also include vessels.

Fish

Any of the cold-blooded (ectothermic) aquatic vertebrates. Amphibians and aquatic reptiles are not included.

Hazard

A biological, chemical or physical agent in food or the condition of food with the potential to cause an adverse health effect.

Hazard analysis

The process of collecting and evaluating information on hazards and conditions leading to their presence in order to decide which are significant for food safety and, therefore, should be addressed in the HACCP plan.

Hazard Analysis and Critical Control Point (HACCP)

A system that identifies, evaluates and controls hazards that are significant for food safety.

Microbiological contamination

The presence, introduction, reintroduction, growth and/or survival of pathogens of public health concern.

Monitor

The act of conducting a planned sequence of observations or measurements of control parameters to assess whether a CCP is under control. For the purposes of this Code, this also applies to DAPs.

Potable water

Freshwater fit for human consumption. Standards of potability should not be lower than those contained in the latest edition of the *International Standards for Drinking-water* issued by the World Health Organization.

Prerequisite programme

A programme that is required prior to the application of the HACCP system to ensure that a fish and shellfish processing facility is operating according to the Codex Principles of Food Hygiene, the appropriate code of practice and appropriate food safety legislation.

Raw materials

Fresh and frozen fish, shellfish and/or their parts that may be utilized to produce fish and shellfish products intended for human consumption.

Refrigerated water

Clean water cooled by a suitable refrigeration system.

Shelf-life

The period during which the product maintains its microbiological and chemical safety and sensory qualities at a specific storage temperature. It is based on identified hazards for the product, heat or other preservation treatments, packaging method and other hurdles or inhibiting factors that may be used.

Shellfish

Those species of aquatic molluscs and crustaceans that are commonly used for food.

Step

A point, procedure, operation or stage in the food chain including raw materials from primary production to final consumption.

Validation

Obtaining evidence that the elements of the HACCP plan are effective.

Verification

The application of methods, procedures, tests and other evaluations, in addition to monitoring to determine compliance with a HACCP plan. For the purposes of this Code, this also applies to DAPs.

Whole fish (or round fish)

Fish as captured, ungutted.

2.2 Aquaculture

Aquaculture

The farming, during part or the whole of their life cycle, of any aquatic animals, except mammalian species, aquatic reptiles and amphibians, intended for human consumption, but excluding species covered in Section 7 of this Code. These aquatic animals are hereafter referred to as “fish” for ease of reference in Section 2.2 and Section 6.

Aquaculture establishment

Any premises for the production of fish intended for human consumption, including the supporting inner infrastructure and surroundings under the control of the same management.

Chemicals

Any substance, either natural or synthetic, that can affect live fish, their pathogens, the water, the equipment used for production or the land within the aquaculture establishment.

Colouring

Obtaining a specifically coloured feature (e.g. flesh, shell or gonad) of a targeted organism by incorporating into the fish food a natural or artificial substance or additive approved for this purpose by the competent authority with jurisdiction.

Diseased fish

A fish on or in which pathological changes or other abnormalities that affect safety and quality are apparent.

Extensive farming

Raising fish under conditions of little or incomplete control over the growing process and production conditions where their growth depends on endogenously supplied nutrient inputs.

Feed additives

Chemicals other than nutrients for fish that are approved for addition to their feed.

Fish farm

An aquaculture production unit (either land- or water-based), usually consisting of holding facilities (tanks, ponds, raceways, cages), plant (buildings, storage, processing), service equipment and stock.

Fish feed

Fodder intended for fish in aquaculture establishments, in any form and of any composition.

Good aquaculture (or good fish farming) practices

Those practices of the aquaculture sector necessary to produce quality and safe food products conforming to food laws and regulations.

Harvesting

Operations involving taking the fish from the water.

Intensive farming

Raising fish under controlled growing process and production conditions where their growth is completely dependent on externally supplied fish feed.

Official agency having jurisdiction

The official authority or authorities charged by the government with the control of food hygiene (sometimes referred to as the competent authority) as well as/or with sanitation in aquaculture.

Pesticide

Any substance intended for preventing, destroying, attracting, repelling or controlling any pest, including unwanted species of plants or animals, during the production, storage, transportation, distribution and processing of food, agricultural commodities or animal feeds or which may be administered to animals for the control of ectoparasites. The term normally excludes fertilizers, plant and animal nutrients, food additives and veterinary drugs.

Pesticide residue

Any specified substance in food, agricultural commodities or animal feed resulting from the use of a pesticide. The term includes any derivatives of a pesticide, such as conversion products, metabolites and reaction products, and impurities considered to be of toxicological significance.

Residues

Any foreign substance, including their metabolites, that remain in fish prior to harvesting as a result of either application or accidental exposure.

Semi-intensive farming

Raising fish under conditions of partial control over the growing process and production conditions where their growth is dependent upon endogenously supplied nutrient inputs and externally supplied fish feed.

Stocking density

The amount of fish stocked per unit of area or volume.

Veterinary drug

Any substance applied or administered to any food-producing animal, such as meat- or milk-producing animals, poultry, fish or bees, whether used for therapeutic, prophylactic or diagnostic purposes or for modification of physiological functions or behaviour.

Withdrawal time

The period of time necessary between the last administration of a veterinary drug to fish, or exposure of these animals to a veterinary drug, and harvesting to ensure that the concentration of the veterinary drug in their edible flesh intended for human consumption complies with the maximum permitted residue limits.

2.3

Live and raw bivalve molluscs

Accepted/acceptable/approved

Accepted by the official agency having jurisdiction.

Conditioning

Placing live bivalve molluscs in tanks, floats or natural sites to remove sand, mud or slime and improve product acceptability.

Distribution centre

Any approved onshore or offshore installation or establishment for the reception, conditioning, washing, cleaning, grading and packaging of live bivalve molluscs fit for human consumption from which the bivalve molluscs are dispatched alive.

Growing areas

All brackish and marine areas approved for the production or harvesting of bivalve molluscs either by natural growth or by aquaculture destined for human consumption. The growing areas may be approved as production or harvesting areas for bivalve molluscs for direct consumption, or they may be approved as production or harvesting areas for bivalve molluscs for either depuration or relaying.

Heat shocking

The process of subjecting bivalve molluscs in the shell to any form of heat treatment, such as steam, hot water or dry heat, for a short period to facilitate rapid removal of meat from the shell for the purpose of shucking.

Depuration

The reduction of microorganisms to a level acceptable for direct consumption by the process of holding live bivalve molluscs for a period of time under approved, controlled conditions in natural or artificial seawater suitable for the process, which may be treated or untreated.

Depuration centre

Any approved establishment for the depuration of live bivalve molluscs.

Relaying

The removal of bivalve molluscs from a microbiologically contaminated growing area to an acceptable growing or holding area under the supervision of the agency having jurisdiction and holding them there for the time necessary for the reduction of contamination to an acceptable level for human consumption.

2.4

Fresh and quick frozen raw scallop products

Roe-on scallop meat

Fresh or quick frozen “roe-on scallop meat” are prepared by completely removing the adductor muscle and attached roe from the shell and detaching all other viscera to the extent practical. The roe should remain attached to the adductor muscle. “Roe-on scallop meat” contain no added water, phosphates or other ingredients. The adductor muscle and roe are presented whole.

Scallop meat

Fresh or quick frozen “scallop meat” is prepared by completely removing the adductor muscle from the shell and completely detaching the viscera and roe from the adductor muscle of live scallops. Scallop meat contains no added water, phosphates or other ingredients. The adductor muscle is presented whole.

Quick frozen scallop meat or quick frozen roe-on scallop meat with added water and/or a solution of water and phosphate

Quick frozen scallop meat, or quick frozen roe-on scallop meat, with added water and/or solutions of water and phosphates contain the products defined in 2.1.1 and 2.1.2 of the *Standard for Fresh and Quick Frozen Raw Scallop Products* (CXS 315-2014), and a solution of water and/or phosphates and optionally salt.

Scallop products

Refers to all the scallop products identified above.

Shucking

The process of removing the scallop meat or roe-on scallop meat from the shell.

Roe

The scallop gonad(s) containing the ovary and/or testis.

Viscera

All of the internal organs excluding the roe.

2.5

Fresh, frozen and minced fish

Candling

Passing fillets of fish over a translucent table illuminated from below to detect parasites and other defects.

Dehydration

The loss of moisture from frozen products through evaporation. This may occur if the products are not properly glazed, packaged or stored. Deep dehydration adversely affects the appearance and surface texture of the product and is commonly known as “freezer burn”.

Fillet

A slice of fish of irregular size and shape removed from the carcass by cuts made parallel to the backbone.

Freezer

Equipment designed for freezing fish and other food products, by quickly lowering the temperature so that after thermal stabilization the temperature in the thermal centre of the product is the same as the storage temperature.

Freezing process

A process carried out in appropriate equipment in such a way that the range of temperature of maximum crystallization is passed quickly. The quick freezing process shall not be regarded as complete unless and until the product temperature has reached $-18\text{ }^{\circ}\text{C}$ ($0\text{ }^{\circ}\text{F}$) or below at the thermal centre after thermal stabilization.

Frozen storage facility

A facility capable of maintaining the temperature of fish at -18 °C.

Fresh fish Fish or fishery products that have received no preserving treatment other than chilling.

Frozen fish

Fish that have been subjected to a freezing process sufficient to reduce the temperature of the whole product to a level low enough to preserve the inherent quality of the fish and that have been maintained at this low temperature as specified in the Standard for Quick Frozen Finfish, Uneviscerated and Eviscerated (CXS 36-1981) during transportation, storage and distribution up to and including the time of final sale. For the purposes of this Code, the terms “frozen”, “deep frozen”, “quick frozen”, unless otherwise stated, shall be regarded as synonymous.

Glazing

The application of a protective layer of ice formed at the surface of a frozen product by spraying it with, or dipping it into, clean seawater, potable water or potable water with approved additives, as appropriate.

Minced fish

Comminuted flesh produced by separation from skin and bones.

Modified atmosphere packaging (MAP)

Packaging in which the atmosphere surrounding the fish is different from the normal composition of air.

Separation

A mechanical process for producing minced fish whereby the skin and bone are substantially removed from the flesh.

Separator

A mechanical device used for separation.

Steak

A section of fish removed by cutting approximately at right angles to the backbone.

2.6

Frozen surimi

Dewatering

Removal of excess wash water from the minced fish flesh.

Frozen surimi

The fish protein product for further processing that has been processed by heading, gutting and cleaning fresh fish, and mechanically separating the edible muscle from the skin and bone. The minced fish muscle is then washed, refined, dewatered, mixed with cryoprotective food ingredients and frozen.

Gel-forming ability

The ability of surimi to form an elastic gel when fish meat is comminuted with the addition of salt and then formed and heated. This elasticity is a function possessed by myosin as the primary component of myofibrillar protein.

Myofibrillar protein

A generic term for skeletal muscle proteins such as myosin and actin.

Refining

A process of removing from washed meat – by the use of a strainer – small bones, sinews, scales and bloody flesh of such sizes as may not be mixed in a final product, thereby concentrating myofibrillar protein.

Surimi-based products

A variety of products produced from surimi with addition of ingredients and flavour such as “surimi gel” and shellfish analogues.

Water-soluble components

Any water-soluble proteins, organic substances and inorganic salts contained in fish meat.

Washing

A process of washing away blood and water-soluble components from minced fish with cold water by the use of a rotary filter, thus increasing the concentration of myofibrillar proteins thereof.

Washed meat

Fish meat that is washed and then drained of water.

2.7
**Quick-frozen
coated fish
products**

Batter

Liquid preparation from ground cereals, spices, salt, sugar and other ingredients and/or additives for coating. Typical batter types are: non-leavened batter and leavened batter.

Breading

Dry breadcrumbs or other dry preparations mainly from cereals with colourants and other ingredients used for the final coating of fishery products. Typical breading types are: free-flowing breading, coarse breading and flour-type breading.

Coating

Covering the surface of a fishery product with batter and/or breading.

Pre-frying

Frying of breaded and battered fishery products in an oil bath in such a way that the core remains frozen.

Sawing

Cutting (by hand or fully mechanized) of regular shapes of fish blocks into pieces suitable for later coating.

2.8 Salted and dried salted fish

Barrel

A cylindrical container made of wood or plastic or other suitable food contact material with a lid for watertight closure.

Black membrane

Parietal peritoneum, the pigmented lining of the abdominal cavity.

Brine

Solution of salt in water.

Brine injection

The process of injecting brine directly into the fish flesh.

Brining

The process of placing fish in brine for a period of sufficient length for the fish tissue to absorb a specific quantity of salt.

Dry-salting

The process of mixing fish with suitable food-grade salt and stacking the fish in such a manner that the resulting brine drains away.

Dun

Discoloration and development of the mould *Sporendonema epizoum*, which affects the fish surface and makes it look peppered. The fish flesh is unaffected.

Fatty fish

Fish in which the main reserves of fat are in the body tissue and the fat content is more than two percent.

Gibbing

The process of removing the gills, long gut and stomach from fatty fish, such as herring, by inserting a knife or using hands at the gills; the milt or roe and some of the pyloric caeca are left in the fish.

Lean fish (white fish)

Fish in which the main reserves of fat are in the liver and less than two percent fat in the body tissue.

Maturing

The process from salting until the fish is salt-matured.

Nobbing

Removing the head and gut from fatty fish, such as herring, in one operation by partially severing the head and pulling the head away together with the attached gut; the roe or milt is left in.

Pickle

Brine that may contain vinegar and spices.

Pickling

The process whereby primary fatty fish is mixed with suitable salt (which may contain vinegar and spices) and stored in watertight containers under the resultant pickle that forms by solution of salt in the water extracted from the

fish tissue. Pickle may be added to the container. Pickled products will always remain in a brine solution.

Pink

Discoloration caused by red halophilic bacteria that damages the fish flesh.

Salt

A crystalline product consisting predominantly of sodium chloride. It is obtained from the sea, from underground rock salt deposits or from vacuum processed and refined brine.

Salt-matured fish

Salted fish that has an appearance, consistency and flavour characteristic of the final product.

Salted fish/salted fillet

Fish/fillets that have been treated by brining, brine injection, dry-salting, pickling or wet-salting, or a combination thereof.

Saturated

The water phase of the fish muscle is saturated with salt (26.4 g salt/100 g water phase).

Split fish

Fish that have been cut open from throat or nape to the tail, with gills, guts, roe or milt removed. Head and whole or part of backbone may be left in or removed.

Stacking (restacking)

Laying fish in piles with salt spread evenly on the surface.

Wet-salting

The process whereby primary lean fish is mixed with suitable food-grade salt and stored in watertight containers under the resultant brine that forms by solution of salt in the water extracted from the fish tissue. Brine may be added to the container. The fish can be removed from the container and stacked so that the brine drains away.

2.9

**Smoked fish,
smoked-
flavoured fish
and smoke-
dried fish**

Smoking

The process of treating fish by exposing it to smoke from smouldering wood or plant materials. This process is usually characterized by an integrated combination of salting, drying, heating and smoking steps in a smoking chamber.

Smoking by regenerated smoke

The process of treating fish by exposing it to smoke that is regenerated by atomizing smoke condensate in a smoking chamber under the time and temperature conditions similar to those for hot or cold smoking.

Smoke drying

The process whereby fish is treated by combined smoking and drying steps to such an extent that the final product can be stored and transported without refrigeration and to achieve a water activity of 0.75 or less (10 percent of moisture or less), as necessary to control bacterial pathogen or fungal spoilage.

Drying

The process in which the moisture content in the fish is decreased to appropriate required characteristics under controlled hygienic conditions.

Hot smoking

The process in which fish is smoked at an appropriate combination of temperature and time sufficient to cause the complete coagulation of the proteins in the fish flesh. Hot smoking is generally sufficient to kill parasites, to destroy non-sporulated bacterial pathogens and to injure spores of human health concern.

Cold smoking

The process of treating fish with smoke using a time/temperature combination that will not cause significant coagulation of the proteins in the fish flesh but that will cause some reduction of the water activity.

Smoke condensates

Products obtained by controlled thermal degradation of wood in a limited supply of oxygen (pyrolysis), subsequent condensation of the resultant smoke vapours and fractionation of the resulting liquid products.

Smoke flavours

Smoke condensates or artificial flavour blends prepared by mixing chemically defined substances in known amounts or any combination of both (smoke preparations).

Smoke flavouring

A process in which fish or fish preparations are treated with smoke flavour. The smoke flavour can be applied by any technology (e.g. dipping, spraying, injecting, soaking).

Salting

The process of treating fish with salt of food-grade quality to lower water activity in fish flesh and to enhance flavour by any appropriate salting technology (e.g. dry salting, brining, injection salting).

Packaging of smoked fish or smoke-flavoured fish

The process in which smoked fish or smoke-flavoured fish is put in a container, either aerobically or under reduced oxygen conditions, including under vacuum or in a modified atmosphere.

Packaging of smoke-dried fish

The process in which smoke-dried fish is put in a container to avoid contamination and prevent dehydration.

Storage

The process in which products covered by this Code are kept under conditions to assure their safety and quality in conformity with Sections 3 and 6 of the *Standard for Smoked Fish, Smoke-Flavoured Fish and Smoke-Dried Fish*.

2.10

Lobsters and Crabs

Lobsters

Autolysis

The breakdown or deterioration of lobster meat or viscera by means of indigenous enzymes.

Black spot

The appearance of dark pigments at the joints and injured parts of lobster segments, caused by oxidative enzyme reaction.

Butt end of the tail

That part of the tail muscle of the lobster which extends into the cephalothorax.

Cephalothorax

The body region of the lobster formed anatomically by the fusion of head and thorax.

Claw

The pincer appendage at the end of the lobster arm.

Cooking

Boiling of lobsters in potable water, clean seawater or brine or heating in steam for a period of time sufficient for the thermal centre to reach a temperature adequate to coagulate the protein.

Deterioration

Those natural processes of quality reduction that occur after harvesting independent of deliberate human intervention.

Devein

To remove the intestine/vein from the lobster tail.

Enzymatic activity

The catalytic action of enzymes on biochemical reactions.

Insensible

The state of unresponsiveness as a result of pacifying through thermal, electrical or physical process imposed on lobsters prior to cooking.

Intestine/Vein

The posterior portion of the lobster alimentary tract.

Lobster

Commercially important species in the order Decapoda, and families Nephropidae, Palinuridae or Scyllaridae or other economically important taxonomic families.

Pasteurization

Subjecting lobster meat to heat at times and temperatures that inactivate spoilage and pathogenic microorganisms of public health concern without noticeable changes in appearance, texture or flavour of the product.

Pounding

The holding of live lobsters in water tanks or floating crates for extended periods of time.

Shell

The hard outer covering of lobsters.

Shucking

The process of removing the meat from the shell and appendages of the lobsters.

Tail

The abdomen or posterior part of the body.

Tailing

The process of separating the tail from the cephalothorax.

Trimming

The process of removing any signs of blood, membrane or remnants of the gut that may be attached to the shell or meat of lobsters.

Waste

Those lobster parts remaining after the meat removal operation is completed.

Crabs**Batch systems**

Processing methods whereby crabs are processed as bulk units.

Butchering

The process of removing crab back shell, viscera and gills. In some fisheries, it may also include the removal of walking legs and claws. Butchering may take place either before or after cooking.

Brown meat

The edible parts of the crab, excluding the claw, leg and shoulder meat, which may include the liver and gonads or parts thereof.

Claw

The pincer appendage at the end of the crab.

Cooking

Boiling of crabs in potable water, clean seawater or brine or heating in steam for a period of time sufficient for the thermal centre to reach a temperature adequate to coagulate the protein.

Crab

The commercially important species of the Decapoda order in the Brachyura and Anomura sections.

Deterioration

Those natural processes of quality reduction that occur after harvesting independent of deliberate human intervention.

Enzymatic activity

The catalytic action of enzymes on biochemical reactions.

Insensible

The state of unresponsiveness resulting from the pacifying of a crab through a thermal, electrical or physical process imposed on crabs prior to cooking.

Leg tips

The third leg segments counting from the crab shell.

Pasteurization

Subjecting crab meat to heat at times and temperatures that inactivate spoilage and pathogenic microorganisms of public health concern without noticeable changes in appearance, texture and flavour of the product.

Picking

The process of removing meat from the crab shell by machine or by hand.

Pounding

The holding of live crabs in water tanks or floating crates for extended periods of time.

Sections

The cleaned, eviscerated and de-gilled crab parts usually consisting of one half of the crab body and the attached walking legs and claw.

Shaking

The industrial practice of manual meat extraction used for king, snow and Dungeness crabs Cancer magister. The cooked sections are processed by hitting or shaking the meat out of the shell.

Shell

The hard outer covering of crabs.

Shoulder

The section containing meat in the body of the crab.

Shucking

The process of removing the meat from the shell.

Trimming

The process of removing any signs of blood, membrane or remnants of the gut which may be attached to the shell.

Waste

Those crab parts remaining after the meat removal operation is completed.

2.11 Shrimps and prawns

Dehead

To remove the head from the whole shrimp or prawn.

Deveined shrimps

Shrimps that have been peeled, the back of the peeled segment opened out and the gut (“vein”) removed.

Fresh shrimps

Freshly caught shrimps that have received no preserving treatment or have been preserved only by chilling. It does not include freshly cooked shrimps.

Peeled shrimps

Shrimps with heads and all shell removed.

Raw headless shrimps

Raw shrimps with heads removed and the shell on.

Shrimp

The term shrimp (which includes the frequently used term “prawn”) refers to the species covered by the most recent edition of the *FAO listing of shrimps, FAO Species Catalogue, Volume 1, Shrimps and prawns of the world, an annotated catalogue of species of interest to fisheries*, FAO Fisheries Synopsis No. 125.

2.12 Cephalopods

Splitting

The process of cutting cephalopods along the mantle to produce a single fillet.

2.13 Canned fish and shellfish

For the purposes of this Code, only the definitions of the main terms related to the canning industry and used in Section 17 are given. For further definitions, please refer to the *Code of Hygienic Practice for Low and Acidified Low Acid Canned Foods* (CXC 23-1979).

Canned food

Commercially sterile food in hermetically sealed containers.

Commercial sterility of thermally processed food

The condition achieved by applying heat sufficient, alone or in combination with other appropriate treatments, to render the food free from microorganisms capable of growing in the food under normal non-refrigerated conditions in which the food is likely to be held during distribution and storage.

Hermetically sealed containers

Containers sealed to protect their contents against the entry of microorganisms during and after heat treatment.

Retort

A pressure vessel designed for thermal processing of food packed in hermetically sealed containers.

Scheduled process (or sterilization schedule)

The thermal process chosen by the processor for a given product and container size to achieve at least commercial sterility.

Sterilization temperature

The temperature maintained throughout the thermal process as specified in the scheduled process.

Sterilization time

The time between the moment sterilization temperature is achieved and the moment cooling starts.

Thermal process

The heat treatment to achieve commercial sterility, quantified in terms of time and temperature.

Venting

Thorough removal of the air from steam retorts by steam prior to a scheduled process.

2.14

Fish sauce

Fish sauce

A translucent, not turbid liquid product with a salty taste and fish flavour obtained from fermentation of a mixture of fish and salt.

2.15

Sturgeon caviar

Fish egg

Non-ovulated eggs separated from the connective tissue of ovaries. Ovulated eggs may be used from aquacultured sturgeons.

Caviar

The product made from fish eggs of the Acipenseridae family by treating with food grade salt.

2.16 Transportation

2.17 Retail

Retail

An operation that stores, prepares, packages, serves or otherwise provides fish, shellfish and their products directly to the consumer for preparation by the consumer for human consumption. This may be free-standing seafood markets, seafood sections in grocery or department stores, packaged, chilled or frozen and/or full service.

Packaged

Packaged in advance and displayed chilled or frozen for direct consumer pick-up.

Full-service display

A display of chilled fish, shellfish and their products to be weighed and wrapped by establishment personnel at the request of the consumer.





3

Prerequisite programme



Prior to the application of Hazard Analysis and Critical Control Point (HACCP)³ to any segment of the product-processing chain, that segment must be supported by prerequisite programmes based on good hygienic practice or as required by the competent authority.

The establishment of prerequisite programmes will allow the HACCP team to focus on the HACCP application to food safety hazards that are directly applicable to the product and the process selected, without undue consideration and repetition of hazards from the surrounding environment. The prerequisite programmes would be specific to the individual establishment or vessel and would require monitoring and evaluation to ensure their continued effectiveness.

For further information to assist with the design of the prerequisite programmes for a processing facility or vessel, reference should be made to the *General Principles of Food Hygiene* (CXC 1-1969), Annex: Hazard Analysis and Critical Control Point (HACCP) system and guidelines for its application.

It should be noted that some of the issues listed below, such as those related to damage, are designed to maintain quality rather than food safety and are thus not always essential to a prerequisite programme for a food safety-oriented HACCP system.

HACCP principles can also be applied to defect action points.

3.1 Fishing and harvesting vessel design and construction

Many different types of fishing vessels are used throughout the world. They have evolved in particular regions to take account of the prevailing economics, environment and the types of fish and shellfish caught or harvested. This Section highlights the basic requirements for facilitating cleaning and minimizing damage, contamination and decomposition to which all vessels should have regard to the extent possible in order to ensure hygienic, high-quality handling of fresh fish and shellfish intended for further processing and freezing.

The design and construction of a fishing vessel and vessels used to harvest farmed fish and shellfish should take into consideration the following:

3.1.1

For ease of cleaning and disinfection

- Vessels should be designed and constructed to minimize sharp inside corners and projections so as to avoid dirt traps.
- Construction should facilitate ample drainage.
- A good supply of clean water or potable water⁴ at adequate pressure.

³ Refer to Annex II for a comprehensive list of the acronyms used in this Code.

⁴ WHO Guidelines for Drinking-water Quality, Geneva, Switzerland.

3.1.2

To minimize contamination

- All surfaces in handling areas should be non-toxic, smooth, impervious and in sound condition in order to minimize the build-up of fish slime, blood, scales and guts and to reduce the risk of physical and microbial contamination.
- Where appropriate, adequate facilities should be provided for the handling and washing of fish and shellfish and should have an adequate supply of cold potable water or clean water for that purpose.
- Adequate facilities should be provided for washing and disinfecting equipment, where appropriate.
- The intake for clean water should be so located as to avoid contamination.
- All plumbing and waste lines should be capable of coping with peak demand.
- Non-potable water lines should be clearly identified and separated from potable water to avoid contamination.
- Objectionable substances, which could include bilge water, smoke, fuel oil, grease, drainage and other solid or semi-solid wastes, should not contaminate the fish and shellfish.
- Where appropriate, containers for offal and waste material should be clearly identified, suitably constructed with a fitted lid and made of impervious material.
- Separate and adequate facilities should be provided to prevent the contamination of fish and shellfish and dry materials, such as packaging, by:
 - poisonous or harmful substances;
 - dry storage of materials, packaging, etc.; and
 - offal and waste materials.
- Adequate hand washing and toilet facilities, isolated from the fish and shellfish handling areas, should be available where appropriate.
- Prevent the entry of birds, insects or other pests, animals and vermin, where appropriate.

3.1.3

To minimize damage to the fish, shellfish and other aquatic invertebrates

- In handling areas, surfaces should have a minimum of sharp corners and projections.
- In boxing and shelving storage areas, the design should preclude excessive pressure being exerted on the fish and shellfish.
- Chutes and conveyors should be designed to prevent physical damage caused by long drops or crushing.
- Fishing gear and its usage should minimize damage to and deterioration of fish and shellfish.

3.1.4 **To minimize damage during harvesting of aquacultured and molluscan shellfish**

- When aquacultured products and molluscan shellfish are harvested using seines, nets or other means and transported live to facilities:
- Seines, nets and traps should be carefully selected to ensure minimum damage during harvesting.
- Harvesting areas and all equipment for harvesting, catching, sorting, grading, conveying and transporting of live products should be designed for their rapid and efficient handling without causing mechanical damage. These should be easy to clean and free from contamination.
- Conveying equipment for live and slaughtered products should be constructed of suitable corrosion-resistant material that does not transmit toxic substances and should not cause mechanical injuries to them.
- Where fish are transported live, care should be taken to avoid overcrowding and to minimize bruising.
- Where fish are held or transported live, care should be taken to maintain factors that affect fish health (e.g. CO₂, O₂, temperature and nitrogenous wastes).

3.2 **Facility** **design and** **construction**

Facilities should include a product flow-through pattern designed to prevent potential sources of contamination, minimize process delays (which could result in further reduction in essential quality) and prevent cross-contamination of finished product from raw materials. Fish, shellfish and other aquatic invertebrates are highly perishable foods and should be handled carefully and chilled without undue delay. Facilities should therefore be designed to facilitate rapid processing and subsequent storage.

The design and construction of a facility should take into consideration the following:

3.2.1 **For ease of cleaning and disinfection**

- The surfaces of walls, partitions and floors should be made of impervious, non-toxic materials.
- All surfaces with which fish, shellfish and their products might come into contact should be made of corrosion-resistant, impervious material that is light in colour, smooth and easy to clean.
- Walls and partitions should have a smooth surface up to a height appropriate to the operation.
- Floors should be constructed to allow adequate drainage.
- Ceilings and overhead fixtures should be constructed and finished to minimize the build-up of dirt and condensation, and the shedding of particles.
- Windows should be constructed to minimize the build-up of dirt and, where necessary, fitted with removable and cleanable insect-proof screens. Where necessary, windows should be fixed.
- Doors should have smooth, non-absorbent surfaces.
- Joints between floors and walls should be constructed for ease of cleaning (round joints).

3.2.2

To minimize contamination

- Facility layout should be designed to minimize cross-contamination and may be accomplished by physical or time separation.
- All surfaces in handling areas should be non-toxic, smooth, impervious and in sound condition in order to minimize the build-up of fish slime, blood, scales and guts and to reduce the risk of physical contamination.
- Working surfaces that come into direct contact with fish, shellfish and their products should be in sound condition, durable and easy to maintain. They should be made of smooth, non-absorbent and non-toxic materials, and inert to fish, shellfish and their products, detergents and disinfectants under normal operating conditions.
- Adequate facilities should be provided for the handling and washing of products and should have an adequate supply of cold potable water for that purpose.
- Suitable and adequate facilities should be provided for the storage and/or production of ice.
- Ceiling lights should be covered or otherwise suitably protected to prevent contamination by glass or other materials.
- Ventilation should be sufficient to remove excess steam, smoke and objectionable odours, and cross-contamination through aerosols should be avoided.
- Adequate facilities should be provided for washing and disinfecting equipment, where appropriate.
- Non-potable water lines should be clearly identified and separated from potable water to avoid contamination.
- All plumbing and waste lines should be able to cope with peak demand.
- Accumulation of solid, semi-solid or liquid wastes should be minimized to prevent contamination.
- Where appropriate, containers for offal and waste material should be clearly identified, suitably constructed with a fitted lid and made of impervious material.
- Separate and adequate facilities should be provided in order to prevent contamination by:
 - poisonous or harmful substances;
 - dry storage of materials, packaging, etc.; and
 - offal and waste materials.
- Adequate hand washing and toilet facilities, isolated from the handling area, should be available.
- Birds, insects or other pests and animals should be prevented entry.
- Water supply lines should be fitted with back-flow devices, where appropriate.

3.2.3

To provide adequate lighting

- Adequate lighting should be provided on all work surfaces.

3.3 Design and construction of equipment and utensils

The equipment and utensils used for the handling of fishery products on a vessel or in a facility will vary greatly depending on the nature and type of operation involved. During use, they are constantly in contact with fish, shellfish and their products. The condition of the equipment and utensils should be such that it minimizes the build-up of residues and prevents them becoming a source of contamination.

The design and construction of equipment and utensils should take into consideration the following:

3.3.1

For ease of cleaning and disinfection

- Equipment should be durable and movable and/or capable of being disassembled to allow for maintenance, cleaning, disinfection and monitoring.
- Equipment, containers and utensils coming into contact with fish, shellfish and their products should be designed to provide for adequate drainage and constructed to ensure that they can be adequately cleaned, disinfected and maintained to avoid contamination.
- Equipment and utensils should be so designed and constructed as to minimize sharp inside corners, projections and tiny crevices or gaps so as to avoid dirt traps.
- A suitable and adequate supply of cleaning utensils and cleaning agents, approved by the competent authority with pertinent jurisdiction, should be provided.

3.3.2

To minimize contamination

- All surfaces of equipment in handling areas should be non-toxic, smooth, impervious and in sound condition to minimize the build-up of fish slime, blood, scales and guts and to reduce the risk of physical contamination.
- Accumulation of solid, semi-solid or liquid wastes should be minimized to prevent contamination of fish.
- Adequate drainage should be provided in storage containers and equipment.
- Drainage should not be permitted to contaminate products.

3.3.3

To minimize damage

- Sharp corners and projections on surfaces should be minimized.
- Chutes and conveyors should be designed to prevent physical damage caused by long drops or crushing.
- Storage equipment should be fit for purpose and not lead to crushing of the product.

3.4 Hygiene control programme

The potential effects of harvesting and handling of products, on-board vessel handling or in-plant production activities on the safety and suitability of fish, shellfish and their products should be considered at all times. In particular, this includes all points where contamination may exist and taking specific measures to ensure the production of a safe and wholesome product. The type of control and supervision necessary will depend on the size of the operation and the nature of its activities.

Schedules should be implemented to:

- prevent the build-up of waste and debris;
- protect fish, shellfish and their products from contamination;
- dispose of any rejected material in a hygienic manner;
- monitor personal hygiene and health standards;
- monitor the pest control programme;
- monitor cleaning and disinfecting programmes; and
- monitor the quality and safety of water and ice supplies.

The hygiene control programme should take into consideration the following:

3.4.1

A permanent cleaning and disinfection schedule

A permanent cleaning and disinfection schedule should be drawn up to ensure that all parts of the vessel, processing facility and equipment therein are cleaned appropriately and regularly. The schedule should be reassessed whenever changes occur to the vessel, processing facility and/or equipment. Part of this schedule should include a “clean as you go” policy.

A typical cleaning and disinfecting process may involve as many as seven separate steps:

Pre-cleaning Preparation of area and equipment for cleaning. Involves steps such as removal of all fish, shellfish and their products from area, protection of sensitive components and packaging materials from water, removal by hand or squeegee of fish scraps, etc.

Pre-rinse A rinsing with water to remove remaining large pieces of loose soil.

Cleaning The removal of soil, food residues, dirt, grease or other objectionable matter.

Rinse A rinsing with potable water or clean water, as appropriate, to remove all soil and detergent residues.

Disinfection Application of chemicals, approved by the official agency having jurisdiction, and/or heat to destroy most microorganisms on a surface.

Post-rinse A final rinse with potable water or clean water to remove all disinfectant residues, as appropriate.

Storage Cleaned and disinfected equipment, container and utensils should be stored in such a way as to prevent their contamination.

Check of the efficiency of the cleaning The efficiency of the cleaning should be controlled as appropriate.

Handlers or cleaning personnel, as appropriate, should be well trained in the use of special cleaning tools and chemicals, methods of dismantling equipment for cleaning and they should be knowledgeable in terms of the significance of contamination and the hazards involved.

3.4.2 **Designation of personnel for cleaning**

- In each processing plant or vessel, a trained individual should be designated as responsible for the sanitation of the processing facility or vessel and the equipment therein.

3.4.3 **Maintenance of premises, equipment and utensils**

- Buildings, materials, utensils and all equipment in the establishment – including drainage systems – should be maintained in a good state and order.
- Equipment, utensils and other physical facilities of the plant or vessel should be kept clean and in good repair.
- Procedures for the maintenance, repair, adjustment and calibration, as appropriate, of apparatus should be established. For each item of equipment, these procedures should specify the methods used, the persons in charge of their application, and their frequency.

3.4.4 **Pest control systems**

- Good hygienic practices should be employed to avoid creating an environment conducive to pests.
- Pest control programmes could include preventing access, eliminating harbourage and infestations, and establishing monitoring detection and eradication systems.
- Physical, chemical and biological agents should be properly applied by appropriately qualified personnel.

3.4.5 **Supply of water, ice and steam**

3.4.5.1 **Water**

When an establishment has its own supply of fresh water or seawater or other water sources, and chlorine is used for the treatment of water that may come in direct contact with fish and fishery products, the residual content of chlorine should not exceed that of potable water. The use of higher concentrations of chlorine in water treatment in the primary production-to-consumption food chain is subject to approval by the competent authority, where appropriate.

3.4.5.2 **Ice**

- Ice should be produced using potable water⁵ or clean water.
- Ice should be protected from contamination.

3.4.5.3 **Steam**

- For operations that require steam, an adequate supply at sufficient pressure should be maintained.
- Steam used in direct contact with fish or shellfish or food contact surfaces should not constitute a threat to the safety or suitability of the food.

3.4.6 **Waste management**

- Offal and other waste materials should be removed from the premises of a processing facility or vessel on a regular basis.
- Facilities for the containment of offal and waste material should be properly maintained.
- Vessel waste discharge should not contaminate vessel water intake systems or incoming product.

3.5 **Personal hygiene and health**

3.5.1 **Facilities and equipment**

Facilities and equipment should include:

- Adequate means to hygienically wash and dry hands.
- Adequate toilet and changing facilities for personnel should be suitably located and designated.

3.5.2 **Personnel hygiene**

- No person who is known to be suffering from, or who is a carrier of, any communicable disease or has an infected wound or open lesion should be engaged in preparation, handling or transportation.
- Where necessary, adequate and appropriate protective clothing, head coverings and footwear should be worn.
- All persons working in a facility should maintain a high degree of personal cleanliness and should take all necessary precautions to prevent contamination.
- Hand washing should be carried out by all personnel working in a processing area:
 - at the start of fish or shellfish handling activities and upon re-entering a processing area; and
 - immediately after using the toilet.

⁵ Attention must be paid to the possible formation of potentially toxic compounds such as chloramines when adding chlorine to seawater.

- The following should not be permitted in handling and processing areas:
 - smoking;
 - spitting;
 - chewing or eating;
 - sneezing or coughing over unprotected food; and
 - the adornment of personal effects, such as jewellery, watches or pins, or other items that, if dislodged, might pose a threat to the safety and suitability of the products.

3.6 Transportation

Vehicles should be designed and constructed:

- such that walls, floors and ceilings, where appropriate, are made of a suitable corrosion-resistant material with smooth, non-absorbent surfaces. Floors should be adequately drained;
- where appropriate with chilling equipment to maintain chilled fish or shellfish during transportation to a temperature as close as possible to 0 °C or, for frozen fish, shellfish and their products, to maintain a temperature of -18 °C or below (except for brine frozen fish intended for canning, which may be transported at -9 °C or colder);
- so that live fish and shellfish are transported at temperatures tolerable for the species;
- to provide the fish or shellfish with protection against contamination, exposure to extreme temperatures and the drying effects of the sun or wind; and
- to permit the free flow of chilled air around the load when fitted with mechanical refrigeration means.

3.7 Product tracing and recall procedures

Experience has demonstrated that a system for recalling a product is a necessary component of a prerequisite programme because no process is fail-safe. Product tracing, which includes lot identification, is essential to an effective recall procedure.

- Managers should ensure effective procedures are in place to undertake the complete product tracing and rapid recall of any lot of fishery product from the market.
- Appropriate records of processing, production and distribution should be kept and retained for a period that exceeds the shelf-life of the product.
- All containers of fish, shellfish or products thereof intended for end consumers or for further processing should be clearly marked to allow for the identification of the producer and of the lot.
- Where there is a health hazard, products produced under similar conditions and likely to present a similar hazard to public health may be withdrawn. The need for public warnings should be considered.
- Recalled products should be held under supervision until they are destroyed, used for purposes other than human consumption or reprocessed in a manner to ensure their safety.

3.8 Training

Fish or shellfish hygiene training is of fundamental importance. All personnel should be aware of their role and responsibility in protecting fish or shellfish from contamination and deterioration. Handlers should have the necessary knowledge and skill to enable them to handle fish or shellfish hygienically. Those who handle strong cleaning chemicals or other potentially hazardous chemicals should be instructed in safe handling techniques.

All fish and shellfish facilities should ensure that individuals have received adequate and appropriate training in the design and proper application of HACCP systems and process controls. Training personnel in the use of HACCP is fundamental to the successful implementation and delivery of the programme in fish or shellfish processing establishments. The practical application of such systems will be enhanced when the individual responsible for HACCP has successfully completed a course. Managers should also arrange for adequate and periodic training for relevant employees in the facility so as to ensure they understand the principles involved in HACCP.





A close-up photograph of a fish's body, showing the scales and fins. The scales are a mix of light blue and white, with some darker spots. The fins are a reddish-brown color. A large, white, outlined number '4' is overlaid on the upper left portion of the image.

4

**General
considerations
for the handling
of fresh fish,
shellfish and
other aquatic
invertebrates**

Unless they can be reduced to an acceptable level by normal sorting and/or processing, no fish, shellfish or other aquatic invertebrates should be accepted if they are known to contain parasites, undesirable microorganisms, pesticides, veterinary drugs or toxic, decomposed or extraneous substances known to be harmful to human health. When fish and shellfish determined as unfit for human consumption are found, they should be removed and stored separately from the catch and either reworked or disposed of in a proper manner. All fish and shellfish deemed fit for human consumption should be handled properly, with particular attention to time and temperature control.

4.1 Time and temperature control

Temperature is the single most important factor affecting the rate of fish and shellfish deterioration and multiplication of microorganisms. For species prone to scombrototoxin production, time and temperature control is the most effective method for ensuring food safety. It is therefore essential that fresh fish, fillets, shellfish and their products that are chilled, be chilled rapidly and held at a temperature as close as possible to 0 °C. Refer to Section 10 for further information on control of scombrototoxin.

4.1.1

Minimize deterioration – time

To minimize deterioration, it is important that:

- Chilling should commence as soon as possible.
- Fresh fish, shellfish and other aquatic invertebrates should be kept chilled, processed and distributed with care and minimum delay.

4.1.2

Minimize deterioration – temperature control

Where temperature control is concerned:

- Sufficient and adequate icing or chilled or refrigerated water systems where appropriate, should be employed to ensure that fish, shellfish and other aquatic invertebrates are kept chilled at a temperature as close as possible to 0 °C.
- Fish, shellfish and other aquatic invertebrates should be stored in shallow layers and surrounded by finely divided melting ice.
- Live fish and shellfish are to be transported at temperatures tolerable for species.
- Chilled or refrigerated water systems and/or cold storage systems should be designed and maintained to provide adequate cooling and/or freezing capacities during peak loads.
- Fish should not be stored in refrigerated water systems to a density that impairs its working efficiency.
- The time, temperature and homogeneity of chilling should be monitored and controlled regularly.

4.2 Minimize deterioration – handling

Poor handling practices can lead to damage of fresh fish, shellfish and other aquatic invertebrates that can accelerate the rate of decomposition and increase unnecessary post-harvest losses. To minimize handling damage:

- Fish and shellfish should be handled and conveyed with care, particularly during transfer and sorting, to avoid physical damage such as puncture and mutilation.
- Where fish and shellfish are held or transported live, care should be taken to maintain factors that can influence fish health (e.g. CO₂, O₂, temperature and nitrogenous wastes).
- Fish and shellfish should not be trampled or stood upon.
- Where boxes are used for storage of fish and shellfish, they should not be overfilled or stacked too deep.
- While fish and shellfish are on deck, exposure to the adverse effects of the elements should be kept to a minimum to prevent unnecessary dehydration.
- Finely divided ice should be used where possible as it can help minimize damage to fish and shellfish and maximize cooling capacity.
- In refrigerated water storage areas, the density of the fish should be controlled to prevent damage.





A large fish, possibly a salmon, is lying on a wet, speckled floor. The floor is dark with many small, light-colored spots. The fish is positioned diagonally across the bottom of the frame, with its head towards the left and its tail towards the right. The background is a textured, wet surface that looks like a concrete or stone floor.

5

Hazard Analysis and Critical Control Point (HACCP) and Defect Action Point (DAP) Analysis

Hazard Analysis and Critical Control Point (HACCP)⁶ is a science-based system that aims to prevent food safety problems from occurring rather than having to react to non-compliance of the finished product. The HACCP system accomplishes this by identifying specific hazards and implementing control measures. An effective HACCP system should reduce the reliance on traditional end-product testing. Section 5 explains the principles of HACCP as it applies to aquaculture and molluscan shellfish production and to handling and processing. However, the present Code can only provide guidance on how to use these principles and offer suggestions as to the type of hazards that may occur in a variety of fishery products. The HACCP plan, which should be incorporated into the food management plan, should be well documented and as simple as possible. This Section demonstrates one format that may be considered in the development of an HACCP plan.

Section 5 also explains how a similar approach involving many of the principles can apply to the broader application covering the essential quality, composition and labelling provisions of Codex standards or other non-safety requirements, which in this case are referred to as defect action point (DAP) analysis. This approach to defect analysis is optional; other techniques that achieve the same objective may be considered.

Figure 5.1 summarizes how to develop an HACCP and defect analysis system.

5.1 HACCP principles

The HACCP system⁷ consists of seven principles:

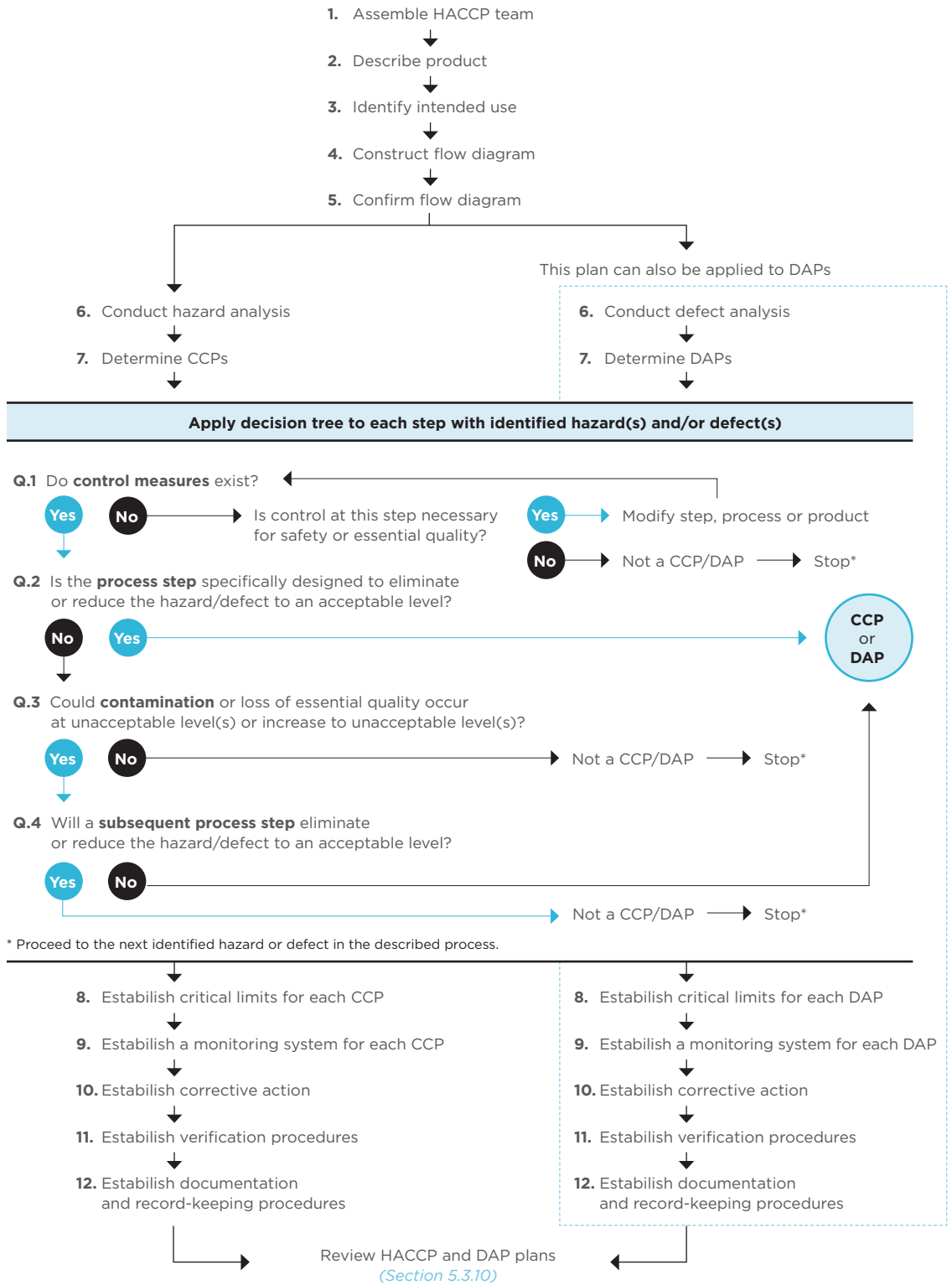
- Principle 1** Conduct a hazard analysis.
- Principle 2** Determine the critical control points (CCPs).
- Principle 3** Establish critical limits.
- Principle 4** Establish a system to monitor control of the CCPs.
- Principle 5** Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control.
- Principle 6** Establish procedures for verification to confirm that the HACCP system is working effectively.
- Principle 7** Establish documentation concerning all procedures and records appropriate to these principles and their application.

These principles have to be followed in any consideration of HACCP.

⁶ Refer to Annex II for a comprehensive list of the acronyms used in this Code.

⁷ General principles of food hygiene (CXC 1-1969), Annex: Hazard Analysis and Critical Control Point (HACCP) system and guidelines for its application.

Figure 5.1 Summary of how to implement an HACCP and defect analysis system



HACCP is an important management tool that can be used by operators for ensuring safe, efficient processing. It must also be recognized that personnel training is essential in order for HACCP to be effective. In following HACCP principles, users are requested to list all of the hazards that may reasonably be expected to occur for each product type at each step or procedure in the process, from point of harvest through to unloading, transportation, storage or processing, as appropriate to the process defined. It is important that HACCP principles be considered on a specific basis to reflect the risks of the operation.

5.2 Defect action point analysis

The Code is intended not only to cover hazards associated with safety, but also to include other aspects of production, including the essential product quality, composition and labelling provisions as described in product standards developed by the Codex Alimentarius Commission. The Code therefore not only describes critical control points (CCPs) but also includes defect action points (DAPs). The HACCP principles may be applied to determine a DAP, with quality instead of safety parameters being considered at the various steps.

5.3 Application

Each aquaculture, molluscan shellfish, shellfish and fish facility should ensure that the provisions of the appropriate Codex standards are met. To accomplish this, each facility should implement a food safety management system based on HACCP principles and should at least consider a similar approach for defects, both of which are described in the present Code. Prior to the application of HACCP to any segment of the growing, handling and processing chain, that segment must be supported by a prerequisite programme based on good hygienic practice (see Section 3). It should be noted that parts of the prerequisite programme may be classified as a CCP or DAP within a particular process.

The food management system developed should indicate the responsibility, authority and interrelationships of all personnel who manage, perform and verify work affecting the performance of such systems. It is important that the collection, collation and evaluation of scientific and technical data be carried out by a multidisciplinary team. Ideally, a team should comprise individuals with the appropriate level of expertise together with those having a detailed knowledge of the process and product under review. Examples of the type of personnel to include on the team are the processing facility manager, a microbiologist, a quality assurance/quality control specialist, and others such as buyers and operators, as necessary. For small-scale operations, it may not be possible to establish such a team; in such cases, external advice should be sought.

The scope of the HACCP plan should be identified and should describe which segments of the food chain are involved and the general classes of hazards to be addressed.

The design of this programme should identify CCPs in the operation where the processing facility or product will be controlled, the specification or standard to be met, the monitoring frequency and sampling plan used at the

CCP, the monitoring system used to record the results of these inspections and any corrective action when required. A record for each CCP that demonstrates that the monitoring procedures and corrective actions are being followed should be provided. The records should be maintained as verification and evidence of the quality assurance programme of the plant. Similar records and procedures may be applied to DAPs with the necessary degree of record-keeping. A method to identify, describe and locate the records associated with HACCP programmes should be established as part of the HACCP programme.

Verification activities include the application of methods, procedures (review/audit) and tests in addition to those used in monitoring to determine:

- the effectiveness of the HACCP or DAP plan in delivering expected outcomes i.e. validation;
- compliance with the HACCP or DAP plan, e.g. audit/review; and
- whether the HACCP or DAP plan or its method of application needs modification or revalidation.

The implementation of HACCP principles is better identified in the logical sequence for implementation of HACCP (Figure 5.1).

5.3.1

Describe product

In order to gain a greater understanding and knowledge of the product under review, a thorough product description evaluation should be carried out. This exercise will facilitate the identification of potential hazards or defects. An example of the type of information used in describing a product is given in Table 5.1.

Table 5.1 A product description for canned tuna in salted water

	Objective	Example
Product name(s)	Identify the species and method of processing.	Canned tuna in salted water
Source of raw material	Describe the origin of the fish.	Yellowfin tuna caught by purse seine in the Gulf of Guinea Whole brine frozen
Important final product characteristics	List characteristics that affect product safety and essential quality, especially those that influence microbial flora.	Compliance with Codex Standard for canned tuna and bonito; “low-acid” food; can-seal integrity
Ingredients	List every substance added during processing. Only ingredients approved by the official agency having jurisdiction may be used.	Water, salt
Packaging	List all packaging materials. Only materials approved by the official agency having jurisdiction may be used.	Container in coated chromium steel, capacity: 212 ml; total net weight: 185 g; fish weight: 150 g Traditional opening
How the end product is to be used	State how the final product is to be prepared for serving, especially whether it is ready to eat.	Ready to eat
Shelf-life (if applicable)	State the date when the product can be expected to begin to deteriorate if stored according to instructions.	3 years
Where the product will be sold	Indicate the intended market. This information will facilitate compliance with target market regulations and standards.	Domestic retail market
Special labelling instructions	List all instructions for safe storage and preparation.	“Best before the date shown on label”
Special distribution control	List all instructions for safe product distribution.	None

5.3.2 **Flow diagram**

For hazard and defect analysis, it is necessary to examine carefully both the product and the process, and to produce a flow diagram or diagrams. Flow diagrams should be as simple as possible. Each step in the process, including process delays, from the selection of raw materials through to the processing, distribution, sale and customer handling, should be clearly outlined in sequence with sufficient technical data to avoid ambiguity. If a process is too complex to be easily represented by a single flow diagram, then it can be subdivided into constituent parts, provided the relationship between each of the parts is clearly defined. It is helpful to number and label each processing step for ease of reference. An accurate and properly constructed flow diagram will provide the multidisciplinary team with a clear vision of the process sequence. Once CCPs and DAPs have been identified they can be incorporated into the flow diagram specific to each processing facility. Figure 5.2 represents an example of a flow diagram for a canned tuna fish processing line. For examples of different processes, see Figures 9.1-12.1 in the individual processing sections of the Code.

5.3.3 **Conduct hazard and defect analysis**

The purposes of hazard analysis are to identify all such food safety hazards at each step, to determine their significance and to assess whether control measures for those hazards are available at each step. Defect analysis serves the same purpose for potential quality defects.

5.3.3.1 **Identification of hazards and defects**

It cannot be overstressed that, where practical and feasible, each individual facility should gather sound scientific and technical data relevant to the businesses for each step, from primary production, processing, manufacture, storage and distribution until the point of consumption. The assembly and nature of this information should be such to ensure that the multidisciplinary team is able to identify and list, at each step of the process, all of the hazards that may reasonably be likely to occur and defects that, in the absence of control measure(s), may likely result in the production of unacceptable food. Potential hazards that have been known to be associated with fresh fish and shellfish are described in Annex 1. Table 5.2 summarizes possible pre-harvest and harvest safety hazards in incoming fish and shellfish, and Table 5.3 summarizes possible safety hazards introduced in the post-harvest and further processing of fish and shellfish.

It is important to identify potential hazards and defects in the operation from the point of view of plant construction, equipment used in the plant and hygienic practices, including those that may be associated with the use of ice and water. This is covered by the prerequisite programme and is used to denote hazards that are common to almost any point in the process.

For the example on canned tuna developed in this Section, Table 5.4 lists the essential potential hazards and Table 5.5 lists the potential defects.

Figure 5.2 Example flow chart for a canned tuna fish in brine-processing line.

This flow chart is for illustrative purpose only. For in-factory HACCP implementation, a complete and comprehensive flow chart has to be drawn up for each process.

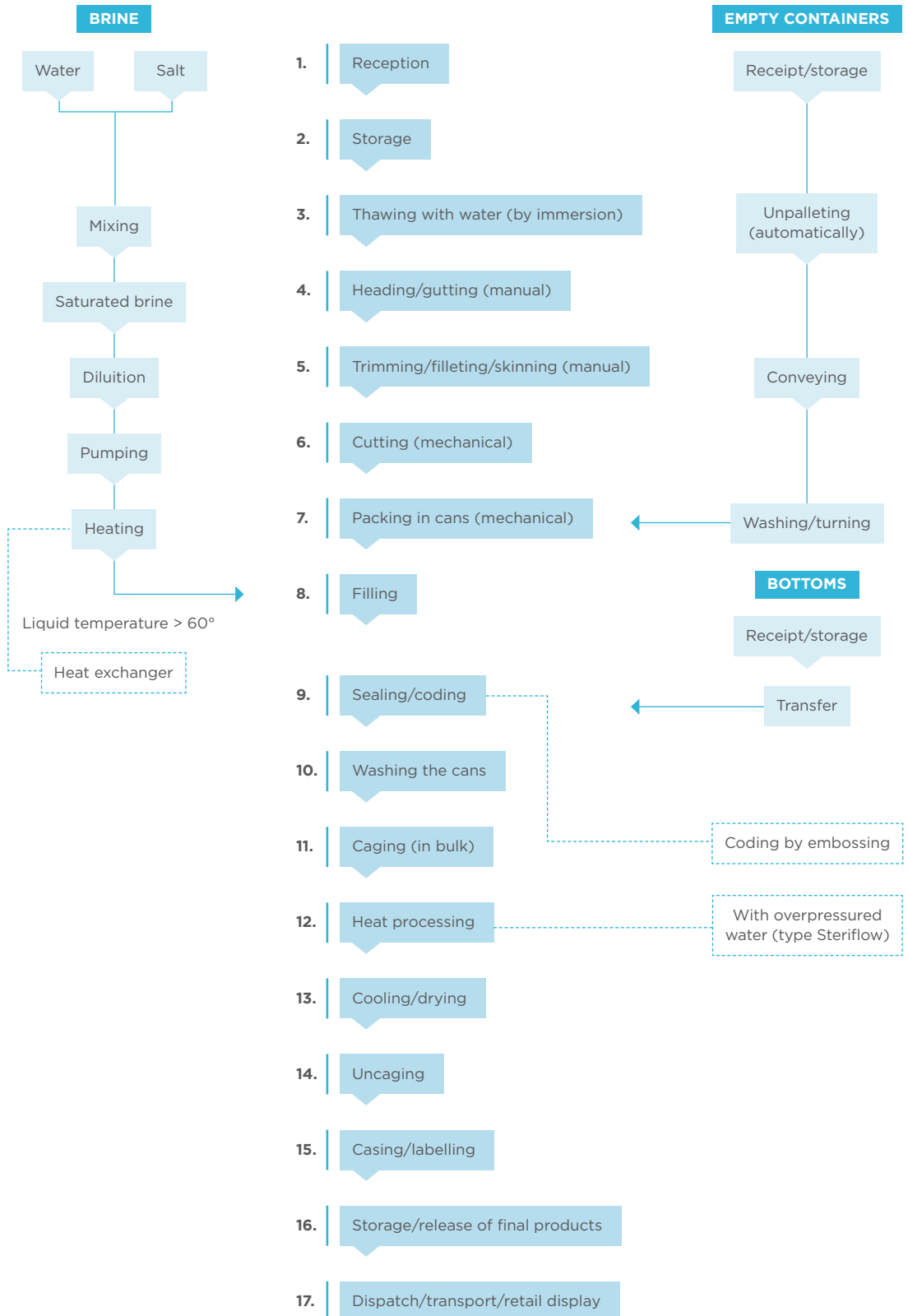


Table 5.2 Examples of pre-harvest and harvest hazards in incoming fish and shellfish

Biological		Chemical		Physical	
Parasites	Parasites of public health significance: trematodes, nematodes, cestodes	Chemicals	Pesticides, herbicides, algicides, fungicides, anti-oxidants (added in feeds)	Foreign matter	Fish hooks
Pathogenic bacteria	<i>Salmonella</i> , <i>Shigella</i> , <i>E. coli</i> , <i>Vibrio cholerae</i> , <i>Vibrio parahaemolyticus</i> , <i>Vibrio vulnificus</i>	Veterinary drug residues	Antibiotics, growth promoters (hormones), other veterinary drugs and feed additives		
Enteric viruses	Norovirus	Heavy metals	Metals leached from marine sediments and soil, from industrial wastes, from sewage or animal manures		
Biotoxins	Biotoxins, scombrototoxin	Miscellaneous	Petroleum		

Table 5.3 Examples of hazards introduced in the post-harvest and further processing of fish and shellfish*

Biological		Chemical		Physical	
Pathogenic bacteria	<i>Listeria monocytogenes</i> , <i>Clostridium botulinum</i> , <i>Staphylococcus aureus</i>	Chemicals	Disinfectants, sanitizers or lubricants (misapplication and non-approved)	Foreign matter	Metal fragments; hard or sharp objects
Enteric viruses	Hepatitis A, rotavirus	Ingredients and additives	Misapplication and non-approved		
Biotoxins	Scombrototoxin, staph. enterotoxin, botulinum toxin				

* For hazards relating to specific products, see the relevant processing section.

Note: For biological hazards, environmental factors (e.g. temperature, oxygen availability, pH and A_w) play a major role in their activity and growth. Therefore, the type of processing the fish or shellfish will undergo, and their subsequent storage, will determine their risk to human health and inclusion in a food safety management plan. In addition, some hazards may show a certain degree of overlap between the two levels of operation through their existence and manifestation into the water supply.

Table 5.4 An example of potential hazards for canned tuna

In raw materials (frozen tuna)		During processing, storage or transportation
Biological	Presence of <i>C. botulinum</i> , presence of scombrototoxin	Contamination by <i>C. botulinum</i> , growth of <i>C. botulinum</i> , survival of spores of <i>C. botulinum</i> , contamination and growth of <i>Staphylococcus aureus</i> Microbial recontamination after heat processing Production of scombrototoxin during processing Production of staphylootoxin
Chemical	Presence of heavy metals	Recontamination by metals coming from the cans Recontamination by cleaning agents, by the brine, by mechanical grease, etc.
Physical	Presence of foreign material	Recontamination during processing (pieces of knives, by the cans, etc.)

Table 5.5 An example of potential defects of canned tuna

In raw materials (frozen tuna)		During processing, storage or transportation
Biological	Decomposition	Decomposition, survival of microorganisms responsible for decomposition, etc.
Chemical		Oxidation during storage, etc.
Physical		Objectionable matter (viscera, scales, skin, etc.), formation of struvite crystals, container defects (panelled container, etc.)
Others	Species substitution	Abnormal flavours, incorrect weight, incorrect coding, incorrect labelling

5.3.3.1.1 Hazards

It is equally important to consider naturally occurring food safety hazards in the environment from which fish or shellfish are harvested. In general, risks to consumer health from seafood captured in unpolluted marine environments are low, provided that these products are handled in line with principles of good manufacturing practice (GMP). However, as with all foods, there are some health risks associated with the consumption of certain products, which may be increased when the catch is mishandled during and after harvest (e.g. scombrototoxin). Fish from some marine environments, such as tropical reef fish, can pose a consumer risk from natural marine toxins, such as ciguatera. The risk of adverse health effects from certain hazards might be increased under certain circumstances in products from aquaculture when compared with fish and crustacean from the marine environment. The risks of foodborne disease associated with products from aquaculture are related to inland and coastal ecosystems, where the potential for environmental con-

tamination is greater when compared with capture fisheries. In some parts of the world where fish or shellfish are consumed either raw or partially cooked there is an increased risk of foodborne parasitic or bacterial disease. In order to perform a hazard analysis as part of the process of developing an HACCP plan, processors must have scientific information on potential hazards associated with raw material and products for further processing.

5.3.3.1.2 **Defects**

Potential defects are outlined in the essential quality, labelling and composition requirements described in the Codex standards. Where no Codex standard exists, reference should be made to national regulations and/or commercial specifications.

5.3.3.2 **Significance of hazards and defects**

One of the most important activities that must be performed in a processing facility as part of the food safety management system is to determine if an identified hazard or defect is significant. The two primary factors that determine whether a hazard or defect is significant for HACCP purposes are probability of occurrence of an adverse health effect and the severity of the effect. A hazard that has a high severity of effect, such as death from *Clostridium botulinum* toxin, may impose a socially unacceptable risk at very low probability of occurrence and thus warrant the application of HACCP controls (i.e. be a significant hazard for HACCP purposes). Thus, in the processed canned tuna, *C. botulinum* should be considered a significant hazard to be controlled through the application of a validated thermal process schedule. On the other hand, a hazard with a relatively low severity, such as mild gastro-enteritis, might not warrant the HACCP controls at the same very low probability of occurrence, and thus not be significant for HACCP purposes.

Information gathered during the product description exercise (refer to Section 5.3.1) could also help facilitate the determination of significance as the likelihood of occurrence of hazard or defect can be affected by factors such as how the consumer will probably use the product (e.g. to be consumed cooked or raw), the types of likely consumer (e.g. immuno-compromised, elderly or children) and the method of storage and distribution (e.g. refrigerated or frozen).

Once significant hazard and defects have been identified, consideration needs to be given to assessing their potential to be introduced or controlled at each step of the process. The use of a flow diagram (refer to Section 5.3.2) is beneficial for this purpose. Control measures must be considered for significant hazard(s) or defect(s) associated with each step with the aim of eliminating possible occurrence or of reducing it to an acceptable level. A hazard or defect may be controlled by more than one control measure. For illustrative purposes, Tables 5.6 and 5.7 demonstrate an approach to listing significant hazards and defects and the related control measures for the processing step “heat processing”.

Table 5.6 An example of the significant hazard survival of *C. botulinum* at the step of heat processing for canned tuna

Processing Step	Potential hazard	Is the potential hazard significant?	Justification	Control measures
12. Heat processing	<i>C. botulinum</i> viable spores	Yes	An insufficient heat processing may result in the survival of <i>C. botulinum</i> spores and, therefore, the possibility of toxin production. A product must be commercially sterile.	Ensure adequate heat applied for proper time at retort.

Table 5.7 An example of the significant defect rancidity during the storage of frozen tuna for canned tuna

Processing Step	Potential defect	Is the potential defect significant?	Justification	Control measures
2. Storage of frozen tuna	Persistent and distinct objectionable odours or flavours indicative of rancidity.	Yes	Product does not meet quality or customer requirements.	Controlled temperature in the storage premises. Stock management procedure. Maintenance procedure of the refrigeration system. Personnel training and qualification.

5.3.4 Determine critical control points and defect action points

A thorough and concise determination of CCPs and DAPs in a process is important in ensuring food safety and compliance with elements related to essential quality, composition and the labelling provisions of the appropriate Codex standard. The Codex decision tree (Figure 5.1, Step 7) is a tool that can be applied to the determination of CCPs and a similar approach may be used for DAPs. Using this decision tree, a significant hazard or defect at a step can be assessed through a logical sequence of questions. At a step where CCPs and DAPs have been identified, that point in the process must be controlled to prevent, reduce or eliminate the likely occurrence of the hazard or defect to an acceptable level. For illustrative purposes, examples of the application of the Codex decision tree to a hazard and defect using the canned tuna fish processing line are shown in Tables 5.8 and 5.9, respectively.

Table 5.8 A schematic example of a hazard analysis with corresponding control measures and the application of the Codex decision tree for the determination of a critical control point at Processing Step 12 of the example process as set out in Figure 5.2

Processing Step No. 12 Heat processing		Application of Codex decision tree			
Potential hazards	Control measures				
<i>C. botulinum</i> viable spores	Ensure adequate heat applied for proper time at retort.	<p>Q1: Do control measures exist?</p> <p>If yes Go to Q2.</p> <p>If no Consider whether control measures are available or necessary within the process.</p> <p>Proceed to next identified hazard.</p>	<p>Q2: Is the step specifically designed to eliminate or reduce the likely occurrence of <i>C. botulinum</i> to an acceptable level?</p> <p>If yes This step is a CCP.</p> <p>If no Go to Q3.</p>	<p>Q3: Could contamination occur in excess of acceptable levels or could this increase to unacceptable levels?</p> <p>If yes Go to Q4.</p> <p>If no Not a CCP.</p>	<p>Q4: Will a subsequent step eliminate or reduce the hazard to an acceptable level?</p> <p>If yes Not a CCP.</p> <p>If no <i>What about consideration of a previous step?</i></p>
		<p>A: Yes, a heat processing procedure (schedule, method) is clearly defined.</p>	<p>A: Yes, this step was specifically designed to eliminate spores.</p>		
<p>Decision: Processing Step No. 12 <i>Heat processing</i> is a critical control point.</p>					

Table 5.9 A schematic example of a defect analysis with corresponding control measures and the application of the Codex decision tree for the determination of a defect action point at Processing Step 2 of the example process as set out in Figure 5.2

Processing Step No. 2 Storage of frozen tuna		Application of Codex decision tree			
Potential hazards	Control measures				
Persistent and distinct objectionable odours or flavours indicative of rancidity	Controlled temperature in storage premises Stock management procedure	<p>Q1: Do control measures exist?</p> <p>If yes Go to Q2.</p> <p>If no Consider whether control measures are available or necessary within the process.</p> <p>Proceed to next identified hazard.</p>	<p>Q2: Is the step specifically designed to eliminate or reduce the likely occurrence of rancidity to an acceptable level?</p> <p>If yes This step is a DAP.</p> <p>If no Go to Q3.</p>	<p>Q3: Could rancidity occur in excess of acceptable levels or could it increase to unacceptable levels?</p> <p>If yes Go to Q4.</p> <p>If no Not a DAP.</p>	<p>Q4: Will a subsequent step eliminate rancidity or reduce its likely occurrence to acceptable level?</p> <p>If yes Not a DAP.</p> <p>If no DAP. <i>What about consideration of a previous step?</i></p>
		A: Yes, the storage temperature is controlled and procedures exist.	A: No.	A: Yes, if the storage time is too long and/or the storage temperature is too high.	A: No.
<p>Decision: Processing Step No. 2 <i>Storage of frozen tuna</i> is a defect control point.</p>					

5.3.5 Establish critical limits

For each CCP and DAP, critical limits for the control of the hazard or defect must be specified. For any given hazard or defect, it may be necessary to have more than one critical limit designated for each control measure. The establishment of critical limits should be based on scientific evidence and validated by appropriate technical experts to ensure their effectiveness in controlling the hazard or defect to the determined level. Table 5.10 illustrates critical limits for a CCP and a DAP using a canned tuna fish processing line as an example.

5.3.6 Establish monitoring procedures

Any monitoring system developed by the multidisciplinary team should be designed to detect loss of control at a CCP or DAP relative to its critical limit. The monitoring activity of a CCP or DAP should be documented concisely, including details regarding the individual responsible for the observation or measurement, the methodology used, the parameter(s) being monitored and the frequency of the inspections. The complexity of the monitoring procedure should also be carefully considered. Considerations include optimizing the number of individuals performing the measurement and selection of appropriate methods that will produce rapid results (e.g. time, temperature and pH). For CCPs, records of monitoring should be acknowledged and dated by a person responsible for verification.

Since each process is unique for each product, it is possible only to present, for illustrative purposes, an example of a monitoring approach for a CCP and DAP using the canned tuna fish processing line. This example is shown in Table 5.10.

Table 5.10 An example of the results of the application of HACCP principles to the two specific steps in the canned tuna process (Tables 5.8 and 5.9) for a CCP and a DAP, respectively

CCP Processing Step No. 12: Heat processing Hazard: <i>Clostridium botulinum</i> viable spores				
Critical limit	Monitoring procedure	Corrective action	Records	Verification
Those specific parameters associated with heat processing	<p>Who: Qualified person assigned to heat processing</p> <p>What: All parameters</p> <p>How: Checks of sterilization schedule and other factors</p> <p>Frequency: Every batch</p>	<p>Who: Qualified personnel</p> <p>What: Personnel retraining</p> <p>New heat processing or batch destruction</p> <p>Corrective maintenance of equipment</p> <p>Hold product until safety can be evaluated</p> <p>Who: Appropriate trained personnel</p>	Monitoring records, corrective action records, product evaluation records, calibration records, validation records, audit records, HACCP plan review record	Validation, finished product evaluation, internal audit, review of records, calibration of machinery (may be a prerequisite), review of HACCP plan, external audit

(...)

(...)

DAP				
Processing Step No. 2: Storage of frozen tuna				
Defect: Persistent and distinct objectionable odours or flavours indicative of rancidity				
Critical limit	Monitoring procedure	Corrective action	Records	Verification
Number of rancid sample units cannot exceed acceptance number of established sampling plan	Who: Appropriately trained personnel	Who: Appropriately trained personnel	Analysis results	On-site audit
	What: Fish quality and acceptability based on Codex product standard	What: Application of an intensified monitoring	Stock forms Temperature records	Review of monitoring and corrective action reports
Storage temperature and time	How: Organoleptic examination chemical tests	According to the results of this intensified inspection, immediate processing, sorting or rejection of frozen tuna exceeding the critical limits		
	Checking of the storage premise temperature			
	Checking of stock forms			
	Frequency: As required	Adjust storage temperature Personnel retraining		

5.3.7 Establish corrective action

An effective HACCP or DAP plan is anticipatory by nature and it is recognized that corrective action may be necessary from time to time. A documented corrective action programme should be established to deal with instances where the critical limit has been exceeded and loss of control has occurred at a CCP or DAP. The goal of this plan is to ensure that comprehensive and specific controls are in place and can be implemented to prevent the affected lot(s) from reaching the consumer. For example, fish and shellfish should be held and rejected if they are known to contain harmful substances and/or defects that would not be eliminated or reduced to an acceptable level by normal procedures of sorting or preparation. Of equal importance is an assessment by plant management and other appropriate personnel to determine the underlying reason(s) why control was lost. For the latter, a modification to HACCP and DAP plans may be necessary. A record of investigation results and actions taken should be documented by a responsible person for each instance where loss of control occurred at a CCP or DAP. The record should demonstrate that control of the process has been re-established, that appropriate product disposition has occurred and that preventative action has been initiated. An example of a corrective action approach for a CCP and DAP using a canned tuna fish processing line is illustrated in Table 5.10.

5.3.8 **Establish verification procedures**

A processing facility should establish a verification procedure, carried out by qualified individuals, to periodically assess if the HACCP and DAP plans are adequate, implemented and working properly. This step will help determine whether CCPs and DAPs are under control. Examples of verification activities include validation of all components of the HACCP plan (including a paper review of the HACCP system, its procedures and records), review of corrective actions and product disposition actions when critical limits are not met, and validation of established critical limits. The latter is particularly important when an unexplained system failure has occurred, when a significant change to the process, product or packaging is planned or when new hazards or defects have been identified. Observation, measurement and inspection activities within the processing facility should also be incorporated into the verification procedure, where applicable. Verification activities should be carried out by qualified competent individuals. The verification frequency of the HACCP and DAP plans should be sufficient to provide assurance that their design and implementation will prevent food safety problems as well as issues associated with essential quality, composition and labelling provisions of the appropriate Codex standard to allow for problems to be detected and dealt with in a timely manner. For illustrative purposes, an example of a verification procedure approach for a CCP and DAP using the canned tuna fish processing line is shown in Table 5.10.

5.3.9 **Establish documentation and record-keeping procedures**

Documentation may include hazard analysis, CCP determination, critical limit determination and procedures for monitoring, corrective action and verification.

A current, accurate and concise record-keeping system will greatly enhance the effectiveness of an HACCP programme and facilitate the verification process. Examples of the elements of an HACCP plan that should be documented have been provided in this Section for illustrative purposes. Inspection and corrective action records should be practical and collect all the appropriate data necessary to demonstrate real-time control or deviation control of a CCP. Records are recommended but not required for a DAP except where a loss of control occurred. For illustration purposes, an example of a record-keeping approach for a CCP and DAP using the canned tuna fish processing line is shown in Table 5.10.

5.3.10 **Review of HACCP and DAP plans**

Upon completion of all the steps for the development of HACCP and DAP plans as outlined in Figure 5.1, a full review of all components should be conducted. The purpose of these reviews is to verify that the plans can meet their objectives.

5.4 Conclusion

Section 5 has demonstrated the principles of HACCP and how they should be applied to a process to ensure product safety. The same principles can be used to determine the points in a process where it is necessary to control defects. As every facility and processing line is different, it is possible within this Code only to demonstrate the types of potential hazards and defects that must be considered. Furthermore, because of the nature of the significance of hazards and defects, it is not possible to determine categorically which steps in a process will be CCPs and/or DAPs without actually assessing the process, the objectives of the process, its environment and expected outcomes. The example of the canned tuna processing line is intended to illustrate how to apply the principles, given the outcome of a commercially sterile product, and why an HACCP and DAP plan will be unique to each operation.

The remaining sections in the Code concentrate on aquaculture and molluscan shellfish production and on the handling and processing of fish, shellfish and their products, attempting to illustrate the potential hazards and defects at the various stages in a wide range of processes. In developing an HACCP or DAP plan, it will be necessary to consult Sections 3 and 5 before turning to the appropriate processing section for specific advice. It should also be noted that Section 9 refers to the processing of fresh, frozen and minced fish and will provide useful guidance for most of the other processing operations.



An aerial photograph of a large-scale aquaculture farm. The water is a clear, light blue. Numerous circular pens, constructed from metal frames and green mesh, are arranged in a grid-like pattern across the water. Some pens are covered with white tarps. Small red buoys are visible around the pens. The overall scene depicts a well-organized and extensive marine farming operation.

6

Aquaculture production

Aquaculture establishments should operate responsibly, in compliance with the recommendations of the *Code of Conduct for Responsible Fisheries* (FAO, Rome, 1995), so as to minimize any adverse impact on human health and the environment, including any potential ecological changes.

Fish farms should operate effective fish health management practices, to maintain fish free of disease to the extent possible. Fish should be routinely monitored for disease using, where applicable, the methods described in the World Organization for Animal Health (OIE)⁸ *Manual of Diagnostic Tests for Aquatic Animals*. When using chemicals at fish farms, special care should be exercised so that these substances are not released into the surrounding environment.

While the fish health, environmental and ecological aspects are important considerations in aquaculture activities, this Section focuses on food safety and quality aspects.

This Section of the Code applies to industrialized and commercial aquaculture producing all aquatic animals except mammalian species, aquatic reptiles and amphibians for direct human consumption, but excluding bivalve molluscs covered in Section 7 of the Code, hereafter referred to as “fish that are intended for direct human consumption”. Such intensive or semi-intensive aquaculture systems use higher stocking densities, use stock from hatcheries, use mainly formulated feeds and may utilize medication and vaccines. This Code is not intended to cover extensive fish farming systems that prevail in many developing countries or integrated livestock and fish culture systems. This section of the Code covers the feeding, growing, harvesting and transportation stages of aquaculture production. Further handling and processing of fish are covered elsewhere in the Code.

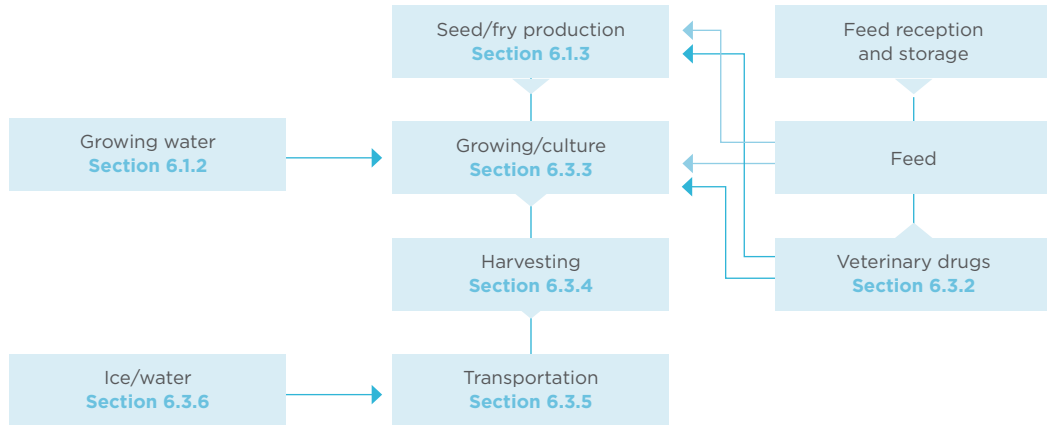
In the context of recognizing controls at individual processing steps, this section provides examples of potential hazards and defects and describes technological guidelines that can be used to develop control measures and corrective action. At a particular step, only the hazards and defects that are likely to be introduced or controlled at that step are listed. It should be recognized that in preparing a Hazard Analysis Critical Control Point (HACCP) and/or defect action point (DAP) plan, it is essential to consult Section 5, which provides guidance for the application of the principles of HACCP and DAP analysis. However, within the scope of this Code, it is not possible to give details of critical limits, monitoring, record-keeping and verification for each of the steps as these are specific to particular hazards and defects.

The example flow chart in Figure 6.1 provides guidance on some of the common steps in aquaculture production.

8 Refer to Annex II for a comprehensive list of the acronyms used in this Code.

Figure 6.1 Example flow chart for aquaculture production

This flow chart is for illustrative purpose only. For implementation of HACCP principles, a complete and comprehensive flow chart has to be drawn up for each product. References correspond to relevant sections of the Code.



6.1 General

The general principles in Section 3 apply to aquaculture production in addition to the following:

6.1.1

Site selection

- The setting, design and construction of fish farms should follow principles of good aquaculture practice, appropriate to species.
- The physical environment with regard to temperature, current, salinity and depth should also be considered as different species have different environmental requirements. Closed recirculation systems should be able to adapt the physical environment to the environmental requirements of the farmed fish species.
- Fish farms should be located in areas where the risk of contamination by chemical, physical or microbiological hazards is minimal and where sources of pollution can be controlled.
- Soil for the construction of earthen ponds should not contain such concentrations of chemicals and other substances as may lead to the presence of unacceptable levels of contamination in fish.
- Ponds should have separated inlets and discharge canals so that water supplies and effluent are not mixed.
- Adequate facilities for the treatment of effluent should be provided to allow sufficient time for sediments and organic load settlement before used water is discharged into the public water body.
- Water inlets and outlets to ponds should be screened to prevent the entrance of unwanted species.

- Fertilizers, liming materials or other chemicals and biological materials should be used in accordance with good aquaculture practice.
- All sites should be operated so as not to cause adverse impacts on human health from the consumption of the farmed fish.

6.1.2 **Growing water quality**

- The water in which fish are raised should be suitable for the production of products that are safe for human consumption.
- The water quality should be monitored regularly so that the health and sanitation of the fish is continuously maintained to ensure aquaculture products are safe for human consumption.
- Fish farms should not be sited where there is a risk of contamination of the water in which fish are reared.
- Appropriate design and construction of fish farms should be adopted to ensure control of hazards and prevention of water contamination.

6.1.3 **Source of fry and fingerlings**

- The source of post-larvae, fry and fingerlings should be such to avoid the carryover of potential hazards into the growing stocks.

6.2 **Identification** **of hazards** **and defects**

Consumption of fish and fishery products can be associated with a variety of human health hazards. The same hazards are generally present in aquaculture products as in corresponding varieties caught in the wild (Section 5.3.3.1). The risk of harm from a particular hazard might be increased, under some circumstances, in aquaculture products compared with fish caught in the wild – for example if the withdrawal time for residues of veterinary drugs has not been observed. High stocking densities, compared with the natural situation, might increase the risk of cross-infection of pathogens within a population of fish and might lead to deterioration in water quality. On the other hand, farmed fish can also present a lower risk of harm. In systems where the fish receive formulated feeds, the risks associated with transmission of hazards through the food consumed by the fish could be reduced. For example, infection with nematode parasites is absent from, or very much reduced in, farmed salmon compared with salmon caught in the wild. Raising fish in cages in the marine environment poses few hazards and low risks. In closed recirculation systems, hazards are even further reduced. In such systems, the water is constantly refreshed and reused and water quality is controlled within safe measures.

6.2.1 **Hazards**

Aquaculture products present broadly the same hazards that are present in corresponding varieties caught in the wild (Section 5.3.3.1). Potential hazards that are specific to aquaculture products include residues of veterinary drugs in excess of recommended guidelines and other chemicals used in aquaculture production, and contamination of faecal origin where the facilities are close to human habitation or animal husbandry.

6.2.2

Defects

The same defects are present in aquaculture products as in corresponding varieties caught in the wild (Section 5.3.3.1). A defect that may occur is objectionable odours/flavours. During transportation of live fish, it is important to reduce stress, as stressing fish can lead to deterioration in quality. Care should also be taken to minimize physical damage to fish, which may lead to bruising.

6.3

Production operations

6.3.1

Feed supply

Feeds used in aquaculture production should comply with the *Code of Practice on Good Animal Feeding* (CXC 54-2004).

Potential hazards: chemical contamination, mycotoxins and microbiological contamination

Potential defects: decomposed feeds, fungal spoilage

Technical guidance:

- Feed and fresh stocks should be purchased and rotated and used prior to the expiry of their shelf-life.
- Dry fish feeds should be stored in cool and dry areas to prevent spoilage, mould growth and contamination. Moist feed should be properly refrigerated according to manufacturer instructions.
- Feed ingredients should not contain unsafe levels of pesticides, chemical contaminants, microbial toxins or other adulterating substances.
- Industrially produced complete feeds and industrially produced feed ingredients should be properly labelled. Their composition must fit the declaration on the label and they should be hygienically acceptable.
- Ingredients should meet acceptable, and if applicable, statutory standards for levels of pathogens, mycotoxins, herbicides, pesticides and other contaminants that may give rise to human health hazards.
- Only approved colours of the correct concentration should be included in the feed.
- Moist feed or feed ingredients should be fresh and of adequate chemical and microbiological quality.
- Fresh or frozen fish should reach the fish farm in an adequate state of freshness.
- Fish silage and offal from fish, if used, should be properly cooked or treated to eliminate potential hazards to human health.
- Feed that is compounded industrially or at the fish farm should contain only such additives, growth promoting substances, fish flesh colouring agents, anti-oxidizing agents, caking agents or veterinary drugs as are permitted for fish by the official agency having jurisdiction.
- Products should be registered with the relevant national authority as appropriate.

- Storage and transportation conditions should conform to the specifications on the label.
- Veterinary drug and other chemical treatments should be administered in accordance with recommended practices and comply with national regulations.
- Medicated feeds should be clearly identified on the package and stored separately, in order to avoid errors.
- Farmers should follow manufacturer instructions on the use of medicated feeds.
- Product tracing of all feed ingredients should be assured by proper record-keeping.

6.3.2

Veterinary drugs

Potential hazards: residues of veterinary drugs

Potential defects: unlikely

Technical guidance:

- All veterinary drugs for use in fish farming should comply with national regulations and international guidelines (in accordance with the *Guidelines for the Design and Implementation of National Regulatory Food Safety Assurance Programmes Associated with the Use of Veterinary Drugs in Food Producing Animals* (CXG 71-2009)).
- Prior to administering veterinary drugs, a system should be in place to monitor the application of the drug to ensure that the withdrawal time for the batch of treated fish can be verified.
- Veterinary drugs or medicated feeds should be used according to manufacturer instructions, with particular attention to withdrawal periods.
- Products should be registered with the appropriate national authority.
- Products should only be prescribed or distributed by personnel authorized under national regulations.
- Storage and transportation conditions should conform to the specifications on the label.
- Control of diseases with drugs should be carried out only on the basis of an accurate diagnosis.
- Records should be maintained for the use of veterinary drugs in aquaculture production.
- For fish found to have drug residue concentrations above the maximum residue limit (MRL) (or, in some countries, above an industry imposed lower level), harvesting should be postponed until MRL compliance is met. After an assessment of the good aquaculture practices regarding pre-harvest measures, appropriate steps should be taken to modify the drug residue control system.
- A post-harvest control should reject all fish that do not comply with the requirements set for veterinary drug residues by the relevant national authority.

6.3.3

Growing

Potential hazards: [microbiological and chemical contamination](#)

Potential defects: [abnormal colour, muddy flavour, physical damage](#)

Technical guidance:

- Source of post-larvae, fry and fingerlings should be controlled to ensure healthy stock.
- Stocking densities should be based on culture techniques, fish species, size and age, carrying capacity of the fish farm, anticipated survival and desired size at harvesting.
- Diseased fish should be quarantined when necessary and appropriate; dead fish should be disposed of immediately in a sanitary manner that will discourage the spread of disease and the cause of death investigated.
- Good water quality should be maintained by using stocking and feeding rates that do not exceed the carrying capacity of the culture system.
- Growing water quality should be monitored regularly so as to identify potential hazards and defects.
- The fish farm should have a management plan that includes a sanitation programme, monitoring and corrective actions, defined following periods, appropriate use of agrochemicals, verification procedures for fish farming operations and systematic records.
- Equipment such as cages and nets should be designed and constructed to ensure minimum physical damage of the fish during the growing stage.
- All equipment and holding facilities should be easy to clean and disinfect and should be cleaned and disinfected regularly and as appropriate.

6.3.4

Harvesting

Potential hazards: [unlikely](#)

Potential defects: [physical damage, physical/biochemical change owing to stress of live fish](#)

Technical guidance:

- Appropriate harvesting techniques should be applied to minimize physical damage and stress.
- Live fish should not be subjected to extremes of heat or cold or sudden variations in temperature and salinity.
- Fish should be free from excessive mud and weed soon after being harvested by washing with clean seawater or freshwater under suitable pressure.
- Fish should be purged, where necessary, to reduce gut contents and pollution of fish during further processing.
- Fish should be handled in a sanitary manner according to the guidelines in Section 4 of the Code.
- Harvesting should be rapid so that fish are not exposed unduly to high temperatures.
- All equipment and holding facilities should be easy to clean and disinfect and should be cleaned and disinfected regularly and as appropriate.

6.3.5 **Holding and transportation**

Potential hazards: microbiological and chemical contamination

Potential defects: physical damage, physical/biochemical change owing to stress of live fish

Technical guidance:

- Fish should be handled in such a way as to avoid unnecessary stress.
- Fish should be transported without undue delay.
- Equipment for the transportation of live fish should be designed for rapid and efficient handling without causing physical damage or stress.
- All equipment and holding facilities should be easy to clean and disinfect and should be cleaned and disinfected regularly and as appropriate.
- Records for transportation of fish should be maintained to ensure full product tracing.
- Fish should not be transported with other products that might contaminate them.

6.3.6 **Storage and transportation of live fish**

This Section is designed for the storage and transportation of live fish originating from aquaculture or capture.

Potential hazards: microbiological contamination, biotoxins, chemical contamination (e.g. oil, cleaning and disinfecting agents)

Potential defects: dead fish, physical damage, off-flavours, physical/biochemical change owing to stress of live fish

Technical guidance:

- Only healthy and undamaged fish should be chosen for live storage and transportation; damaged, sick and dead fish should be removed before introduction to the holding or conditioning tanks.
- Holding tanks should be checked regularly during storage and transportation; damaged, sick and dead fish should be removed immediately when found.
- To reduce fish stress, clean water used to fill holding tanks, pump fish between holding tanks or condition fish should be similar in properties and composition to the water from where the fish were originally taken.
- Water should not be contaminated with either human sewage or industrial pollution; holding tanks and transportation systems should be designed and operated in a hygienic way to prevent contamination of water and equipment.
- Water in holding and conditioning tanks should be well aerated before fish are transferred into it.

- Where seawater is used in holding or conditioning tanks, for species prone to toxic algae contamination, seawater containing a high level of cell concentrations should be avoided or filtered properly.
- No fish feeding should occur during storage and transportation of live fish: feeding will pollute water in holding tanks very quickly; in general, fish should not be fed within the 24 hours preceding transportation.
- The material of holding and conditioning tanks, pumps, filters, piping, temperature control system, intermediate and final packaging or containers should not be harmful to fish or present hazards to humans.
- All equipment and facilities should be cleaned and disinfected regularly and as needed.

6.3.6.1

Live fish stored and transported at ambient temperature

Potential hazards: microbiological contamination, biotoxins, chemical contamination (e.g. oil, cleaning and disinfecting agents)

Potential defects: dead fish, physical damage, off-flavours, physical/biochemical change owing to stress of live fish

Technical guidance:

- Depending on the source of water, requirements of the species and time of storage and/or transportation, it could be necessary to re-circulate the water and filter it through mechanical and/or biofilters.
- Water intake of holding tanks on board of vessels should be located so as to avoid contamination from the sewage, waste and engine cooling discharge of the vessel. Pumping of water should be avoided when the vessel comes into harbour or when sailing through waters near sewage or industrial discharges. Equivalent precautions should be adopted for water intake on land.
- Facilities for storing and transporting live fish (holding tanks) should be able to:
 - maintain the oxygenation of water in the holding tanks through either continuous water flow, direct oxygenation (with oxygen or air bubbling) or regularly and as needed changing of the water of the holding tank;
 - maintain the temperature of storage and transportation for species sensitive to temperature fluctuations, which may require the insulation of the holding tanks and installation of a temperature-control system;
 - keep water in reserve in case the holding tank should drain. The volume in fixed facilities (storage) should be at least the same as the total volume of holding tanks in operation. The volume in land transport facilities should be at least capable of compensating water for evaporation, leakage, purges, filter cleaning and eventual mixing of water for control purposes.
- Species known to exhibit strong territoriality, cannibalism or hyperactivity when under stress should be separated into individual tanks or appropriately secured/banned to prevent damage (an alternative method is reduction in temperature).

6.3.6.2 **Live fish stored and transported at low temperatures**

Potential hazards: microbiological contamination, biotoxins, chemical contamination (e.g. oil, cleaning and disinfecting agents)

Potential defects: dead fish, physical damage, off-flavours, physical/biochemical change owing to stress of live fish

Technical guidance:

- Conditioning is a biological operation to reduce the metabolic rate of the fish in order to minimize their stress. Conditioning fish at low temperatures should be done according to the characteristics of the species (minimum temperature, cooling rate, water/humidity requirements, packaging conditions).
- The temperature to be reached should correspond to the species, transportation and packaging conditions. There is a range of temperature in which fish exhibit reduced or no physical activity. The limit is attained at the temperature at which the metabolic rate of the fish is minimized without causing adverse effects (basal metabolic rate).
- When performing conditioning, only approved anaesthetics and procedures permitted under applicable regulations should be used.
- Conditioned fish should be packed without delay in proper insulated containers.
- Remaining water or water for use with packaging material for conditioned fish should be clean, of similar composition and pH to the water from which the fish were taken, but at the storage temperature.
- Water-absorbent pads, shredded wood, wood shavings or sawdust and tying material that may be utilized for packaging conditioned fish should be clean, not previously used, free of possible hazards and wet at the time of packaging.
- Conditioned and packaged fish should be stored or transported under conditions that ensure proper temperature control.





7

Processing of live and raw bivalve molluscs

In the context of recognizing controls at individual processing steps, this Section provides examples of potential hazards and defects and describes technological guidelines that can be used to develop control measures and corrective action. At a particular step, only the hazards and defects that are likely to be introduced or controlled at that step are listed. It should be recognized that in preparing a Hazard Analysis Critical Control Point (HACCP)⁹ and/or defect action point (DAP) plan it is essential to consult Section 5, which provides guidance for the application of the principles of HACCP and DAP analysis. However, within the scope of this Code, it is not possible to give details of critical limits, monitoring, record-keeping and verification for each of the steps as these are particular to each hazard or defect.

7.1 General remarks – addition to the prerequisite programme

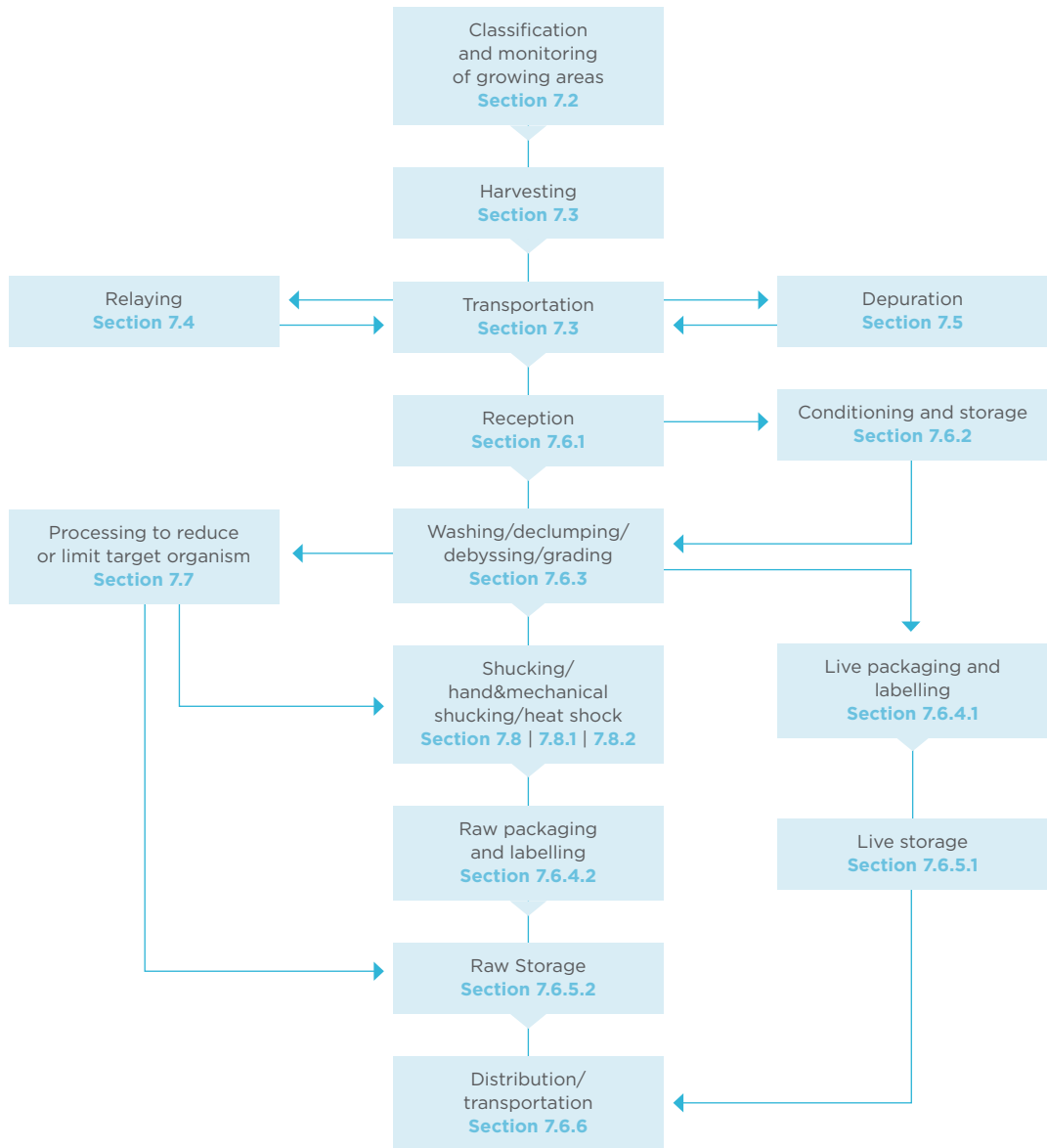
Bivalve molluscs species, such as oysters, mussels, manila and hard shell clams, can survive for extended periods out of water and can be traded for human consumption as live animals. Other species like cockles can be traded live if carefully handled but are normally processed. Species not adapted to dry conditions soon die out of water and are best handled as chilled products or processed. When spawning (following “gonad ripening”) occurs, it become undesirable, and in many instances impracticable, to trade them as live animals. Stress can induce spawning.

The main hazard known for the production of bivalve molluscs is microbiological contamination of the water in which they grow, especially when the bivalve molluscs are intended to be eaten live or raw. Since molluscs are filter feeders, they concentrate contaminants to a much higher degree than in the surrounding seawater. The contamination with bacteria and viruses in the growing area is therefore critical for the end-product specification and determines the process requirements for further processing. Gastro-enteritis and other serious diseases such as hepatitis can occur as a result of agricultural runoff and/or sewage contamination with, for example, enteric bacterial and/or viral pathogens (e.g. norovirus, viruses causing hepatitis), or from natural occurring bacterial pathogens (*Vibrio* spp.). Further hazards include biotoxins. Biotoxins produced by some algae can cause various forms of serious poisoning like diarrhetic shellfish poisoning (DSP), paralytic shellfish poisoning (PSP), neurotoxic shellfish poisoning (NSP), amnesic shellfish poisoning (ASP) or poisoning caused by azaspiracid (AZP). Chemical substances, such as heavy metals, pesticides and organochlorides, and petrochemical substances may also present hazards in certain areas.

⁹ Refer to Annex II for a comprehensive list of the acronyms used in this Code.

Figure 7.1 Example flow chart for the production of live and raw bivalve molluscs

This flow chart is for illustrative purpose only. For implementation of HACCP principles, a complete and comprehensive flow chart has to be drawn up for each product. References corresponde to relevant sections of the Code.



To control hazards, identification and monitoring of growing areas is very important for ensuring the safety of bivalve molluscs. The identification, classification and monitoring of these areas is a responsibility of the competent authorities in cooperation with fishers and primary producers. *Escherichia coli*/faecal coliforms or total coliforms may be used as an indicator for the possibility of faecal contamination. To control viruses, refer to the Annex on the *Control of Hepatitis A Virus (HAV) and Norovirus (NoV) in Bivalve Molluscs* (Annex I) to the *Guidelines on the Application of the General Principles of Food Hygiene to the Control of Viruses in Food* (CXG 79-2012). To control pathogenic *Vibrio* spp., refer to the Annex on the *Control Measures for Vibrio parahaemolyticus and Vibrio vulnificus in Bivalve Molluscs to the Guidelines on the Application of the General Principles of Food Hygiene to the Control of Pathogenic Vibrio Species in Seafood* (CXG 73-2010). If biotoxins are found in bivalve mollusc flesh in hazardous amounts, the growing area must be closed for harvesting bivalve molluscs until toxicological investigation has made clear that the bivalve mollusc meat is free from hazardous amounts of biotoxins. Harmful chemical substances should not be present in the edible part in such amounts that the calculated dietary intake exceeds the permissible daily intake.

Bivalve molluscs from waters subject to microbiological contamination, as determined by the authority having jurisdiction, can be made safe by relaying in a suitable area, applying a depuration process to reduce the level of bacteria if the process is continued long enough, or processing to reduce or limit target organisms. Depuration is a short-term process commonly used to reduce low levels of bacterial contamination, but long-term relaying is required if there is a greater risk of contamination.

Especially when the bivalve molluscs need to undergo relaying or depuration to be eaten live or raw, stress and excessive shocks must be avoided. This is important because these bivalve molluscs should be able to function again during depuration, relaying or conditioning.

7.2

Classification and monitoring of growing areas

Potential hazards: microbiological contamination, biotoxins, chemical contamination

Potential defects: unlikely

Technical guidance:

Five types of important hazard may occur in the growing environment of bivalve molluscs:

- enteric bacterial pathogens (e.g. *Salmonella* spp.);
- enteric viral pathogens (e.g. norovirus, viruses causing hepatitis);
- naturally occurring bacterial pathogens (e.g. *Vibrio* spp.);
- biotoxins (e.g. okadaic acid group [DSP], saxitoxin group [PSP], brevetoxin group [NSP], domoic acid group [ASP], azaspiracid group [AZP]); and
- chemical contaminants (e.g. heavy metals such as lead, cadmium and mercury).

7.2.1

Classification of growing areas

Surveys of the growing area, shoreline and land catchment should be conducted to determine sources of both domestic and industrial pollution that may affect the quality of the growing area water and bivalve molluscs. Sources may include municipal sewage outputs, industrial outputs, mine wastes, geophysical contaminants, domestic animal holding pens, nuclear power plants, refineries or other sources. The need to reschedule hygiene surveys will be determined by population shifts and changes in agricultural and industrial activities in the coastal area. Re-surveys should be conducted at an acceptable frequency and known pollution sources should be re-evaluated on a regular basis to determine any changes in their impact on the growing area.

When pollution sources have been identified and evaluated, sampling stations for water and/or bivalve molluscs and/or sediments should be established and studies conducted to determine the effects of the pollutants on water and bivalve mollusc quality. The data should be evaluated by the official agency having jurisdiction and growing areas should be classified according to official standards and criteria.

When interpreting growing area data, the official agency having jurisdiction should take into account variations that may affect the level of pollution during the most unfavourable hydrographic and climatic conditions as influenced by rainfall, tides, winds, methods of sewage treatment, population variations and other local factors, as bivalve molluscs respond rapidly to an increase in the number of bacteria or viruses in their environment by accumulating these agents. The agency should also consider that bivalve molluscs have the ability to accumulate toxic chemicals in their tissue in concentrations greater than the levels found in the surrounding water. Standards of the Food and Agriculture Organization of the United Nations (FAO), World Health Organization (WHO) or other international or national food standards may be used as a guide to acceptable levels.

The official agency having jurisdiction should immediately announce decisions concerning the classification of growing areas to the affected producers and depuration and distribution centres.

When sampling shellfish meats for classification purposes, if the limits of any biological or chemical hazard set in the end-product specification are exceeded, appropriate measures must be taken under the responsibility of the official agency having jurisdiction.

Classified growing areas should be clearly defined by the official agency having jurisdiction as either:

- suitable for harvesting for direct human consumption, relaying in acceptable water or depuration in an approved depuration centre or approved processing to reduce or limit target organisms; or
- unsuitable for growing or harvesting bivalve molluscs.

7.2.2 **Monitoring of growing areas**

Growing areas should be routinely monitored for changes in water quality and/or bivalve mollusc quality, and substandard areas patrolled to prevent harvesting for purposes other than that established by the official agency.

Biotoxins in bivalve molluscs can be caused by plankton containing toxins. For early warning purposes, where appropriate, it is recommended to have a programme present to monitor growing areas for the species of plankton that can produce toxins and to recognize other environmental signals that a toxic event may be developing.

Harmful chemical substances within bivalve molluscs should not be present in amounts such that the calculated dietary intake exceeds the permissible daily intake. A monitoring system should be present for harmful chemical substances.

When routine monitoring programmes or re-surveys show that the growing area no longer meets the classification criteria, the area should be reclassified or closed for harvesting immediately by the official agency having jurisdiction.

In determining the public health suitability of bivalve mollusc classified growing areas, the official agency having jurisdiction should consider the following actions:

- Classification/reclassification of growing areas by sanitary survey, monitoring of *E. coli*/faecal coliforms or total coliforms at an appropriate frequency based on the risk of contamination, and other sanitary control measures as applicable.
- Classification/reclassification of growing areas by monitoring of pathogens at an appropriate frequency based on the probability of contamination in bivalve mollusc meat (see Section 7.2.2.2).
- Closure/reopening of growing areas by the monitoring of biotoxins in bivalve molluscs alone or in combination with the monitoring of phytoplankton in seawater at an appropriate frequency based on the probability of contamination (see Section 7.2.2.3).
- Control of chemical contaminants.

Under the responsibility of the official agency having jurisdiction, the growing areas providing bivalve molluscs for direct human consumption should meet the following requirements at the time of harvest:

- The area is not subject to contamination that may present an actual or potential hazard to human health.
- The bivalve molluscs harvested meet the end-product specification. This can be determined by examination of the molluscan flesh or through adequate monitoring of the water, as appropriate.

Growing areas providing bivalve molluscs for indirect human consumption should be defined in relation to the further procedure of the lot.

7.2.2.1 **Escherichia coli/faecal coliforms/total coliforms**

All growing water and/or molluscan flesh should be monitored for the presence of *E. coli*/faecal coliforms or total coliforms at an appropriate frequency based on the probability and degree of faecal contamination.

Tests for suitable indicator bacteria such as faecal coliforms or *E. coli* or total coliforms should be used to determine the degree of faecal contamination. The effectiveness of indicator bacteria used should be kept under constant review for their reliability as measures for the degree of faecal contamination. If faecal contamination exceeds a certain threshold level, relaying or depuration for a time approved by the official agency having jurisdiction may be allowed.

E. coli/faecal coliforms or total coliforms may be used as an indicator for the presence of faecal contamination. Because these indicators do not correlate well with the presence of viruses, other controls such as shoreline surveys should always be employed.

Other methods such as bacteriophage and viral detection could also be used as indicators when validated analytical methods become available in the future.

7.2.2.2 **Pathogen monitoring**

Shellfish sanitation programmes rely on the use of indicator organisms for the presence of contamination rather than on attempts to monitor for specific pathogens. However, where there has been a shellfish-borne outbreak caused by an identified pathogen such as *Salmonella* and others (*Vibrio* and viruses), monitoring the bivalve molluscs may be appropriate as part of the process of closure/reopening of the affected harvest area. The species, and typically the actual strain, should be known in order to ensure that monitoring is addressing the source of the pathogen. Predetermined acceptance/rejection levels for the pathogen should have been established in order to use such monitoring results for decision-making. Other conditions including the sanitary survey requirements should also have been satisfied as a condition of reopening the area. When appropriate, taking into account the epidemiological situation as indicated by the results of environmental monitoring and/or other surveillance, the competent authority may decide a criterion for *Salmonella*.

7.2.2.3 **Marine biotoxin control**

Phytoplankton monitoring is a valuable complementary tool that can be used in combination with the required monitoring of marine biotoxins in shellfish tissue to optimize programme management and resources. Growing areas should also be monitored for environmental signals that a toxin event may be occurring, e.g. dead or dying birds, mammals or fish. The risk of blooms of toxic algae may show seasonal variability and areas may also be affected by toxic algae previously unknown in the surrounding sea or coastal waters. These risks should be recognized when drawing up monitoring schedules.

It is important to note that in using indicator shellfish species, the absence of toxicity in indicated species is assumed to imply the absence of toxicity in other species in the growing area. This implication must be verified for each shellfish species and for each group of toxins before defining a particular shellfish species as an indicator for that growing area.

The official agency having jurisdiction should immediately close and effectively patrol affected areas when acceptable levels are exceeded in edible portions of bivalve mollusc meats. These areas should not be re-opened before toxicological investigation has made clear that the bivalve mollusc meat is free from hazardous amounts of biotoxins.

The official agency having jurisdiction should immediately announce these decisions to the affected producers and depuration and distribution centres.

In establishing a sampling programme over space and time, consideration should be given to ensuring adequate location and number of sampling sites. Testing for a particular biotoxin may not be appropriate when it has been demonstrated that that biotoxin has not been associated with bivalve molluscs in the growing and harvesting areas. Sampling frequency must be sufficient to address spatial-temporal changes in microalgae and toxins in shellfish and to cover the risks of rapid rises in shellfish toxicity.

Spatial representational sampling

The selection of sampling stations for both benthic and suspended culture should be based on sites that have historically presented toxicity in the early stages of a toxic event. It is recognized that sampling, generally, cannot be carried out in a statistically valid way without excessive cost. In order to protect public health, the selection of sampling stations should give appropriate coverage of the extent of a toxic event or the likely “worst case scenario” in a growing area. This should be based on expert judgement using the following factors:

- Hydrography, known upwellings, fronts, current patterns and tidal effects.
- Access to sampling stations in all weather conditions during harvesting.
- Desirability of toxin and microalgal sampling at the same sampling station.
- In addition to primary (routine) stations, the need for secondary (complementary) and offshore stations.
- Existence of *in-situ* growth (e.g. toxic microalgae from cyst beds).
- The advection of offshore toxic microalgal blooms into growing areas.

Routine sampling for microalgae will generally mean taking an integrated sample from the water column. When a toxic event is in progress or developing, targeted, depth-specific sampling should be considered.

Sampling for shellfish grown in suspension should at the least involve an integrated sample composed of shellfish taken from the top, middle and bottom of the lines.

Temporal representational sampling

Minimum weekly sampling frequencies are adopted by most monitoring programmes in areas where toxicity is prevalent and where harvesting is taking place or about to take place. Decisions on the frequency of sampling should be based on risk evaluation. Inputs into the decision may include factors such as seasonality (toxicity and/or harvesting), accessibility, historical baseline information, including toxin and microalgal data, and the effects of environmental factors such as wind, tide and currents.

Sampling frequency and the factors that may lead to it being changed should be described in a “marine biotoxin action plan” for the growing area.

Shellfish sample size

There is no internationally agreed sample size for different shellfish species. There may be high variability of toxicity among individual shellfish. The number of shellfish sampled should be sufficient to address this variability. For this reason, the number of shellfish in the sample, rather than the mass of the shellfish flesh, should be the determining factor for the sample size. In addition, the size of the sample should be sufficient to allow the test(s) for which the sample is being taken to be carried out, and the shellfish sampled should be of the size marketed.

7.2.2.4

Marine biotoxin test methods

Methods suitable for the determination of marine biotoxins are listed in the *Standard for Live and Raw Bivalve Molluscs* (CXS 292-2008). Any methods may be deemed suitable for screening purposes provided they are approved by the competent national authority.

7.2.2.5

Chemical contaminants

Growing areas should be monitored for chemical contaminants on a sufficiently frequent basis as to provide confidence that any identified sources of chemical contamination are not contaminating the shellfish. Shellfish-growing areas where there are no known point sources of likely chemical contamination should only require occasional checks every few years. However, where there are known point sources of specific contamination, shellfish may need to be checked more frequently on a routine basis. There should also be the capacity to sample shellfish reactively if and when a specific event occurs, such as a spillage of antifouling paint.

7.3

Harvesting and transportation of live bivalve molluscs

Refer also to Sections 3.1, 3.3, 3.4 and 3.5.

This Section applies to the transportation of bivalve molluscs for the purpose of direct human consumption, relaying, depuration, processing to reduce or limit target organisms, or further processing.

Appropriate handling procedures depend on different species, growing area and season.

Potential hazards: [microbiological contamination](#), [biotoxins](#), [chemical contamination](#)

Potential defects: [physical damage](#)

Technical guidance:

- Dredges and other harvesting equipment, decks, holds and containers that are contaminated from use in a polluted area should be cleaned and, if applicable, disinfected (sanitized) before being used for bivalve molluscs from an unpolluted area.

- Holds in which bivalve molluscs are held and containers should be so constructed that the bivalve molluscs are held above the floor level and drained so that the bivalve molluscs are not in contact with washdown, bilge water or shell fluid. Where necessary, a bilge pumping system must be provided.
- Suitable precautions should be taken to protect bivalve molluscs from being contaminated by polluted water, droppings from sea birds, footwear that may have been in contact with faecal matter or by other polluted material. No overboard discharge of waste, including human faecal material, should occur from harvest vessels around shellfish growing areas. No animals should be allowed on harvest vessels.
- Washdown pumps should draw water only from non-contaminated seawater.
- Bivalve molluscs should be harvested from and stored in a growing area or relaying area acceptable to the official agency having jurisdiction.
- On removal from water or during handling and transportation, bivalve molluscs should not be subjected to extremes of heat or cold or sudden variations in temperature. Temperature control is critical in handling live bivalve molluscs. Special equipment, such as insulated containers and refrigeration equipment, should be used if prevailing temperatures and the time involved so require. Bivalve molluscs should not be exposed to direct sunlight or surfaces heated by the sun or come into direct contact with ice or other freezing surfaces, nor should they be held in closed containers with solid carbon dioxide. In most cases, storage above 10 °C (50 °F) or below 2 °C (35 °F) should be avoided.
- Bivalve molluscs should be freed from excessive mud and weed soon after being harvested by washing with clean seawater or potable water under suitable pressure. Wash water should not be allowed to flow over bivalve molluscs that have already been cleaned. The water could be re-circulated if it meets the definition for clean water.
- The interval between harvesting and immersion in water for relaying, storage, conditioning or depuration should be kept as short as possible. This also applies to the interval between final harvesting and handling in a distribution centre.
- If bivalve molluscs are to be re-immersed after harvest, they should be re-immersed in clean seawater.
- Appropriate documentation should be maintained for harvesting and transportation activities.

7.4 Relaying

The requirements for classification and monitoring of growing areas also apply to relaying areas.

Relaying is intended to reduce the level of biological contaminants that may be present in bivalve molluscs that have been harvested from contaminated areas to such levels that the bivalve molluscs will be acceptable for human consumption without further processing. Bivalve molluscs harvested for relaying should only be harvested from areas that are so designated/classified by the official agency having jurisdiction. Relaying methods vary worldwide. Bivalve molluscs may be placed in floats, rafts or directly on the bottom.

Potential hazards: [microbiological contamination](#), [biotoxins](#),
[chemical contamination](#)

Potential defects: [unlikely](#)

Technical guidance:

- Relaying operations should be strictly supervised by the official agency having jurisdiction to prevent contaminated bivalve molluscs from being diverted directly to the consumer market or from cross-contamination of other bivalve molluscs. Boundaries of relaying areas should be clearly identified by buoys, poles or other fixed means. These areas should be adequately separated from the bivalve molluscs in adjacent waters and suitable control systems should be in place to prevent cross-contamination and commingling.
- Holding time and minimum temperature in the accepted area prior to harvest will be determined by the official agency having jurisdiction according to the degree of contamination before relaying, the temperature of the water, the bivalve mollusc species involved and local geographic or hydrographic conditions to ensure that contamination levels have been adequately reduced.
- Relaying sites could become biotoxic from a bloom or could become an unexpected source of environmental pathogens such as *Vibrio* bacteria and should therefore be monitored as appropriate while they are being used for relaying.
- Bivalve molluscs should be laid out at a density that will permit them to open and undergo natural depuration.
- Appropriate documentation should be maintained for relaying operations.

7.5 Depuration

Refer also to Sections 3.2, 3.3, 3.4 and 3.5.

Depuration is intended to reduce the number of pathogenic microorganisms that may be present in bivalve molluscs that have been harvested from moderately polluted areas to such levels that the bivalve molluscs will be acceptable for human consumption without further processing. Depuration alone is not suitable for cleansing bivalve molluscs from more heavily contaminated areas or areas subject to contamination by hydrocarbons, heavy metals, pesticides, viruses, vibrios or biotoxins. Bivalve molluscs harvested for depuration should only be harvested from areas that are so designated/classified by the official agency having jurisdiction.

The required conditions vary according to the species of molluscs and the design of the depuration system.

For natural functioning and therefore depuration to occur, it is essential that the molluscs have not been overstressed or damaged during harvesting or handling prior to depuration and should not be in a seasonally weak or spawning condition.

Depuration centres should maintain the same hygiene standards as per Sections 3.2, 3.3, 3.4 and 3.5.

Potential hazards: [microbiological contamination](#)

Potential defects: [physical damage](#)

Technical guidance:

- Depuration centres and tanks should be approved by the official agency having jurisdiction.
- Bivalve molluscs subjected to the depuration process should not contain metallic ions, pesticides, industrial wastes or marine biotoxins in such quantities as represent a health hazard for the consumer.
- Only shell stock designated as acceptable by the official agency having jurisdiction should be used.
- The process and the equipment, e.g. tanks, used for depuration should be acceptable to the official agency having jurisdiction.
- Dead or damaged bivalve molluscs should be removed prior to the depuration process, when practicable. Surfaces of shells should be free from mud and soft commensal organisms. If necessary, the bivalve molluscs should be washed with clean seawater before the depuration process.
- The length of the period of depuration should be adapted to the water temperature and physical water quality parameters (clean seawater, salinity, dissolved oxygen and pH levels suitable to permit the bivalve molluscs to function normally), the degree of contamination before depuration and the bivalve mollusc species. Microbiological investigation of process water and of bivalve mollusc meat should be used to assess depuration parameters. It should be taken into account that viruses and *Vibrio* spp. are more persistent during depuration than the indicator bacteria mostly used for microbiological monitoring and that a reduction in the number of indicator bacteria does not always reflect the true situation as regards contamination by viruses and *Vibrio*.
- Water used in depuration tanks should be changed continuously or at suitable intervals or, if re-circulated, be treated properly. The flow of water per hour should be sufficient for the quantity of bivalve molluscs treated and should depend on the degree of their contamination.
- Bivalve molluscs undergoing depuration should remain immersed in clean seawater until they satisfy the sanitary requirements of the official agency having jurisdiction.
- Bivalve molluscs should be laid out at a density that will permit them to open and undergo natural depuration.

- During the process of depuration, the water temperature should not be allowed to fall below the minimum at which bivalve molluscs remain physiologically active; high water temperatures that adversely affect the pumping rate and the depuration process should be avoided; tanks should be protected from the direct sunlight when necessary.
- Equipment in contact with water, i.e. tanks, pumps, pipes or piping, and other equipment should be constructed of non-porous, non-toxic materials. Copper, zinc, lead and their alloys should preferably not be used in the tanks, pumps or piping systems used in depuration processing.
- To avoid recontamination of bivalve molluscs undergoing depuration, unpurified bivalve molluscs should not be placed in the same tank as bivalve molluscs that are already undergoing depuration.
- On removal from the depuration system, bivalve molluscs should be washed with running potable water or clean seawater and handled in the same manner as living bivalve molluscs taken directly from a non-polluted area. Bivalve molluscs that are dead, with broken shells or are otherwise unwholesome should be removed.
- Before removing the bivalve molluscs from the tanks, drain the water from the system to avoid re-suspension and re-ingestion. The tanks should be cleaned after each use and disinfected at suitable intervals.
- After depuration, the bivalve molluscs should meet the end-product specification.
- Appropriate documentation should be maintained for depuration.

7.6 Processing of bivalve molluscs in a distribution centre or an establishment

Some countries require that bivalve molluscs that are to be frozen and/or shucked and/or processed to reduce or limit target organisms must first pass through a “distribution centre” from which they exit alive. Other countries allow freezing, shucking and processing to reduce or limit target organisms to occur in establishments that perform the functions of a “distribution centre”. Both practices are legitimate and the products from each one should be equally permitted in international trade. Where “distribution centre” activities and processing activities occur under the same roof, care must be taken to ensure adequate separation of activities to prevent cross-contamination or commingling of products.

Distribution centres that prepare live bivalve molluscs suitable for direct consumption and establishments that prepare live and raw bivalve molluscs suitable for direct consumption should maintain the same hygiene standards as per Sections 3.2, 3.3, 3.4 and 3.5.

7.6.1

Reception

Potential hazards: [microbiological, chemical and physical contamination](#)

Potential defects: [viable parasites, physical damage, foreign matter, dead or dying bivalve molluscs](#)

Technical guidance:

- Stress and excessive shocks to bivalve molluscs that will be dispatched live from a distribution centre or other establishment must be avoided.

- Distribution centres and other establishments that prepare live bivalve molluscs should only accept bivalve molluscs that meet the end-product specification and that originate directly from approved growing areas or after relaying in an approved relaying area or after depuration in an approved depuration centre or tank.

7.6.2

Conditioning and storage of bivalve molluscs

Refer also to Sections 3.2, 3.3, 3.4 and 3.5.

Potential hazards: microbiological contamination, chemical contamination, biotoxins

Potential defects: physical damage, foreign matter, dead or dying bivalve molluscs

Technical guidance:

- Conditioning means storage of bivalve molluscs in seawater tanks, basins, floats, rafts or natural sites with the intention to remove mud, sand and slime.
- The process of storing bivalve molluscs in seawater tanks, basins, floats, natural sites or rafts can be used if it is acceptable to the official agency having jurisdiction.
- Only clean seawater should be used in the tanks, floats, natural sites or rafts and should be of adequate salinity and adequate physical water quality to permit the bivalve molluscs to function normally. Optimal salinity will vary with bivalve mollusc species and with the harvesting area. Water condition has to be of adequate quality for the process. Where natural sites are used for conditioning, these should be classified by the official agency having jurisdiction.
- Before conditioning or storage, bivalve molluscs should be washed to remove mud and soft commensal organisms and dead or damaged bivalve molluscs should be removed when practicable.
- During storage, bivalve molluscs should be laid out at a density and under such conditions that will permit them to open and function normally.
- The oxygen content in the seawater should be maintained at an adequate level at all times.
- The temperature of the water in storage tanks should not be allowed to rise to such levels as to cause weakness in the bivalve molluscs. If ambient temperatures are excessively high, tanks should be placed in a well-ventilated building or away from direct sunlight. The length of the period of conditioning should be adapted to the water temperature.
- Bivalve molluscs should be stored in clean seawater only for such a time as they remain sound and active.
- Tanks should be drained, cleaned and disinfected at suitable intervals.
- Re-circulating wet storage systems must contain approved water treatment systems.

7.6.3

Washing, declumping, debyssing and grading

Refer also to Sections 3.2, 3.3, 3.4 and 3.5.

Potential hazards: microbiological contamination,
chemical and physical contamination

Potential defects: mechanical damage

Technical guidance:

- All steps in the process, including packaging, should be performed without unnecessary delay and under conditions that will prevent the possibility of contamination, deterioration and the growth of pathogenic and spoilage microorganisms.
- Damage to shells and stress will shorten the shelf-life of bivalve molluscs and increase the risk of contamination and deterioration. Bivalve molluscs have to be handled carefully:
 - the number of handlings of bivalve molluscs should be minimized; and
 - excessive shocks should be avoided.
- The different process steps should be supervised by technically competent personnel.
- The outsides of the shells should be washed free of mud and all soft adhering organisms should be removed. Hard adhering organisms should also be removed when possible, care being taken not to chip lips of shells by vigorous washing. Washing should be carried out using pressurized clean (sea)water.
- Bivalve molluscs having formed clumps should be declumped and debyssed as appropriate. The equipment used should be designed and adjusted to minimize the risk of damage to the shells.

7.6.4

Packaging and labelling

Refer also to Sections 3.2, 3.3, 3.4 and 3.5.

All steps in the packaging process should be performed without unnecessary delay and under conditions that will prevent the possibility of contamination, deterioration and the growth of pathogenic and spoilage microorganisms.

The packaging material should be appropriate for the product to be packaged and for the expected conditions of storage and should not transmit to the product harmful or other objectionable substances or odours and tastes. The packaging material should be sound and should provide appropriate protection from damage and contamination.

7.6.4.1

Packaging and labelling of live bivalve molluscs

Potential hazards: microbiological contamination, physical contamination,
chemical contamination

Potential defects: incorrect labelling, presence of damaged or dead
bivalve molluscs, foreign matter

Technical guidance:

- Before packaging, bivalve molluscs should undergo visual inspection. Bivalve molluscs that are dead, with broken shells, with adhering soil or otherwise unwholesome should be rejected for human consumption.
- The packaging material should avoid contamination and should be drained.
- Labels should be clearly printed and must comply with the labelling laws of the country where the product is marketed. The packaging material or label may be used as a means to convey appropriate storage instructions to the consumer after retail purchase. It is recommended that the date of packaging be included.
- All packaging material should be stored in a clean and sanitary manner. Product containers should not have been used for any purpose that may lead to contamination of the product. Packaging materials should be inspected immediately before use to ensure that they are in a satisfactory condition and, where necessary, disposed of or cleaned and/or disinfected; when washed, they should be well drained before filling. Only packaging material required for immediate use should be kept in the packing or filling area.

7.6.4.2

Packaging and labelling of raw bivalve molluscs

Potential hazards: [microbiological and physical contamination](#)

Potential defects: [objectionable matter such as shell pieces,](#)
[incorrect labelling](#)

Technical guidance:

- Labels should be clearly printed and must comply with the labelling laws of the country where the product is marketed. The packaging material or label may be used as a means to convey appropriate storage instructions to the consumer after retail purchase. It is recommended that the date of packaging be included.
- All packaging material should be stored in a clean and sanitary manner. Only packaging material required for immediate use should be kept in the packing or filling area.
- Shucked and post-harvest treated product should be packed and chilled or frozen as soon as possible.
- Freezing should be done quickly (see Section 9.3). Slow freezing will damage meat.
- If labels on post-harvest treated raw bivalve molluscs make safety claims relating to the post-harvest treatment, the claims should be specific to the target hazard that has been eliminated or reduced.

7.6.5

Storage

7.6.5.1

Storage of live bivalve molluscs

Potential hazards: microbiological contamination,
chemical and physical contamination

Potential defects: physical damage

Technical guidance:

- The end product should be stored under conditions that will preclude contamination with and/or proliferation of microorganisms. The packaging material of the end product should not be in direct contact with the floor but should be placed on a clean, raised surface.
- Storage periods should be kept as short as possible.
- Live bivalve molluscs must not be re-immersed in or sprayed with water after they have been packaged and left the distribution centre or establishment except in the case of retail sale at the distribution centre.

7.6.5.2

Storage of raw bivalve molluscs

Potential hazards: microbiological contamination,
chemical and physical contamination

Potential defects: physical damage

Technical guidance:

- Storage periods should be kept as short as possible.
- Damage to packaging of frozen product should be avoided.

7.6.6

Distribution/transportation

7.6.6.1

Distribution of live bivalve molluscs

Refer also to Sections 3.6 and 20.

Potential hazards: microbiological contamination

Potential defects: physical damage

Technical guidance:

- The product should be dispatched in the sequence of the lot numbers.
- Temperature should be maintained during distribution to control microbial growth.
- Bivalve molluscs intended for human consumption should only be distributed in closed packaging.
- The means of transportation should provide sufficient protection to shells against damage from shocks. The bivalve molluscs should not be transported with other products that might contaminate them.

7.6.6.2

Distribution of raw bivalve molluscs

Potential hazards: microbiological contamination

Potential defects: unlikely

Technical guidance:

- Temperature should be maintained during distribution to control microbial growth.
- The product should be dispatched in the sequence of the lot numbers.
- Transportation should be able to maintain chilled or frozen product for safety and quality.

7.7

Processing to reduce or limit target organisms

Refer also to Sections 3.2, 3.3, 3.4 and 3.5.

Bivalve molluscs processed to reduce or limit target organisms are products prepared from live or raw bivalve molluscs that have been processed after harvest to reduce or limit specified target organisms within the product to levels that are satisfactory to the official agency having jurisdiction. Processing to reduce or limit target microorganisms is intended to retain the sensory qualities of a live bivalve mollusc. As with all live and raw bivalve molluscs, these bivalve molluscs must meet all microbiological criteria associated with traditional harvest water controls designed to prevent faecal contamination and resulting introduction of enteric pathogens as well as toxins and other contaminants. However, these growing area controls are not designed for the control of pathogens that are independent from faecal contamination.

Potential hazards: microbiological contamination

Potential defects: coagulation of meat, defective meat texture, hydrostatic medium forced into the flesh

Technical guidance:

- Any treatment developed to eliminate or reduce pathogens should be thoroughly validated scientifically to ensure that the process is effective (see the *Guidelines for the Validation of Food Safety Control Measures* [CXG 69-2008]).
- The control treatments (heat, pressure, etc.) should be closely monitored to ensure that the product does not undergo textural changes in the flesh that are unacceptable to the consumer.
- The treatment parameters established to reduce or limit pathogens should be approved by the official agency having jurisdiction.
- Each establishment that purifies bivalve molluscs with a heat treatment must develop a heat treatment process schedule, acceptable to the official agency having jurisdiction, that addresses such critical factors as the species and size of bivalve molluscs, time of exposure to heat, internal bivalve molluscs temperature, type of heat process used, water/steam to bivalve molluscs ratios, nature of heat equipment, measurement devices and their calibration, post-heating chilling operations, cleaning and sanitizing of heat process equipment.

7.8 Shucking

Shucking is the processing step that removes the edible portion of the mollusc from the shell. It is usually done by hand, mechanically or through heat shock with steam or hot water. This step may expose the product to microbiological or physical contamination.

7.8.1

Hand and mechanical shucking and washing

Physical removal of shellfish meat from the shell will often expose the product to dirt, mud and detritus that should be removed before further processing through washing or other means.

Potential hazards: physical contamination, microbiological contamination

Potential defects: cuts and tears in the flesh, presence of sand and mud

Technical guidance:

- Care should be taken to eliminate excess mud, detritus and sand from the shucking tables.
- The product should be examined to ensure that cuts and tears are minimized.
- Shucked molluscs should be rinsed or washed to eliminate mud, sand and detritus and to reduce the microbiological level of the products.

7.8.2

Heat shocking of bivalve molluscs followed by packaging

Heat shocking is a method to remove shells from the bivalve molluscs. Refer also to Sections 3.2, 3.3, 3.4 and 3.5.

Potential hazards: physical contamination

Potential defects: unlikely

Technical guidance:

- The bivalve molluscs must come from approved growing areas and/or have undergone relaying in an approved relaying area or depuration in an approved depuration centre or tank. Each establishment that heat shucks bivalve molluscs should develop a heat shuck process schedule, acceptable to the official agency having jurisdiction, that addresses such critical factors as the species and size of bivalve molluscs, time of exposure to heat, internal bivalve molluscs temperature, type of heat process used, water/steam to bivalve molluscs ratios, nature of heat equipment, measurement devices and their calibration, post-heating chilling operations, cleaning and sanitizing of heat process equipment.
- All bivalve molluscs should be washed with pressurized potable water or clean seawater and culled for damaged and dead bivalve molluscs prior to heat treatment.
- Before heat shocking, the bivalve molluscs should be inspected to determine that they are alive and not badly damaged.
- Heat shocked bivalve molluscs should be cooled to 7 °C or below within two hours of being heat treated (this time includes the shucking process). This temperature should be maintained during transportation, storage and distribution.
- The heat-shocked bivalve molluscs should be packaged as soon as possible. Before packaging, the bivalve molluscs should be examined for objectionable matter such as shell pieces.

7.9 Documentation

The transportation of live bivalve molluscs from a growing area to a distribution centre, depuration centre, relaying area or establishment should be accompanied by documentation for the identification of batches of live bivalve molluscs.

Storage and transportation temperatures should be indicated.

Permanent, legible and dated records of relaying and depuration should be kept concerning each lot. These records should be retained for a period of at least one year.

Depuration centres or tanks and distribution centres and establishments should only accept lots of live bivalve molluscs with documentation issued by or accepted by the official agency having jurisdiction. Where appropriate, this documentation should contain the following information:

- the gatherer's identity and signature;
- the date of harvesting;
- common and/or scientific name and quantity of bivalve molluscs;
- the location of the growing area and the status of this area (suitable for harvesting for direct human consumption, suitable for relaying, suitable for depuration, suitable for approved processing to reduce or limit target organisms);
- for distribution centres and establishments, if appropriate, the date and duration of depuration and the identity and signature of the person responsible; and
- for distribution centres and establishments, if appropriate, the date and duration of relaying, the location of the relaying area and the identity and signature of the person responsible.

Complete records of harvest area and date of harvest and length of time of relaying or depuration of each lot should be maintained by the distribution centre or establishment for a period designated by the official agency having jurisdiction.

7.10 Lot identification and recall procedures

Refer also to Section 3.7.

- Each product should have an easily identifiable lot number. This lot number must include an identification code, the number of the establishment that distributes the product, the country of origin and day and month of packaging, in order to facilitate the traceability/product tracing of the product. A record-keeping system should be based on these lot numbers so that individual lots of bivalve molluscs can be traced from the growing area to the end user.



8

Processing of fresh and quick-frozen raw scallop products



In the context of recognizing controls at individual processing steps, this Section provides examples of potential hazards and defects and describes technical guidance that can be used to develop control measures and corrective actions. At any particular step, only the hazards and defects likely to be introduced or controlled at that step are listed. It should be recognized that in preparing a Hazard Analysis Critical Control Point (HACCP)¹⁰ and/or defect action point (DAP) plan, it is essential to consult Section 5, which provides guidance on the application of the principles of the HACCP and DAP analysis. However, within the scope of this Section, it is not possible to give details of critical limits, monitoring, record keeping and verification for each of the steps since these are specific to particular hazards and defects and to the control measures used.

This Section applies to scallop products defined in the *Standard for Fresh and Quick Frozen Raw Scallop Products* (CXS 315-2014), including fresh or quick-frozen scallop meat; fresh or quick-frozen roe-on scallop meat; and quick-frozen scallop meat or quick-frozen roe-on scallop meat with added water and/or solutions of water and phosphates; and covers harvesting through land-based processing operations.

Refer to Section 3, which outlines the minimum requirements for good hygienic practices for a harvesting vessel and processing establishment prior to the application of hazard and defect analysis.

8.1 Identification of hazards and defects

8.1.1

This Section describes the main hazards and defects that may be associated with scallop products.

Refer also to Section 5.3.3.

Hazards

Refer also to Section 5.3.3.1.

When marketing scallop products, all products should meet the relevant contaminant and hygiene provisions outlined in the *Standard for Fresh and Quick Frozen Raw Scallop Products* (CXS 315-2014). Where marketing of roe-on scallop meat is concerned, this product should meet the contaminants and relevant hygiene provisions outlined in the *Standard for Live and Raw Bivalve Molluscs* (CXS 292-2008) and the *Standard for Fresh and Quick Frozen Raw Scallop Products* (CXS 315-2014).

¹⁰ Refer to Annex II for a comprehensive list of the acronyms used in this Code.

8.1.1.1 **Marine biotoxins**

Scientific data has shown that when algal blooms producing marine biotoxins¹¹ are present in harvest areas, toxins may accumulate at a hazardous level in the viscera and roe. Therefore, for roe-on scallop meat products, preventative measures should be in place, in accordance with the *Standard for Live and Raw Bivalve Molluscs* (CXS 292-2008).

With respect to scallop meat products, marine biotoxins are not reasonably likely to present a hazard. While the hazard analysis will consider marine biotoxins a potential hazard, this hazard will be excluded or included depending on the species and the available country-specific scientific evidence for toxins in that species. During shucking to produce scallop meat, incomplete removal of the viscera and roe may introduce biotoxin health hazards. If marine biotoxins are an identified hazard in the meat of the species then biotoxin control measures should be in place.

If a hazard analysis based on information from monitoring of the harvesting area or from biotoxin screening indicates that toxins are present in the viscera/whole body analysis, control measures should be in place to confirm that scallop products are safe for human consumption, e.g. further testing of meat or roe-on scallops or controls ensuring complete removal of viscera and/or roe and any other measures that the competent authority may require.

8.1.2 **Defects**

8.1.2.1 **Objectionable and foreign matter**

Sand, silt, detritus and foreign matter may accompany harvested scallops from the natural environment to shipboard. If not properly rinsed away, sand and silt may become embedded between the fibres of the adductor muscle, which is commonly associated with muscle contraction at time of death. Excessive quantities of foreign matter may result in undesirable physical attributes in the final product that would be objectionable to consumers and potentially hazardous, such as the grinding of teeth on sand and silt while chewing.

8.1.2.2 **Excess water uptake**

It has been shown that freshwater in contact with scallop adductor muscle meat will increase its moisture content over time. Scallop adductor muscle can uptake and retain added water through several physical and chemical mechanisms exhibiting various degrees of water-binding strength. The scallop adductor muscle meat should not be in contact with freshwater, including melting freshwater ice, for a period of time greater than that required for preparation and processing, otherwise the product will absorb excess water, which may be construed as an unfair trade practice or consumer fraud. Proper controls should be put in place by the producer and processor so as to avoid water uptake or limit it to that which is technologically unavoidable.

¹¹ Marine biotoxins: e.g. paralytic shellfish poisoning toxin (PSP); amnesic shellfish poisoning toxin (ASP); diarrhetic shellfish poisoning toxin (DSP).

In the case of quick-frozen scallop meat or quick-frozen roe-on scallop meat products processed with a solution of water and phosphate, or added water alone, proper processing controls should be in place to ensure that the amount of water added is consistent with the percentage of water indicated on the label (to avoid unfair trade practices or consumer fraud).

The use of a solution of water and phosphate, or added water alone, is only permitted in quick-frozen scallop products.

8.2 Processing operations

The commercial harvest practices of scallops are variable. Shucking can occur on board scallop vessels equipped for such operations or in land-based processing facilities. Scallop fishing may be either short (typically 1-2 days) or long (typically 3-15 days).

When scallops are shucked in land-based facilities, the harvest vessel voyages are short in duration so as to ensure that scallops are maintained in good condition until shucking. According to this practice, scallops are landed aboard harvest vessels, then chilled and stored under temperature control.

When scallops are shucked on board harvest vessels, the voyages can be short or long. According to this practice, the scallops are landed aboard harvest vessels, shucked, washed, pre-chilled, drained and bagged, then stored in iced, refrigerated or frozen storage until the scallop vessel has landed on shore.

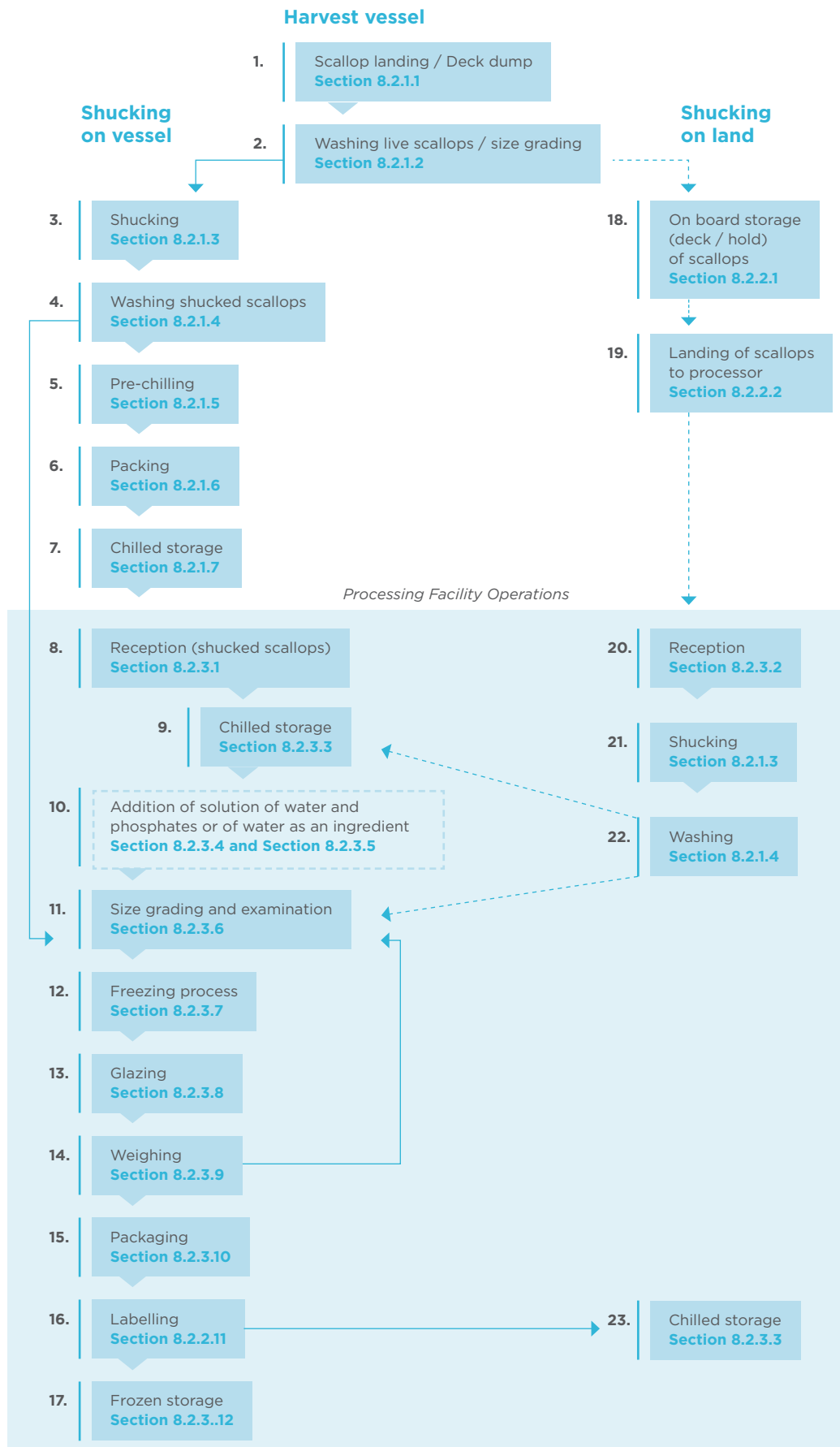
Figure 8.1

Example flow chart for the production of scallop product

This flow chart is for illustrative purpose only. For implementation of HACCP principles, a complete and comprehensive flow chart has to be drawn up for each product.

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Step exclusive to shucking on land

Optional step



8.2.1 Vessel operations (shucking on vessel)

This Section is designed to cover the handling and processing of fresh scallop meat and roe-on scallop meat on harvest vessels where the scallops are shucked on board the vessel.

8.2.1.1 Scallop landing/deck dump (Processing Step 1)

Potential hazards: microbiological contamination, biotoxins and chemical contamination

Potential defects: physical damage, dead scallops

Technical guidance:

- Refer to Section 7.3.
- Scallops showing evident signs of death or damage should be disposed of in a proper manner. Dead scallops can be identified through sensory evaluation, covering characteristics such as shell gaping, lack of response to percussion, sour odour, and/or viscera exposed outside the shell, picking of muscle or mantle, evident signs of decomposition, or other effective methods to assess viability.
 - Rough handling of live scallops should be avoided to minimize stress and injury that could lead to the death of scallops prior to processing.

8.2.1.2 Washing live scallops/size grading (Processing Step 2)

Potential hazards: microbiological, chemical and physical contamination

Potential defects: foreign matter, physical damage

Technical guidance:

- Refer to Section 7.3
- Washing should be carried out using pressurized clean seawater or saltwater made from potable water. If saltwater other than seawater is used, it should be prepared from potable water and of three percent of food grade salt to minimize the uptake of moisture. The salinity of the saltwater should be monitored.
- Scallops should be sorted and graded at this point.

8.2.1.3 Shucking (Processing Steps 3, 21)

Potential hazards: physical contamination, marine biotoxins, microbiological contamination

Potential defects: remaining viscera, remaining roe (in the case of scallop meat, dead or damaged scallops, foreign matter, cuts and tears in the flesh)

Technical guidance:

- Refer to Section 7.8.1
- Scallops should be shucked as soon as possible after harvest.
- For shucking on vessel or land, dead scallops observed during shucking should be disposed of in a proper manner because the time of death is unknown and the quality of the meat and roe may be unacceptable. Dead scallops can be identified through sensory evaluation, covering characteristics such as shell gaping, lack of response to percussion, sour odour,

and/or viscera exposed outside the shell, picking of muscle or mantle, or other effective methods to assess viability.

- For scallop meat, care should be taken to ensure that the viscera and roe are completely removed in order to reduce the risk of contamination with biotoxins and pathogens associated with the viscera.
- For Roe-on Scallop Meat, care should be taken to ensure that the viscera are completely removed.
- Care should be taken to ensure that workers' hands, shucking tables, containers and knives are properly cleaned and disinfected.
- Workers should be trained to avoid damaging scallops.
- The shucked scallops should proceed immediately to the washing step to minimize their exposure to ambient temperatures above 4 °C.

8.2.1.4

Washing shucked scallops (Processing Steps 4, 22)

Potential hazards: shell fragments / foreign matter, marine biotoxins

Potential defects: objectionable matter, foreign matter, excess water uptake

Technical guidance:

- Immediately after shucking, clean seawater or saltwater made from potable water should be used to wash scallops to remove remains of viscera, shell fragments and foreign matter such as sand and debris.
- During washing, scallops should be gently agitated and separated from each other in order to allow the removal of viscera remains, shell fragments and other foreign matter such as sand.
- If saltwater other than seawater is used it should be prepared from potable water and three percent of food grade salt to minimize the uptake of moisture. The salinity of the saltwater should be monitored.
- If potable freshwater is used, the washing/showering method should be clearly defined and the contact time between the water and scallops should be monitored and limited to minimize water uptake to that which is technologically unavoidable.
- Washed scallops should be adequately drained.
- After washing, the shucked scallops should be immediately pre-chilled, packed and refrigerated or iced and kept at an appropriate temperature (between 0 °C and 4 °C).

8.2.1.5

Pre-chilling (Processing Step 5)

Potential hazards: microbiological contamination

Potential defects: excess water uptake (applies to pre-chilling using freshwater), decomposition

Technical guidance:

- Scallops should be pre-chilled immediately following shucking and washing to reduce their core temperature prior to being placed in vessel chilled storage. This step can minimize the amount of ice melt and consequently freshwater contact with the scallops during chilled storage. Rapid chilling will also minimize subsequent drip loss.

- Pre-chilling should include the immersion of the scallops in refrigerated seawater (clean seawater cooled by a suitable refrigeration system in fixed tanks chilled by mechanical refrigeration) or in iced seawater.
- If freshwater ice is used in conjunction with clean seawater, the contact time for each batch should be kept as short as practically possible to limit any excessive uptake of water beyond that which is technologically unavoidable.
- Water used for pre-chilling should be periodically replaced to minimize the bacterial load, maintain salinity and ensure functional water temperature (i.e. $\leq 0^{\circ}\text{C}$).

8.2.1.6

Packing (Processing Step 6)

Potential hazards: microbiological, chemical and physical contamination

Potential defects: damaged scallops, foreign matter/filth, excess water uptake

Technical guidance:

- Shucked scallops should be stored in clean containers or bags made of a suitable material appropriate to be in contact with food.
- Documentation should be maintained to allow traceability of scallop batches from the harvest area, in accordance with the jurisdictional requirements. Also refer to Sections 7.10 and 3.7 as applicable.
- Storage containers/bags should not be too large, should be appropriately filled and not over-stacked in order to facilitate cooling and to prevent scallops from being damaged.

8.2.1.7

Chilled Storage (Processing Step 7)

Potential hazards: microbiological contamination

Potential defects: decomposition, excess water uptake, physical damage

Technical guidance:

- Where ice is used, containers/bags of scallops should be surrounded by sufficient finely divided ice and stored scallops should be examined regularly to ensure sufficient ice cover of the product.
- Where ice is used, measures should be taken to avoid or limit water uptake to that which is technologically unavoidable (e.g. shorter voyages, rapid and complete pre-cooling, effective holding area insulation, impermeable containers, impervious film between ice and container).
- The chilled storage compartment and/or storage containers should be adequately drained so that freshwater from the melted ice does not remain in contact with the product.
- Temperature should be monitored to ensure that the stored scallops remain at a temperature between 0°C and 4°C .
- Care should be taken to prevent damage during chilled storage. Storage containers should be identified by harvest date and other relevant product information to ensure proper utilization of the scallops at the land-based processing facility.
- The duration of shucking on vessel voyages should be limited to the number of days that will assure that at the time of offloading at shore, all harvest scallops will have adequate remaining shelf-life.

- Prior to offloading, product and storage information (e.g. dates of harvest in relation to on-board chilled storage locations) should be given due consideration to ensure the appropriate utilization of the scallops.

8.2.2 **Vessel operations (shucking on land)**

This Section covers the handling and storage of live scallops on board harvesting vessels where shucking is carried out in the land-based processing facility. The common steps for vessel operations and subsequent land-based processing for scallops shucked on land are shown in the right branch of the example flow chart (Figure 8.1).

8.2.2.1 **On board storage (deck/hold) of scallops (Processing Step 18)**

Potential hazards: microbiological, chemical and physical contamination

Potential defects: decomposition, physical damage, stress through thermal shock

Technical guidance:

- Refer to Section 7.3.
- Scallops stored on deck for short periods of time can be hosed down periodically using clean seawater to help lower temperatures in warm ambient conditions.

8.2.2.2 **Landing of scallops to processor (Processing Step 19)**

Potential hazards: microbiological, chemical and physical contamination

Potential defects: Physical damage

Technical guidance:

- Refer to Section 7.3 as well as closely related guidance on Processing Step 8 (Section 8.2.3.1).
- During landing, scallops should be unloaded without undue delay and not subject to excessive physical shock through rough handling.
- Transportation units should be clean, free of contamination and temperature-controlled where necessary.
- Appropriate documentation should be completed to comply with any regulatory requirements.

8.2.3 **Processing facility operations**

This Section covers the processing of scallop products as delineated in the example flow chart (Figure 8.1).

8.2.3.1 **Reception (shucked scallops) (Processing Step 8)**

Potential hazards: marine biotoxins, microbiological, chemical and physical contamination

Potential defects: decomposition, excess water uptake, parasites, objectionable matter, foreign matter

Technical guidance:

- Product specifications commonly include the following provisions:
 - Sensory characteristics such as appearance, flavour, odour, texture, etc.;
 - Species identification;
 - Acceptable upper limit moisture content;
 - Workmanship (e.g. presence of viscera/roe);
 - Chemical contamination (e.g. heavy metals);
 - Presence of foreign matter; and
 - Visible parasites.
- A processor should have a process in place to ensure that the toxicity content meets the regulatory requirements of the official agency having jurisdiction over the harvest area. This could be accomplished by adhering to toxin monitoring programmes or end-product testing. As per Section 8.1.1.1, this consideration would also apply to scallop meat in which the hazard analysis has determined that marine biotoxins are a hazard.
- Scallop handlers and appropriate personnel should acquire skills in sensory and physical examination techniques to ensure incoming lots meet essential quality provisions of the *Standard for Fresh and Quick Frozen Raw Scallop Products* (CXS 315-2014).
- Appropriate procedures should be in place for scallop handlers and appropriate personnel to verify that specifications are met. This could include, but is not limited to, inspecting the product and reviewing product information in commercial documentation.

8.2.3.2**Reception (Processing Step 20)**

Potential hazards: marine biotoxins, microbiological, chemical and physical contamination

Potential defects: dead or damaged scallops, parasites, objectionable matter, foreign matter

Technical guidance:

- Refer to Section 7.6.1.
- Scallops should be carefully unloaded without undue delay and adequately chilled to avoid microbiological contamination and decomposition.
- Scallops showing evident signs of death or damage should be disposed of in a proper manner. Dead scallops can be identified through sensory evaluation, covering characteristics such as shell gaping, lack of response to percussion, sour odour, viscera exposed outside the shell, picking of muscle or mantle, evident signs of decomposition or other effective methods to assess viability.
 - Rough handling of live scallops should be avoided to minimize stress and injury that could lead to the death of scallops prior to processing.

- Product specifications commonly include the following provisions:
 - Evident signs of death;
 - Broken shells;
 - Species identification;
 - Chemical contamination (e.g. heavy metals);
 - Presence of foreign matter; and
 - Visible parasites.
- A processor should have a process in place to ensure that the toxicity content meets the regulatory requirements of the official agency having jurisdiction over the harvest area. This could be accomplished by adhering to toxin monitoring programmes or end-product testing. As per Section 8.1.1.1, this consideration would also apply to scallop meat in which the hazard analysis has determined that marine biotoxins are a hazard.
- Scallop handlers and appropriate personnel should acquire skills in sensory and physical examination techniques to ensure incoming lots meet essential quality provisions of the *Standard for Fresh and Quick Frozen Raw Scallop Products* (CXS 315-2014).
- Appropriate procedures should be in place for scallop handlers and appropriate personnel to verify that specifications are met. This could include, but is not limited to, inspecting the product and reviewing product information in commercial documentation.

8.2.3.3

Chilled storage (Processing Steps 9, 23)

Potential hazards: [microbiological, chemical and physical contamination](#)

Potential defects: [decomposition, physical damage](#)

Technical guidance:

- Refer to Section 7.6.5.2.
- Stock rotation schemes should be used to ensure proper utilization of the scallop products. For scallops packed in containers, their identification tag facilitates the determination of the harvest date.
- Scallop products should be stored between 0 °C and 4 °C. The temperature should be monitored during chilled storage.
- Product should be stacked in a manner that facilitates adequate and uniform temperature distribution to all parts of the stored product.
- If freshwater ice is used to chilled scallops, care should be taken to provide adequate drainage and minimize water uptake (see Section 8.2.1.7). Any measurable absorbed water from ice should be properly measured and labelled.

8.2.3.4 **Addition of a solution of water and phosphate (Optional) (Processing Step 10)**

Potential hazards: microbiological and chemical contamination, use of unapproved or non-food grade additives

Potential defects: incorrect application of formulation of phosphate solution, excess water uptake, off-flavours and textures, decomposition, inaccurate measurement and labelling of percent added phosphate solution

Technical guidance:

- Food grade phosphates should be used in compliance with the requirements of the *Standard for Fresh and Quick Frozen Raw Scallop Products* (CXS 315-2014).
- Addition of phosphate solutions (phosphates and water) is an optional step that results in a different product requiring different descriptive labelling.
- The quantity of phosphate solution added to scallops (for the production of quick-frozen products only) should be limited to the lowest possible level necessary to accomplish the technological purpose (e.g. moisture retention, preservative). Phosphate solutions should not be used for the purpose of adding water to increase net weight. However, their use will result in the binding of additional water from the phosphate solution into the scallop meat. A processor should develop and follow a process for the application of phosphate solutions in order to consistently achieve the functional goals.
- The net weight of the in-process scallop batch should be recorded prior to and following the phosphate treatment in order to calculate the percentage added solution for labelling purposes.
- Refer to Sections 9.5.1 and 9.5.2 for guidance on the reception and storage of ingredients.

8.2.3.5 **Addition of water (Optional) (Processing Step 10)**

Potential hazards: microbiological and chemical contamination

Potential defects: inaccurate measurement and labelling of percentage added water

Technical guidance:

- The quantity of water added to scallops as an ingredient (for the production of quick-frozen products only) should be limited to the lowest possible level.
- The weight of added water and scallops should be controlled and accurate in order to calculate the percentage added water for labelling purposes.

8.2.3.6 **Size grading and examination (Processing Step 11)**

Potential hazards: microbiological contamination

Potential defects: decomposition, improper size variation, parasites, physical contamination (filth)

Technical guidance:

- Size grading of scallops is typically undertaken through mechanical graders of various degrees of sophistication. Given the possibility of scallops becoming trapped in the bars of the graders, regular inspection and cleaning are required to prevent “carryover” of old scallops.
- Grey or black adductor meat, which indicates that the scallop was dead at the time of shucking and is likely decomposed and may present a consumer health hazard, should be removed from the lot.
- Scallops with an objectionable level of parasites should be culled from the lot.
- Containers of graded and examined scallops should be kept cool to ensure that the internal temperature is kept between 0 °C and 4 °C.
- Exposure to ambient temperatures above 4 °C should be minimal and monitored.

8.2.3.7 **Freezing Process (Processing Step 12)**

Potential hazards: unlikely

Potential defects: texture deterioration, freezer burn

Technical guidance:

- Refer to Section 9.3.1.

8.2.3.8 **Glazing (Processing Step 13)**

Potential hazards: unlikely

Potential defects: dehydration

Technical guidance:

- Refer to Section 9.3.2.
- When scallops are individually quick-frozen, glaze is usually applied. If scallops are block frozen, glaze is not commonly applied (block freezing could occur after the packaging step).

8.2.3.9 **Weighing (Processing Step 14)**

Potential hazards: unlikely

Potential defects: incorrect net weight

Technical guidance:

- Refer to Section 9.2.1.
- Net weight is often determined by weighing glazed scallops and accounting for the weight of the glaze. For that reason, glaze levels should be routinely measured to ensure that proper net weights are identified.
- Scales should be properly adjusted to account for the estimated glaze percentage and re-adjusted when glaze percentage changes.

8.2.3.10 **Packaging (Processing Step 15)**

Potential hazards: microbiological, chemical and physical contamination

Potential defects: misdescription, loss of quality characteristics of packaging materials

Technical guidance:

- Refer to Sections 7.6.4.2 and 9.5.2.
- Fresh scallops and scallops intended for block freezing should be adequately drained before packing into cartons.

8.2.3.11 **Labelling (Processing Step 16)**

Potential hazards: unlikely

Potential defects: incorrect labelling, inaccurately declared added phosphate solution or added water

Technical guidance:

- Information on the labels should be in compliance with the *General Standard for the Labelling of Prepackaged Foods* (CXS 1-1985) and the *Standard for Fresh and Quick Frozen Raw Scallop Products* (CXS 315-2014).
- When a solution of water and phosphate is used in the process or water is added as an ingredient in quick-frozen scallops, this shall be declared on the label in accordance with the *Standard for Fresh and Quick Frozen Raw Scallop Products* (CXS 315-2014). Also refer to Sections 8.2.3.4 and 8.2.3.5

8.2.3.12 **Frozen storage (Processing Step 17)**

Potential hazards: unlikely

Potential defects: dehydration, decomposition, development of rancid flavours and odours, loss of nutritional quality

Technical guidance:

- Refer to Section 9.1.3.
- The length of time after which rancid flavours and odours may develop under the packaging and frozen storage conditions in use should be determined to assure that the frozen product is distributed with adequate remaining shelf-life.



9

Processing of fresh, frozen and minced fish



In the context of recognizing controls at individual processing steps, this Section provides examples of potential hazards and defects and describes technological guidelines that can be used to develop control measures and corrective action. At any particular step, only the hazards and defects that are likely to be introduced or controlled at that step are listed. It should be recognized that in preparing a Hazard Analysis Critical Control Point (HACCP)¹² and/or defect action point (DAP) plan it is essential to consult Section 5, which provides guidance for the application of the principles of HACCP and DAP analysis. However, within the scope of this Code, it is not possible to give details of critical limits, monitoring, record-keeping and verification for each of the steps as these are specific to particular hazards and defects.

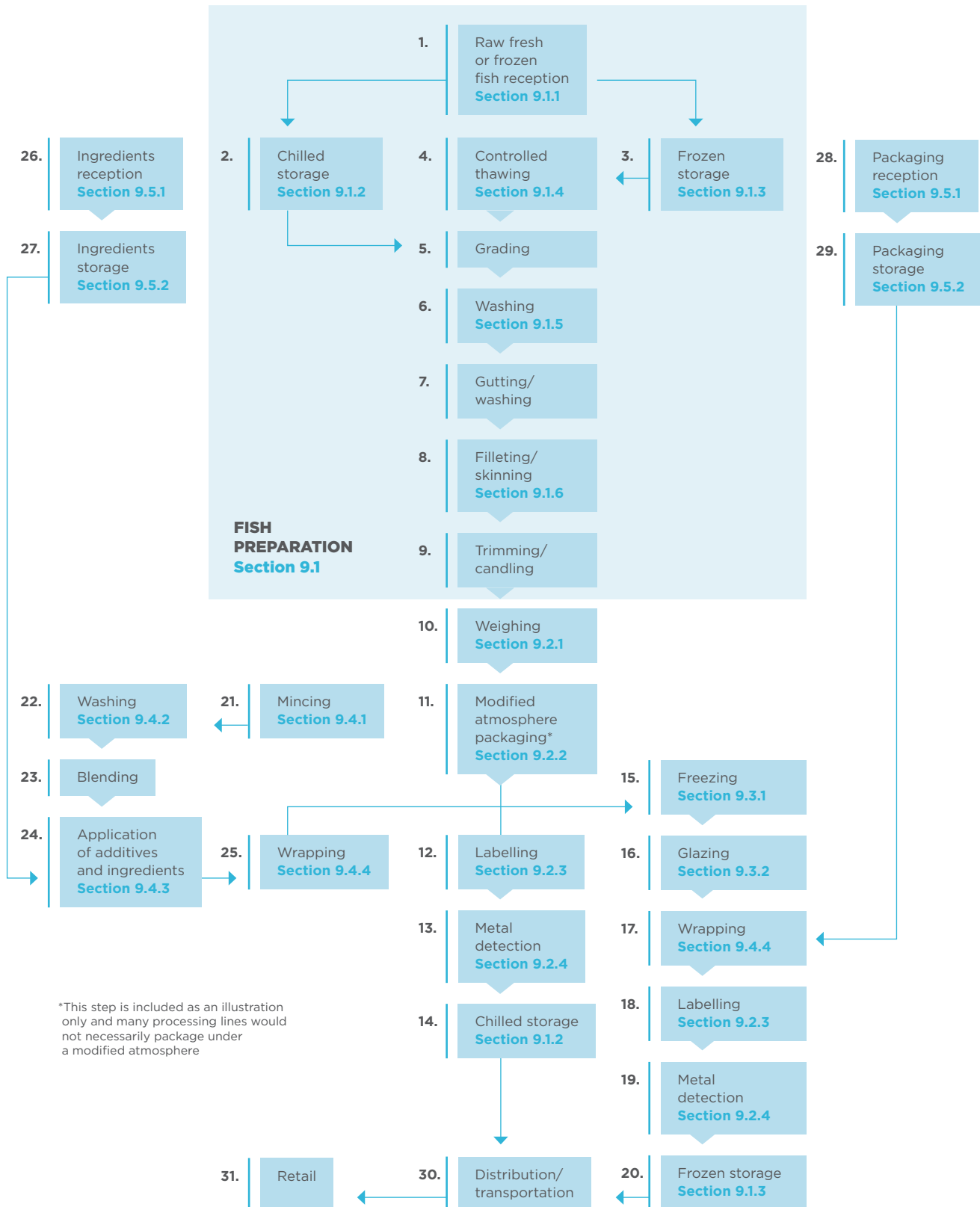
In general, the processing of fresh, frozen and minced fish will range in sophistication. In its simplest form, the processing of fresh and frozen fish may be presented in a raw state, such as dressed, fillets and minced, to be distributed in markets and institutions or used in processing facilities. For the latter, the processing of fresh, frozen and minced fish is often an intermediate step to the production of value-added products (for example, smoked fish as described in Section 14, canned fish as described in Section 18, frozen breaded or battered fish as described in Section 12). Traditional methods often prevail in the design of a process. However, modern scientific food technology is playing an increasingly important role in enhancing the preservation and shelf-stability of products. Regardless of the complexity of a particular process, the production of the desired product relies on the consecutive execution of individual steps. As stressed in this Code, the application of appropriate elements of the prerequisite programme (Section 3) and HACCP principles (Section 5) at these steps will provide the processor with reasonable assurance that the essential quality, composition and labelling provisions of the appropriate Codex standard will be maintained and food safety issues controlled.

The example of the flow diagram (Figure 9.1) provides guidance for some of the common steps involved in a fish fillet-preparation line, and three examples of final product types: modified atmosphere packaging (MAP), minced fish and frozen fish. As in the further processing of fresh fish in a MAP product, or minced or frozen fish, the section labelled “Fish preparation” is used as the basis for all the other fish-processing operations (Sections 11, 13, 14, 18 and 22), where appropriate. For fish susceptible to scombrototoxin formation, refer to Section 10 “Harvesting, Processing, Storage and Distribution of Fish and Fishery Products at Risk for Scombrototoxin (Histamine) Formation” for information on the control of histamine, including guidance for harvest vessel operations.

¹² Refer to Annex II for a comprehensive list of the acronyms used in this Code.

Figure 9.1 Example flow chart of a fish fillet-preparation line, including MAP, mincing and freezing operations

This flow chart is for illustrative purpose only. For in factory HACCP implementation, a complete and comprehensive flow chart has to be drawn up for each process. References correspond to relevant sections of the Code.



9.1 Finfish preparation

The hygienic conditions and technical manner in which fish is prepared are similar and not influenced greatly by the intended purpose (for direct distribution or for further processing). However, variations will exist in the form in which the fresh fish flesh is to be utilized. The forms may include, but are not limited to, dressed, fillets or steaks.

9.1.1

Raw, fresh or frozen fish reception (Processing Step 1)

Potential hazards: microbiological contamination, viable parasites, biotoxins, scombrototoxin, chemicals (including veterinary drug residues) and physical contamination.

Potential defects: decomposition, parasites, physical contamination

Technical guidance:

- For raw fish material, product specifications could include the following characteristics:
 - organoleptic characteristics, such as appearance, odour, texture;
 - chemical indicators of decomposition and/or contamination, for example, total volatile basic nitrogen (TVBN), histamine, heavy metals, pesticide residues, nitrates;
 - microbiological criteria, in particular for intermediate raw materials, to prevent the processing of raw material containing microbial toxins;
 - foreign matter;
 - physical characteristics, such as size of fish; and
 - species homogeneity.
- Training in species identification and communication in product specification should be provided to fish handlers and appropriate personnel to ensure a safe source of incoming fish where written protocols exist. Warranting special consideration are the reception and sorting of fish species that pose a risk of biotoxins such as ciguatera in large carnivorous tropical and subtropical reef fish or scombrototoxin in scombroid species or parasites.
- Skills should be acquired by fish handlers and appropriate personnel in sensory evaluation techniques to ensure raw fish meet essential quality provisions of the appropriate Codex standard.
- Fish requiring gutting on arrival at the processing facility should be gutted efficiently, without undue delay and with care to avoid contamination (see Section 9.1.5).
- Fish should be rejected if it is known to contain harmful, decomposed or extraneous substances that will not be reduced or eliminated to an acceptable level by normal procedures of sorting or preparation.
- Information about the harvesting area.

9.1.1.1 **Sensory evaluation of fish**

The best method of assessing the freshness or spoilage of fish is by sensory evaluation techniques.¹³ It is recommended that appropriate sensory evaluation criteria be used to evaluate the acceptability of fish and to eliminate fish showing loss of essential quality provisions of the appropriate Codex standards. As an example, fresh whitefish species are considered unacceptable when showing the following characteristics:

Skin/slime	dull, gritty colours with yellow-brown dotting slime.
Eyes	concave, opaque, sunken, discoloured.
Gills	grey-brown or bleached, slime opaque yellow, thick or clotting.
Odour	flesh odour amines, ammonia, milky lactic, sulphide, faecal, putrid, rancid.

9.1.2 **Chilled storage (Processing Steps 2 and 14)**

Potential hazards: [microbiological contamination](#), [biotoxins](#), [scombrotoxin](#)

Potential defects: [decomposition](#), [physical damage](#)

Technical guidance:

- Fish should be moved to the chilled storage facility without undue delay.
- The facility should be capable of maintaining the temperature of fish between 0 °C and 4 °C.
- The chill room should be equipped with a calibrated indicating thermometer. Fitting of a recording thermometer is strongly recommended.
- Stock rotation plans should ensure proper utilization of the fish.
- Fish should be stored in shallow layers and surrounded by sufficient finely divided ice or with a mixture of ice and water before processing.
- Fish should be stored in such a way as to prevent damage from over-stacking or overfilling of boxes.
- Where appropriate, replenish ice supply on the fish or alter temperature of the room.

9.1.3 **Frozen storage (Processing Steps 3 and 20)**

Potential hazards: [microbiological contamination](#), [toxins](#), [viable parasites](#)

Potential defects: [dehydration](#), [rancidity](#), [loss of nutritional quality](#)

Technical guidance:

- The facility should be capable of maintaining the temperature of the fish at or colder than -18 °C, and with minimal temperature fluctuations.
- The store should be equipped with a calibrated indicating thermometer. Fitting of a recording thermometer is strongly recommended.
- A systematic stock rotation plan should be developed and maintained.

¹³ Guidelines for the sensory evaluation of fish and shellfish in laboratories (RCXG 31-1999).

- Product should be glazed and/or wrapped to protect it from dehydration.
- Fish should be rejected if known to contain defects that subsequently cannot be reduced or eliminated to an acceptable level by re-working. An appropriate assessment should be carried out to determine the reason(s) for loss of control and the DAP plan modified where necessary.
- For killing parasites harmful to human health, the freezing temperature and monitoring of duration of freezing should be combined with good inventory control to ensure sufficient cold treatment.

9.1.4

Controlled thawing (Processing Step 4)

Potential hazards: microbiological contamination, biotoxins, scombrototoxin

Potential defects: decomposition

Technical guidance:

- The thawing method should be clearly defined and should address the time and temperature of thawing, temperature measuring instrument used and placement of device for measurement. The thawing schedule (time and temperature parameters) should be carefully monitored. Selection of the thawing method should take into account in particular the thickness and uniformity of size of the products to be thawed.
- Thawing time and temperature and fish temperature critical limits should be selected so as to control the development of microorganisms and histamine (where high-risk species are concerned) or persistent and distinctive objectionable odours or flavours indicative of decomposition or rancidity.
- Where water is used as the thawing medium, it should be of potable quality.
- Where recycling of water is used, care should be taken to avoid the build-up of microorganisms.
- Where water is used, circulation should be sufficient to produce even thawing.
- During thawing, according to the method used, products should not be exposed to excessively high temperatures.
- Particular attention should be paid to controlling condensation and drip from the fish. Effective drainage should be ensured.
- After thawing, fish should be immediately processed or refrigerated and kept at the adequate temperature (temperature of melting ice).
- The thawing schedule should be reviewed as appropriate and amended where necessary.

9.1.5

Washing and gutting (Processing Steps 6 and 7)

Potential hazards: microbiological contamination, biotoxins and scombrototoxin

Potential defects: presence of viscera, bruising, off-flavours, cutting faults, decomposition

Technical guidance:

- Gutting is considered complete when the intestinal tract and internal organs have been removed.
- An adequate supply of clean seawater or potable water should be available for washing of:
 - whole fish, to remove foreign debris and reduce bacterial load prior to gutting;
 - gutted fish, to remove blood and viscera from the belly cavity;
 - surface of fish, to remove any loose scales;
 - gutting equipment and utensils, to minimize build-up of slime, blood and offal.
- Depending on the vessel or processing facility product flow pattern and where a prescribed critical limit for staging time and temperature regime has been established for the control of histamine or a defect, the gutted fish should be drained and well iced or appropriately chilled in clean containers and stored in specially designated and appropriate areas within the processing facility.
- Separate and adequate storage facilities should be provided for the fish roe, milt and livers, if these are saved for later utilization.

9.1.6

Filleting, skinning, trimming and candling (Processing Steps 8 and 9)

Potential hazards: viable parasites, microbiological contamination, biotoxins, scombrototoxin, presence of bones

Potential defects: parasites, presence of bones, objectionable matter (e.g. skin, scales), decomposition

Technical guidance:

- To minimize time delays, the design of the filleting line and candling line, where applicable, should be continuous and sequential to permit uniform flow without stoppages or slowdowns and removal of waste.
- An adequate supply of clean seawater or potable water should be available for washing of:
 - fish prior to filleting or cutting, especially fish that have been scaled;
 - fillets after filleting, skinning or trimming to remove any signs of blood, scales or viscera;
 - filleting equipment and utensils to minimize build-up of slime and blood and offal;

- for fillets to be marketed and designated as boneless, fish handlers should employ appropriate inspection techniques and use the necessary tools to remove bones not meeting Codex Standards¹⁴ or commercial specifications.
- The candling of skinless fillets by skilled personnel, in a suitable location that optimizes the illuminating effect, is an effective technique in controlling parasites (in fresh fish) and should be employed when implicated fish species are being used.
- The candling table should be frequently cleaned during operation in order to minimize the microbial activity of contact surfaces and the drying of fish residue caused by heat generated from the lamp.
- Where a prescribed critical limit for staging time and temperature regime has been established for the control of histamine or a defect, the fish fillets should be well iced or appropriately chilled in clean containers, protected from dehydration and stored in appropriate areas within the processing facility.

9.2 Processing of vacuum or modified atmosphere packaged fish

9.2.1

This Section is designed to augment the section on the processing of fresh fish with additional operational steps pertaining specifically to the modified atmosphere packaging of fish.

Weighing (Processing Step 10)

Potential hazards: unlikely

Potential defects: incorrect net weight

Technical guidance:

- Weigh scales should be periodically calibrated with a standard mass to ensure accuracy.

9.2.2

Vacuum or modified atmosphere packaging (Processing Step 11)

Potential hazards: subsequent microbiological contamination and biotoxins, scombrototoxin produced subsequent to packaging, physical contamination (metal)

Potential defects: subsequent decomposition

Technical guidance:

- The extent to which the shelf-life of the product can be extended by vacuum or MAP will depend on the species, fat content, initial bacterial load, gas mixture, type of packaging material and, especially important, the temperature of storage.

¹⁴ Standard for Quick Frozen Blocks of Fish Fillets, Minced Fish Flesh and Mixtures of Fillets and Minced Fish Flesh (CXS 165-1989) and General Standard for Quick Frozen Fish Fillets (CXS 190-1995).

- MAP should be strictly controlled by:
 - monitoring the gas-product ratio;
 - types and ratio of gas mixtures used;
 - type of film used;
 - type and integrity of the seal;
 - temperature control of product during storage; and
 - existence of adequate vacuum and packaging.
- Fish flesh should be clear of the seam area.
- Packaging material should be inspected prior to use to ensure that it is not damaged or contaminated.
- Packaging integrity of the finished product should be inspected at regular intervals by appropriately trained personnel to verify the effectiveness of the seal and the proper operation of the packaging machine.
- Following sealing, MAP or vacuum-packed products should be transferred carefully and without undue delay to chilled storage.
- Ensure that adequate vacuum is attained, and the package seals are intact.

9.2.3

Labelling (Processing Steps 12 and 18)

Potential hazards: unlikely

Potential defects: incorrect labelling

Technical guidance:

- Prior to their application, labels should be verified to ensure that all information declared meets, where applicable, the *General Standard for the Labelling of Prepackaged foods* (CXS 1-1985), labelling provisions of the appropriate Codex Standard for products and/or other relevant national legislative requirements.
- In many cases, it will be possible to re-label incorrectly labelled products. An appropriate assessment should be carried out to determine the reason(s) for incorrect labelling and the DAP plan should be modified where necessary.

9.2.4

Metal detection (Processing Steps 13 and 19)

Potential hazards: metal contamination

Potential defects: unlikely

Technical guidance:

- It is important that line speeds are adjusted to allow for the proper functioning of a metal detector.
- Routine procedures should be initiated to ensure product rejected by the detector is investigated as to the cause of the rejection.
- Metal detectors, if used, should be periodically calibrated with a known standard to ensure proper operation.

9.3 Processing of frozen fish

This Section is designed to augment the section on the processing of fresh fish with additional operational steps pertaining specifically to the processing of frozen fish.

9.3.1

Freezing process (Processing Step 15)

Potential hazards: viable parasites, scombrototoxin

Potential defects: texture deterioration, development of rancid odours, freezer burn, decomposition

Technical guidance:

- The fish product should be subjected to a freezing process as quickly as possible because unnecessary delays before freezing will cause temperature of the fish products to rise, increasing the rate of quality deterioration and reducing shelf-life owing to the action of microorganisms and undesirable chemical reactions.
- A time and temperature regime for freezing should be established and should take into consideration the freezing equipment and capacity, the nature of the fish product including thermal conductivity, thickness, shape and temperature and the volume of production to ensure that the range of temperature of maximum crystallization is passed through as quickly as possible.
- The thickness, shape and temperature of fish product entering the freezing process should be as uniform as possible.
- Processing facility production should be geared to the capacity of freezers.
- Frozen product should be moved to the cold storage facility as quickly as possible.
- The core temperature of the frozen fish should be monitored regularly for completeness of the freezing process.
- Frequent checks should be made to ensure correct operation of freezing.
- Accurate records of all freezing operations should be kept.
- For killing parasites harmful to human health, the freezing temperature and monitoring of duration of freezing should be combined with good inventory control to ensure sufficient cold treatment.

9.3.2

Glazing (Processing Step 16)

Potential hazards: microbiological contamination

Potential defects: subsequent dehydration, incorrect net weight

Technical guidance:

- Glazing is considered complete when the entire surface of the frozen fish product is covered with a suitable protective coating of ice and should be free of exposed areas where dehydration (freezer burn) can occur.
- If additives are used in the water for glazing, care should be taken to ensure its proper proportion and application with product specifications.

- Where the labelling of a product is concerned, information on the amount or proportion of glaze applied to a product or a production run should be kept and used in the determination of the net weight, which is exclusive of the glaze.
- Where appropriate, monitoring should ensure that spray nozzles do not become blocked.
- Where dips are used for glazing, it is important to replace the glazing solution periodically to minimize the bacterial load and build-up of fish protein, which can hamper freezing performance.

9.4 Processing of minced fish

This Section is designed to augment the section on the processing of fresh fish (prior to mincing) and the section on the processing of frozen fish section (after mincing) with additional operation steps pertaining specifically to the processing of minced fish.

9.4.1

Mincing fish using mechanical separation process (Processing Step 21)

Potential hazards: microbiological contamination, biotoxins and scombrototoxin, physical contamination (metal, bones, rubber from separator belt, etc.)

Potential defects: incorrect separation (i.e. objectionable matter), decomposition, presence of defect bones, parasites

Technical guidance:

- The separator should be fed continuously but not excessively.
- Candling is recommended for fish suspected of high infestation with parasites.
- Split fish or fillets should be fed to the separator so that the cut surface contacts the perforated surface.
- Fish should be fed to the separator in a size that it is able to handle.
- In order to avoid time-consuming adjustments of the machinery and variations in quality of the finished product, raw materials of different species and types should be segregated and processing of separate batches should be carefully planned.
- The perforation sizes of the separator surface as well as the pressure on the raw material should be adjusted to the characteristics desired in the final product.
- The separated residual material should be carefully removed on a continuous or near-continuous basis to the next processing stage.
- Temperature monitoring should ensure undue temperature rises of the product are avoided.

9.4.2

Washing of minced fish (Processing Step 22)

Potential hazards: microbiological contamination and scombrototoxin

Potential defects: poor colour, poor texture, excess of water, decomposition

Technical guidance:

- If necessary, the mince should be washed and should be adequate for the type of product desired.
- Stirring during washing should be carried out with care, but it should be kept as gentle as possible in order to avoid excessive disintegration of the minced flesh, which will reduce the yield owing to the formation of fines.
- The washed minced fish flesh may be partially dewatered by rotary sieves or centrifugal equipment and the process completed by pressing to appropriate moisture content.
- If necessary, and depending on eventual end use, the dewatered mince should be either strained or emulsified.
- Special attention should be taken to ensure mince being strained is kept cool.
- The resulting wastewater should be disposed of in a suitable manner.

9.4.3

Blending and application of additives and ingredients to minced fish (Processing Step 23 e 24)

Potential hazards: physical contamination, microbiological contamination, non-approved additives and/or ingredients, scombrototoxin

Potential defects: physical contamination, incorrect addition of additives, decomposition

Technical guidance:

- If fish, ingredients and /or additives are to be added, they should be blended in the proper proportions to achieve the desired sensory quality.
- Additives should comply with the requirements of the *General Standard for Food Additives* (CXS 192-1995).
- The minced fish product should be packaged and frozen immediately after preparation; if it is not frozen or used immediately after preparation, it should be chilled.

9.4.4

Wrapping and packaging (Processing Steps 17 and 25)

Potential hazards: microbiological contamination, scombrototoxin

Potential defects: subsequent dehydration, decomposition

Technical guidance:

- Packaging material should be clean, sound, durable, sufficient for its intended use and of food-grade material.
- The packaging operation should be conducted to minimize the risk of contamination and decomposition.
- Products should meet appropriate standards for labelling and weights.

9.5

Packaging, labels and ingredients

9.5.1

Reception – packaging, labels and ingredients (Processing Steps 26 and 28)

Potential hazards: microbiological contamination, chemical and physical contamination

Potential defects: misdescription

Technical guidance:

- Only ingredients, packaging material and labels complying with the specifications of the processors should be accepted into the processing facility.
- Labels that are to be used in direct contact with the fish should be made of a non-absorbent material and the ink or dye used on that label should be approved by the official agency having jurisdiction.
- Ingredients and packaging material not approved by the official agency having jurisdiction should be investigated and rejected at reception.

9.5.2

Storage – packaging, labels and ingredients (Processing Steps 27 and 29)

Potential hazards: microbiological contamination, chemical and physical contamination

Potential defects: loss of quality characteristics of packaging materials or ingredients

Technical guidance:

- Ingredients and packaging should be stored appropriately in terms of temperature and humidity.
- A systematic stock rotation plan should be developed and maintained to avoid out-of-date materials.
- Ingredients and packaging should be properly protected and segregated to prevent cross-contamination.
- Defective ingredients and packaging should not be used.







10

**Harvesting,
processing, storage
and distribution
of fish and fishery
products at risk
for scombrototoxin
(histamine) formation**

This Section complements other sections of the Code by providing detailed control recommendations for the prevention of scombrototoxin fish poisoning (SFP). This Section only applies to specific marine finfish species (e.g. *Scombridae*, *Clupeidae*, *Engraulidae*, *Coryphaenidae*, *Pomatomidae*, *Scomberesocidae*) that present the greatest potential for developing hazardous levels of histamine. This Section contains specific guidelines for preventing SFP; however, within the scope of this Code, it is not possible to provide all the appropriate controls and alternatives that may apply to every operation as these will vary with each particular operation.

SFP is a worldwide food safety challenge that, in some parts of the world, accounts for the largest proportion of fish-borne illness cases. Individuals suffering from SFP may show one or more symptoms including flushing, swelling, rash, itching, headache, heart palpitations, abdominal cramps, diarrhoea, and vomiting. In some cases, exacerbation of asthma and more serious cardiac manifestations may occur. Symptoms typically develop rapidly (from 5 minutes to 2 hours after ingestion of implicated fish), with a usual duration of 8-12 hours, although symptoms may persist for up to several days. SFP is rarely fatal. Scombrototoxin poisoning is generally a mild disorder where the symptoms disappear quickly after an anti-histamine treatment and where no known long-term sequelae were reported.

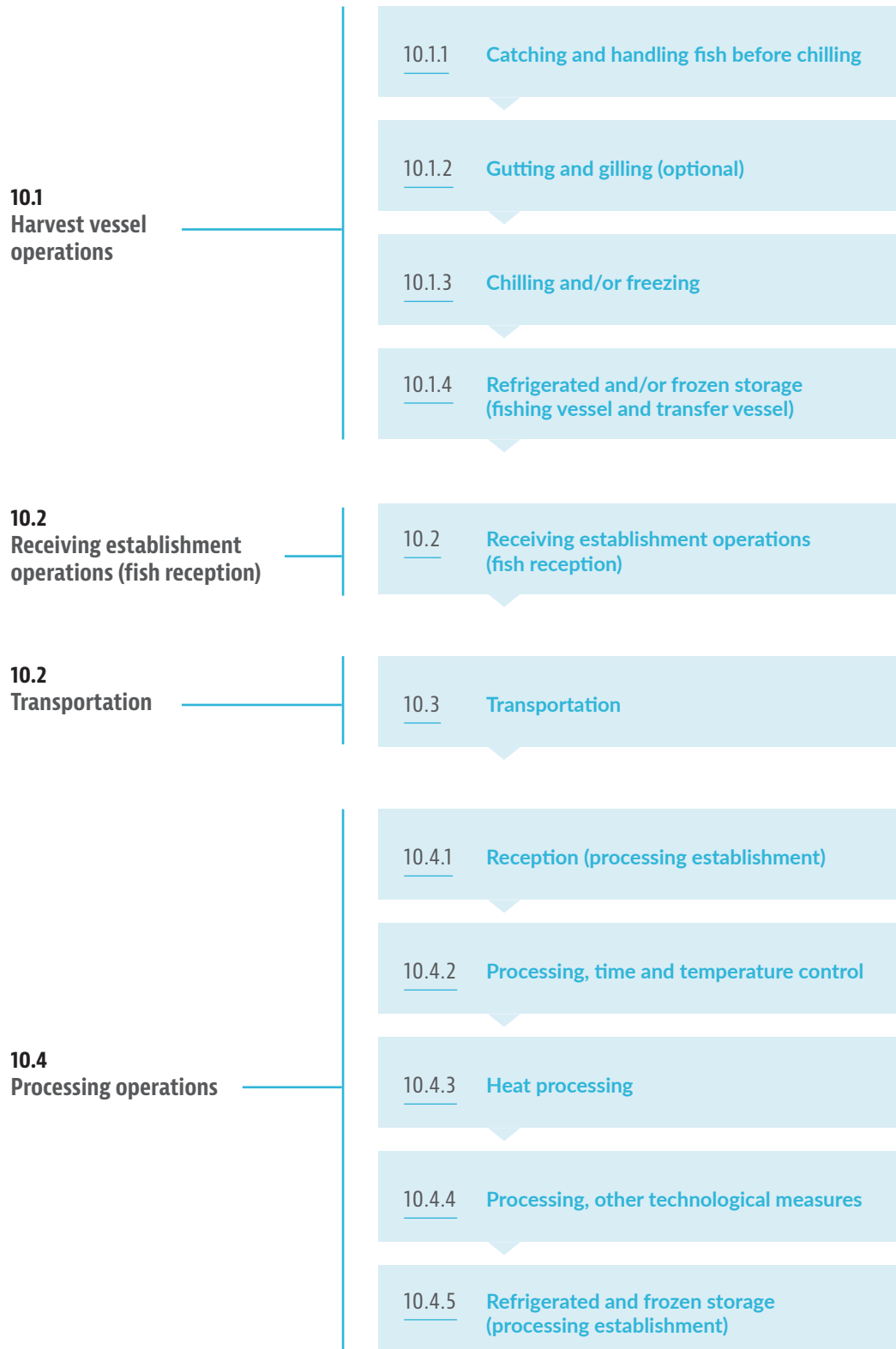
Scombrototoxin fish poisoning is caused by the ingestion of certain species of marine fish that have been subjected to conditions that are favourable for the multiplication of bacteria and development of scombrototoxin, such as time-temperature abuse. Generally, this takes place at a temperature of more than 25°C over a period of more than six hours or for longer at lower temperatures.

Although detailed components of scombrototoxin have not been identified, it is generally accepted that biogenic amines produced by spoilage bacteria, especially histamine, play an important role in the pathogenesis of SFP. Other biogenic amines that are also produced during fish spoilage, such as cadaverine and putrescine, are thought to increase the toxicity of histamine. However, in most epidemiological studies, SFP is associated with high histamine levels in the implicated fish, and the controls used to inhibit histamine-producing bacteria and enzymes are also expected to be effective at preventing the formation of other biogenic amines. Therefore, histamine serves as a useful indicator compound for scombrototoxin, and histamine is monitored for scombrototoxin control purposes.

Histamine is produced in fish and fishery products by spoilage bacteria that are part of the natural microflora of the skin, gills, and gut of freshly caught fish. After the fish die, these bacteria migrate into the previously sterile fish musculature where they multiply if time and temperature are not controlled. When histamine-producing bacteria multiply in fish flesh, they produce histidine decarboxylase (HDC) enzymes, that convert histidine (naturally present in muscle tissue flesh of at risk fish) into the toxic metabolite histamine. Rapid multiplication of histamine-producing bacteria can be prevented or de-

Figure 10.1 Example flow chart for the production of fish at risk of scombrototoxin formation

This flow chart is for illustrative purpose only. A complete and comprehensive flow chart has to be drawn up for each product.



layed by chilling fish immediately after death and maintaining the fish in a chilled, or frozen state from harvest to consumption. However, once sufficient bacterial multiplication has occurred to produce histidine decarboxylase, enzymatic activity can continue to produce histamine slowly at refrigeration temperatures.

The following subsections contain technical guidance for the control of histamine formation at key steps in the food chain (harvesting, receiving, transportation, and processing operations).

The relevant sections of the guidelines in this Section may also apply to aquacultured fish.

10.1 Harvest vessel operations

Fishers use many different harvesting methods throughout the world, employing hooks, nets, and traps. In all cases, live retrieval or quick retrieval of dead fish, rapid chilling of the fish in a timely manner, and maintenance of the fish at cold temperatures, are critical to prevent histamine formation.

The fishing vessel and equipment, and the methods used, should be designed or adapted to prevent histamine formation for the catch sizes, fish sizes, fish species, and air and water temperatures encountered. Vessel crews should be trained in hygienic practices and temperature control methods and understand their importance for histamine control. Where HACCP principles are used, persons responsible for developing HACCP documentation should be trained in HACCP principles used to control histamine formation.

Harvest vessel operations are considered primary productions and GMPs are sufficient to control histamine at this level. However, in the absence of information to document on-vessel histamine control, for example, records of temperature, the shore-based receiving establishment should perform histamine testing on each vessel delivery to monitor and to document that the histamine levels in the raw material received are acceptable. If vessel operations provide documented evidence that histamine was controlled on the vessel, then the receiving establishment may choose to examine the vessel monitoring records as an alternative to testing each lot. The control of fish time-temperature exposure on harvest vessels and associated evidence of control provide more reliable consumer protection than testing histamine levels after delivery.

10.1.1

Catching and handling fish before chilling

- Limits should be established for the time period between death of the fish and the start of chilling that will effectively minimize histamine production. The time period may be adjusted according to water and air temperatures, the size and species of fish caught, and other relevant factors of the operation. The types of histamine-producing bacteria present and how rapidly they produce histamine can also change, therefore established limits should take into account the worst-case scenario. The FAO/WHO Expert Report (Section 6.1.1 Chilling)¹⁵ provides examples of time limits from fish death to chilling for medium to large fish.

¹⁵ Joint FAO/WHO Expert Meeting on the Public Health Risks of Histamine and Other Biogenic Amines from Fish and Fishery Products, July 2012, Rome (Section 6.1.1 Chilling.)
Link: http://www.fao.org/fileadmin/user_upload/agns/pdf/Histamine/Histamine_AdHocfinal.pdf

- Time of death of the fish may be the time slaughtered onboard, or where the actual time of death is not observed or truly known, an estimated time based on an observable event, such as the time of deployment of a longline when some of the fish are landed dead.
- The time period that nets or hooks are left in the water, and the number and rate of fish caught, should be optimized to allow live landing of fish where practical.
- Fish should be removed from nets and hooks as quickly as possible to prevent death or to minimize the period from death until chilling of the fish.
- If captured fish are held in the sea for too long following death, decomposition commences, and histamine can begin to form. The warmer the seawater, the more rapid the decomposition and the greater the risk of histamine formation. Dead fish that exhibit signs of decomposition, consistent with exposure to time-temperature abuse, should not be retained on board the vessel, or, if retained, should be segregated and identified to allow proper disposition when off-loaded. In addition, the harvesting methods should be modified in a way that no dead fish with signs of decomposition will be brought on board in the future.
- The rate or volume of catch should not exceed the ability of the crew to quickly initiate chilling and should not exceed the capability of the vessel's chilling system to achieve and maintain established limits.
- Rough handling, overcrowding and over stacking of fish should be avoided where practical because crushing, bruising, and lacerations of the skin accelerate the spread of histamine-producing bacteria from the gut, gills, and skin into the fish muscle.
- Before landing fish, the deck area and equipment should be hygienically cleaned to avoid contamination of fish (see Section 3.4 Hygiene control programme), and the chilling medium should be ready and at the target temperature.

10.1.2 **Gutting and gilling (optional)**

- Histamine-producing bacteria are universally present in the gut, gills, and skin of fish at the point of capture. Rapid removal of guts and gills, and rinsing of the gut cavity, significantly delays histamine formation in the muscle.
- For large fish, removing the gut aids chilling by allowing chilling media (e.g. ice, refrigerated seawater) access to the visceral cavity, resulting in more rapid chilling of this bacteria-laden part of the fish.
- Care should be taken and hygienic practices should be maintained during gutting and gilling in order to minimize the spread of bacteria from the guts, gills, skin, and other contamination sources, into the muscle.

10.1.3 **Chilling and/or freezing**

Rapid chilling as soon as possible after death is the most crucial aspect of histamine control because bacterial growth and histamine formation accelerate exponentially with time under unrefrigerated conditions. Few prolific histamine-producing bacteria will grow and multiply at refrigeration temperatures, and the growth rates of those that do are greatly reduced.

- Temperature limits and monitoring frequencies should be established for the onboard chilling/freezing process. For example, limits may be established for maximum loading volumes and rates, and maximum starting temperature for refrigerated seawater (RSW) and/or brine tanks to ensure an adequate chilling environment is maintained for each harvested set¹⁶ of fish.
- Sufficient ice to completely surround the fish, or preferably, ice/seawater slurries or RSW should be used to bring the internal temperature of fish to below 4°C as quickly as possible after death to slow bacterial growth and enzymatic activity. For fish used to produce fish sauce, refer to Section 18.
- Where ice is used, fishing vessels should have sufficient ice for the amount of fish that could be caught and for the potential length of the fishing trip. For further information see FAO Fisheries Technical Paper 436 (The use of ice on small fishing vessels).¹⁷
- For larger eviscerated fish, the belly cavity should be packed with ice, or other cooling media, for more rapid chilling of this bacteria-laden part of the fish.
- Freezing fish is more effective in preventing histamine formation than chilling and maintaining fish below 4°C. It is good practice to gut the fish before freezing. Freezing to -18 °C, or below, will halt the growth of histamine-producing bacteria and will prevent any preformed histidine decarboxylase enzymes from producing additional histamine.
- Note that freezing does not detoxify preformed histamine, nor does it effectively eliminate histamine-producing bacteria and enzymes, which can become active when temperatures increase again, such as during processing or meal preparation.
- Crew members responsible for chilling should provide feedback to the catching operation to ensure that the rate or volume of incoming fish does not exceed the ability to rapidly chill the fish within established time-temperature limits and maintain the fish in a chilled state.
- Care should be taken to manage the chilling of dead fish to ensure that none are inadvertently left exposed on deck past the time limit established for the temperature conditions.
- Refrigeration and other chilling equipment should be in good repair and operated in a manner that quickly chills fish without physical damage. For example, fish should be packed loosely in ice slurries and brine tanks to allow good circulation and rapid cooling.

10.1.4

Refrigerated and/or frozen storage (fishing vessel and transfer vessel)

- Refrigerated fish should be stored at a temperature as close as possible to 0°C. The storage temperature should be kept below 4°C until off-loading. Storage at these temperatures will inhibit or slow the growth and enzyme production for most histamine-producing bacteria.
- Ice, where used, should completely surround the stored fish and be regularly monitored throughout the trip and replenished as necessary.

¹⁶ A "set" means the fish from one set net, or the fish from one set long-line, etc.

¹⁷ FAO Fisheries Technical Paper 436 ("The use of ice on small fishing vessels.")
Link: <http://www.fao.org/docrep/006/Y5013E/y5013e00.htm#Contents>

- Refrigerated seawater and/or brine temperature should be regularly monitored throughout the trip and controlled in order to maintain inhibitory storage temperatures.
- Continuous temperature recording devices, or thermometers, should be used in refrigerated and frozen storage compartments to ensure that inadequate holding conditions are identified, and appropriate actions taken to minimize consumer risk.

10.1.5

Monitoring records

- Records of histamine control monitoring activities should be maintained so that they can be readily retrieved for trace-back to possible causes if elevated levels of histamine are detected later.
- Records should be made available to the receiving establishment that offloads the fish from the vessel to provide evidence that histamine controls were implemented effectively by the vessel.
- Vessel records should include documentation of actual observed activities pertinent to onboard controls for all histamine-forming fish harvested from each fishing set on each fishing trip.
- The records of histamine control monitoring activities depend on the operation and may include:
 - Dates and times of earliest fish death, and times to get fish into appropriate chilling media;
 - Brine, RSW, or storage compartment refrigeration temperature monitoring records or checks for adequacy of ice during the chilling operation and during storage of the fish for the duration of the fishing trip; and
 - Water and ambient temperature.
- A responsible crew member should review the monitoring records daily to confirm that limits were met, and that appropriate corrective actions were taken when necessary.
- Where onboard record keeping is impractical, such as for small artisanal day boats, the operation receiving the fish may be able to monitor and record all the parameters necessary to ensure histamine control (e.g. time of departure and return, air and water temperature, adequacy of ice and fish internal temperature, etc.), and avoid the need to test histamine levels upon reception.
- If some of the fish on the vessel are determined – based on monitoring records – to be at risk for unacceptable histamine levels, then these fish should be segregated and identified in order to allow targeted testing and/or proper disposition at unloading.

10.2 Receiving establishment operations (fish reception)

Fish reception (at the establishment where the fish are offloaded from the fishing or transfer vessel) is an important control point for histamine. This is where 1) fish temperatures, 2) signs of decomposition, and 3) histamine levels and/or vessel records are best monitored.

Reception controls may need to be specific to both the harvest vessels as well as to any collection/transfer vessels that deliver the fish to the receiving establishment.

If deficiencies in vessel controls are found at reception, feedback should be provided to the vessel operator, and the cause(s) of the problem should be evaluated and corrected before future deliveries from the fishing vessel are considered. In addition, appropriate corrective actions regarding the delivered fish should be taken and recorded.

During offloading of fish from the vessel (and at any point of transfer in the supply chain), care should be taken that the cold chain is maintained. For example, fish should be offloaded quickly, fish totes should not be left exposed to elevated temperatures, and fish should be re-iced or placed under refrigeration in a timely manner. Frozen fish should be maintained in the frozen state.

10.2.1

Temperature monitoring

- Internal fish temperatures should be measured at reception to ensure reception temperature limits are met, and to help provide confidence that fish were properly stored onboard the fishing and transfer vessel.
- For fish stored in ice, the adequacy of ice surrounding the fish should be observed and recorded at the time of offloading the fishing vessel, along with internal temperature measurements. More fish should be monitored when the quantity or distribution of ice appears inadequate. Temperatures near the surface of exposed un-iced portions should be measured, as well as deep core temperatures of the fish, to ensure all edible portions of the fish are taken into consideration in the assessment.
- Sampling should be done randomly throughout the fishing vessel delivery lot. The number of fish temperatures monitored and results recorded should be sufficient to provide reasonable assurance that the temperatures appeared to be controlled by the vessel crew. Variations in species, morphologies, and sizes of fish should be taken into account when taking samples.
- Fish on the vessel should have been stored at a temperature as close as possible to 0°C (4°C or below). If an internal temperature in a sample fish exceeds 4°C (or the established temperature limit based on elapsed time from death) then this indicates a lapse in histamine control. The cause of the deviation should be determined and corrected, and histamine testing of the entire vessel delivery lot performed, or the delivery rejected. For fish used for producing fish sauce, refer to Section 19.
- Higher temperatures usually correspond to higher histamine risk; however, higher deep core temperatures may need to be allowed for in larger fish that have been delivered soon after harvest and have not yet chilled to 4°C or below, despite implementation of appropriate chilling procedures. Cooling curves based on studies applicable to the specific fishing sector are useful to establish proper fish reception temperatures in these circumstances.

10.2.2 **Sensory evaluation**

Sensory evaluation of fish at reception is a useful screening method to identify fishing vessel delivery lots that have been mishandled or subjected to time-temperature abuse and, hence, are at risk of elevated histamine levels. Neither histamine formation nor decomposition occurs in the absence of time-temperature abuse. However, the correlation between histamine level and sensory evidence of decomposition is not absolute, and histamine formation often occurs without readily detectable sensory indicators of decomposition. Therefore, sensory evaluation should not be used as the only or final assurance that the histamine level is acceptable, and reliable vessel control records or histamine testing, along with temperature monitoring, should be part of a complete receiving control system.

- Fish for sensory evaluation should be chosen randomly from throughout the vessel delivery lot. Deliveries of multiple species with different compositions, morphologies, and sizes should be taken into account in the sampling plan. It may be appropriate to select more fish from portions of the delivery lot identified by vessel records or temperature examination to be at greater risk for histamine formation.
- The number of fish examined should be sufficient to provide assurance that the vessel crew appears to have been vigilant about time-temperature exposures of the fish. The number of samples taken should be increased when conditions or fishing methods are more likely to introduce variable time-temperature exposures of fish, e.g. longlining, unusually warm weather, unusually large catch size, limited remaining ice, etc.
- Evidence of abuse that may be conducive to histamine formation is indicated when the fish sensory attributes indicate marginal quality, not only when the sensory attributes show advanced decomposition. See FAO “Sensory Assessment of Fish Quality”¹⁸ and Codex “Guidelines for the Sensory Evaluation of Fish and Shellfish in Laboratories”¹⁹ for guidance on sensory evaluation of fish.
- If sensory evidence of decomposition is detected at reception, it indicates that controls on the vessel may have been inadequate and that the entire vessel lot is at risk for elevated histamine. The cause of the decomposition should be determined and the necessary procedural changes, and improvement to facilities or equipment verified. It is justifiable to reject the entire delivery lot based on evidence of inadequate time-temperature control; however, if further evaluation is used to determine if some of the fish are suitable for human consumption, then intensified histamine sampling and testing should be performed on the entire delivery lot. The testing should also include the decomposed fish found to determine if the type of decomposition detected was conducive to histamine formation.

18 FAO/Torry Advisory Note No. 91, “Sensory Assessment of Fish Quality.”
Link: <http://www.fao.org/wairdocs/tan/x5989e/x5989e00.htm>

19 CXG 31-1999, *Guidelines for the Sensory Evaluation of Fish and Shellfish in Laboratories*.
Link: http://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252Fstandards%252FCAC%2BGL%2B31-1999%252FCXG_031e.pdf

10.2.3 **Review of vessel control records (receiving establishment)**

If vessel operators monitor and document histamine control, review of vessel histamine control records, when available, is an effective control method at reception to ensure that appropriate procedures were followed on the vessel to minimize histamine formation in the fish while on the fishing vessel and is more effective than routine histamine testing.

- Refer to Section 10.1.5 Monitoring records.
- Vessel records applicable to histamine control should be requested and reviewed by the receiving personnel, unless the information is available by other means, to determine if they are complete and reflect appropriate harvest and onboard handling practices, and that all applicable fishing vessel limits were met.
- If vessel records are reviewed and found to be incomplete and the receiving establishment cannot verify by other means, such as by intensified histamine sampling and testing, that the specific delivery of fish was harvested, handled, and stored in a manner that prevents histamine formation, the delivery should be rejected. (Refer to Section 10.2.4 Histamine testing).
- The impact of a limit deviation on the fishing vessel may be minimized if the records clearly show that only part of a delivery was affected (e.g. one brine well or one specific fishing set) and the affected fish were effectively segregated when the vessel was unloaded.

10.2.4 **Histamine testing**

When review of fishing vessel histamine control records is used as one of the histamine controls by a receiving establishment, then histamine testing should be performed periodically as verification that the control system is continuing to work effectively. If verification test results indicate elevated histamine levels, then the vessel control system should be reviewed and corrected, and the frequency of testing should be increased until testing results and other evidence suggest that the vessel control systems are being effectively implemented (e.g. a series of consecutive problem-free deliveries).

When a fishing vessel operation uses GMPs but has not implemented a histamine control system including monitoring and record keeping that provide documented evidence of control, then histamine testing is an important monitoring procedure at the reception critical control point, rather than a verification procedure, and testing should be applied to every vessel delivery lot. If histamine levels exceed the established critical limit, the vessel should be notified, and the cause determined and corrected. In addition, the affected fishing vessel delivery lot should be rejected.

Note that histamine testing can be less reliable than receipt of appropriate vessel control records because histamine may be unevenly distributed within and between fish, and fish with high histamine are difficult to identify using limited or small sample sizes. Sampling and testing that is statistically meaningful in terms of appropriate consumer protection can be resource intensive. Histamine testing at fishing vessel reception is therefore best used as verification of the effectiveness of a properly implemented and documented histamine control system on the fishing vessel.

The histamine testing guidance in this subsection can also be applied to intensified sampling or periodic verification of histamine controls throughout the supply chain.

10.2.4.1 **Histamine levels**

In order to better use the test results, the receiving establishment should establish the acceptable histamine level for incoming fish. To do so, the following information should be taken into account:

- Information on histamine level in freshly harvested fish.²⁰
- Elevated histamine levels could indicate poor implementation of hygienic processes and histamine controls during harvest, chilling and/or on-vessel storage, and an elevated risk that some fish in a lot will have unacceptable histamine levels. In addition, they could indicate that histidine decarboxylase enzymes are present that can contribute to histamine formation during exposure to elevated temperatures further along the food chain, even without growth of histamine-forming bacteria.
- Additional increases in histamine levels are likely with time and exposure to non-refrigerated temperatures during further processing and handling.

10.2.4.2 **Histamine testing, sampling strategies**

- Sampling plans for testing histamine levels should be selected based on statistical performance parameters. Statistical tables and computer programs can provide the information needed to design a sampling plan based on the histamine limits, the degree of protection, and the confidence in results desired. The FAO/WHO Histamine Sampling Tool²¹ is an example of an application designed for this purpose.
- Because histamine is distributed unevenly in lots (has a high standard deviation), hazardous fish are statistically difficult to find using small sample numbers. The FAO/WHO Expert Report (Section 6.2.2.2)²² suggests using histamine accept/reject levels (“value for m”) that are lower than the acceptable limit in order to reduce the number of samples required to achieve a given level of confidence in the testing results.
- More sample units should be tested whenever vessel records, sensory analysis, or fish temperatures indicate possible lapses in time-temperature control that could result in elevated histamine.
- It is best to sample the raw fish material upon arrival from the fishing vessels, where individual loin sections can be identified for trace back to vessel lots. As the fish are processed into various market products, or produce from different vessel lots is comingled, assessments of the suitability and safety of the fish from the individual fishing vessels becomes more difficult and less effective.
- Samples taken should be representative of the lot.

20 According to the FAO/WHO Expert Meeting Report 2013, freshly harvested scombrotoxin-forming fish typically have histamine levels below 2 mg/kg, and food business operators that apply HACCP principles can achieve a histamine level lower than 15 mg/kg .

21 FAO/WHO Histamine Sampling Tool. Link: <http://tools.fstools.org/histamine/>

22 Joint FAO/WHO Expert Meeting on the Public Health Risks of Histamine and Other Biogenic Amines from Fish and Fishery Products, July 2012, Rome (Section 6.2.2.2 Using the known standard deviation and the derived mean to design a sampling plan.)

10.2.4.3 **Histamine testing, analytical methods**

- Several reliable test methods exist for determining histamine levels in fish. The FAO/WHO Expert Report (Section 2.5 Analytical methods for histamine)²³ lists some of the available methods.
- The testing method used should be properly validated for the detection limits used. Staff responsible for the sampling and for sample analysis should receive training in the procedures used.
- The part of the fish selected for testing can significantly affect the test results. Test portions should be cut from the head-end of the lower loin near the gills because that area has the highest probability of elevated histamine in raw fish at risk. Sufficient representation of fish muscle should be collected to prepare for analysis (e.g. 100–250 g). The weight of the representative sample unit may depend on the product and sampling strategy. For smaller fish, in addition to the lower anterior loin portion, the upper anterior loin, and the mid-section of the lower loin, in that order, can also be collected. For very small fish, multiple fish may need to be collected to acquire a representative sample unit. The entire sample unit should be thoroughly combined so that the smaller aliquot used for the analytical method is representative of the entire sample unit.
- To screen deliveries more economically, sample units from different fish can be optionally combined (composite sample) to reduce the number of histamine analyses required, provided that the histamine level critical limit is lowered proportionately.

10.2.5 **Monitoring records (receiving establishment)**

- Histamine control records should be maintained at the receiving establishment for trace-back to possible causes if elevated histamine level is discovered further along the distribution chain.
- Receiving establishment monitoring records may include, but are not limited to:
 - Relevant information about vessel delivery lot (e.g. vessel name and type, captain's name, date/time of offloading, type and volume (weight) of fish off-loaded);
 - Sensory evaluation results;
 - Internal temperatures at the time of offloading;
 - Histamine test results, when applicable; and
 - Copies of the fishing vessel's monitoring records reviewed, when applicable.
- A responsible person should examine, as a part of verification activity, the monitoring records before product release, to confirm that critical limits were maintained, and that appropriate corrective actions were taken when necessary.

²³ Joint FAO/WHO Expert Meeting on the Public Health Risks of Histamine and Other Biogenic Amines from Fish and Fishery Products, July 2012, Rome (Section 2.5 Analytical methods for histamine.)

10.3 Transportation

- Refer to Section 21 (Transportation).
- Refer to Section 10.1.4 (Refrigerated and/or frozen storage (fishing vessel and transfer vessel)).
- Transport vehicles or vessels should be adequately equipped to keep fish cold by mechanical refrigeration or by completely surrounding the fish with ice or other cooling media.
- Vehicles or vessels should be pre-chilled before loading fish where applicable.
- Refrigerated compartment temperatures, or cooling media such as ice slurries, should be monitored during transportation between locations (e.g. receiving establishment, processing establishment, distributor, market) using continuous temperature recording devices, where practical, and the receiving establishment should review the temperature record from the device. Devices should be periodically calibrated for accuracy.
- At delivery, internal temperatures of a representative sample of fish, and adequacy of ice or other cooling media when applicable, should be monitored by receiving personnel as described in Section 10.2.1 Temperature monitoring.
- If established fish reception or vehicle compartment temperature control limits are exceeded, the cause of the problem should be identified and corrected by the operator of the vehicle or vessel. If evidence indicates that temperature abuse leading to elevated histamine could have occurred, the affected lot may be rejected by the receiving personnel, or the receiver may perform intensified histamine analysis on representative fish collected throughout the lot, and the lot rejected if any fish exceed the established histamine limit.

10.4 Processing operations

This section applies to processing on land or at sea (e.g. factory vessel, mother ship).

10.4.1

Reception (processing establishment)

- If fish are delivered directly from the fishing vessel to the processing establishment, then also refer to Section 10.2 Receiving establishment operation (fish reception).
- If fish are delivered by transport vehicle or vessel, then also refer to Section 10.3 Transportation.
- If the processing establishment is a secondary processor receiving product from a primary processor (e.g. receiving establishment or factory vessel), then the secondary processor should confirm that the primary processor uses a HACCP system designed to prevent formation of unacceptable levels of histamine.
- When it is impractical for the initial receiving establishment to conduct all the necessary histamine controls listed in subsection 10.2 (i.e. temperature monitoring, sensory evaluation, vessel records review, and/or histamine testing), then the processing establishment should conduct these activi-

ties, and should ensure that, where practical, the controls and decisions are applied to intact fishing vessel lots that are not comingled with other lots. Note, however, that fish internal temperatures (and adequacy of ice, where applicable) should always be monitored at vessel delivery by the receiving establishment (to evaluate vessel control), as well as at reception by the processing establishment (to evaluate land-transportation control). If lots are comingled and there may be unacceptable levels of histamine in fish, the entire lot should be considered when making decisions on disposition.

10.4.2 **Processing time and temperature control**

When fish undergo processing (e.g. thawing, cutting, re-chilling, salting, drying, pickling, cooking, smoking, canning), it is important that they are not subjected to time-temperature conditions where histamine-producing bacteria can grow and produce histamine to unacceptable levels.

- Scientific studies and microbial growth models²⁴ may be used to estimate the exposure times and temperatures that result in elevated histamine levels.
- Histamine formation is quite variable and strongly depends on the previous handling of the raw material and the different species of histamine-producing bacteria that are present; therefore, the worst-case scenario should be considered when establishing critical limits.
- The acceptable maximum histamine level used to establish processing time-temperature critical limits should take into consideration the point in the supply chain and any further handling, processing, storage, and preparation that may lead to further histamine formation before consumption.
- The measure used for time-temperature critical limits should be the cumulative product non-refrigerated time-temperature exposure over all processing steps.
- Processing room temperature should be maintained as cool as practical during processing operations, and product exposure times should be minimized. For example, fish should be iced, or returned to refrigerated storage, during production breaks or production flow slow-downs.
- Controlled product flow and batch monitoring is an effective strategy to ensure product is not subjected to unacceptable time-temperature exposures. For example, periodically measure the ambient temperature and the time for a marked batch to begin and complete the processing step.
- Air thawing of raw material should occur at refrigerated temperatures to prevent excessive warming of the surface of the fish. Immersion in circulating cold water or spraying with cold water may be used to shorten thawing time. For re-chilling and refreezing, see Section 10.1.3.
- When time-temperature critical limits are exceeded, the cause should be determined and corrected. In addition, intensified histamine testing should be performed (see Section 10.2.4.2) before releasing the affected product for human consumption. Alternatively, the product should be rejected.

²⁴ Joint FAO/WHO Expert Meeting on the Public Health Risks of Histamine and Other Biogenic Amines from Fish and Fishery Products, July 2012, Rome (Section 6.1.9 Microbiological modelling.)

10.4.3 **Heat processing**

- Adequate heat treatment (e.g. cooking, hot smoking) can kill histamine-producing bacteria and inactivate histidine decarboxylase enzymes. *Morganella morganii* is probably the most heat resistant of the histamine-producing bacteria, and in *Arripis trutta* at temperatures between 58 °C and 62 °C, the D-values for eliminating these bacteria and their associated HDC enzymes were between 15 and 1.5 minutes (FAO/WHO 2012).
- Once formed, however, histamine itself is heat stable and is not destroyed by heat. Therefore, histamine controls during harvesting, and during other steps prior to thermal processing, are critical to minimize the presence of histamine in the finished product.
- If the product is exposed to bacterial contamination and temperature abuse after initial heating, histamine formation may start again. Thus, for products such as hot smoked fish, care should be taken to avoid contamination after smoking. Additionally, refrigerated storage is essential unless the water activity is sufficiently reduced or some other means is used to prevent bacterial growth.
- For commercially sterile canned or pouched products, the container protects the product from bacterial recontamination, and no further histamine is produced when stored at ambient temperatures. However, once the product package is opened, histamine formation can occur again if the product is re-contaminated in the absence of preventative time-temperature controls.

10.4.4 **Processing, other technological measures**

Time and temperature control is the recommended method for preventing histamine formation in fresh, frozen, and refrigerated processed fish products.

Some products and processes (e.g. fermenting, smoking, salting, drying, pickling, acidifying, preserving, modified atmosphere packaging) introduce other technological factors that may inhibit the introduction and/or growth of histamine-producing bacteria. The interaction of these factors is complex and often unpredictable. For example, increased salt content, or increased acidity, may decrease or increase histamine production, depending on conditions.

Thorough scientific studies, and proper establishment and validation of control parameters for each specific process and product, are imperative to ensure the safe manufacture of foods that incorporate other technological measures as an element of histamine control. (See *Guidelines for the Validation of Food Safety Control Measures*, (CXG 69-2008))

The success of these treatments is dependent on the rapid chilling and maintenance of chilled temperatures of the raw fish from the time of death until the inhibitory effects from the treatments are achieved. In addition, depending on the treatment, the finished product may need to remain chilled until consumed to ensure safety.

10.4.5

Refrigerated and frozen storage (processing establishment)

- Refer to Section 10.1.4 Refrigerated and/or frozen storage (fishing vessel and transfer vessel).
- For products whose preparation does not include a heating step or other means to eliminate histamine-producing bacteria and their enzymes, refrigerated storage will continue to be a critical control point to prevent histamine formation throughout the shelf-life of the products.

10.4.6

Monitoring records (processing establishment)

- Processing establishment monitoring records may include, but are not limited to:
 - Transport vehicle or vessel temperature records or adequacy of ice, and fish internal temperatures;
 - Temperatures and exposure times of product during unrefrigerated processing steps;
 - Critical control point monitoring records for other validated methods used to control histamine formation in processed fish; and
 - Refrigerated storage temperature logs.
- A responsible person should examine the monitoring records before product release to confirm that critical limits were maintained, and that appropriate corrective actions were taken when necessary.
- The processing facility should use histamine testing to periodically verify that histamine controls are working properly (Refer to Section 10.2.4 Histamine testing).



11

Processing of frozen surimi



In the context of recognizing controls at individual processing steps, this section provides examples of potential hazards and defects and describes technological guidelines that can be used to develop control measures and corrective action. At any particular step, only the hazards and defects that are likely to be introduced or controlled at that step are listed. It should be recognized that in preparing a Hazard Analysis Critical Control Point (HACCP)²⁵ and/or defect action point (DAP) plan it is essential to consult Section 5, which provides guidance for the application of the principles of HACCP and DAP analysis. However, within the scope of this Code it is not possible to give details of critical limits, monitoring, record-keeping and verification for each of the steps as these are specific to particular hazards and defects.

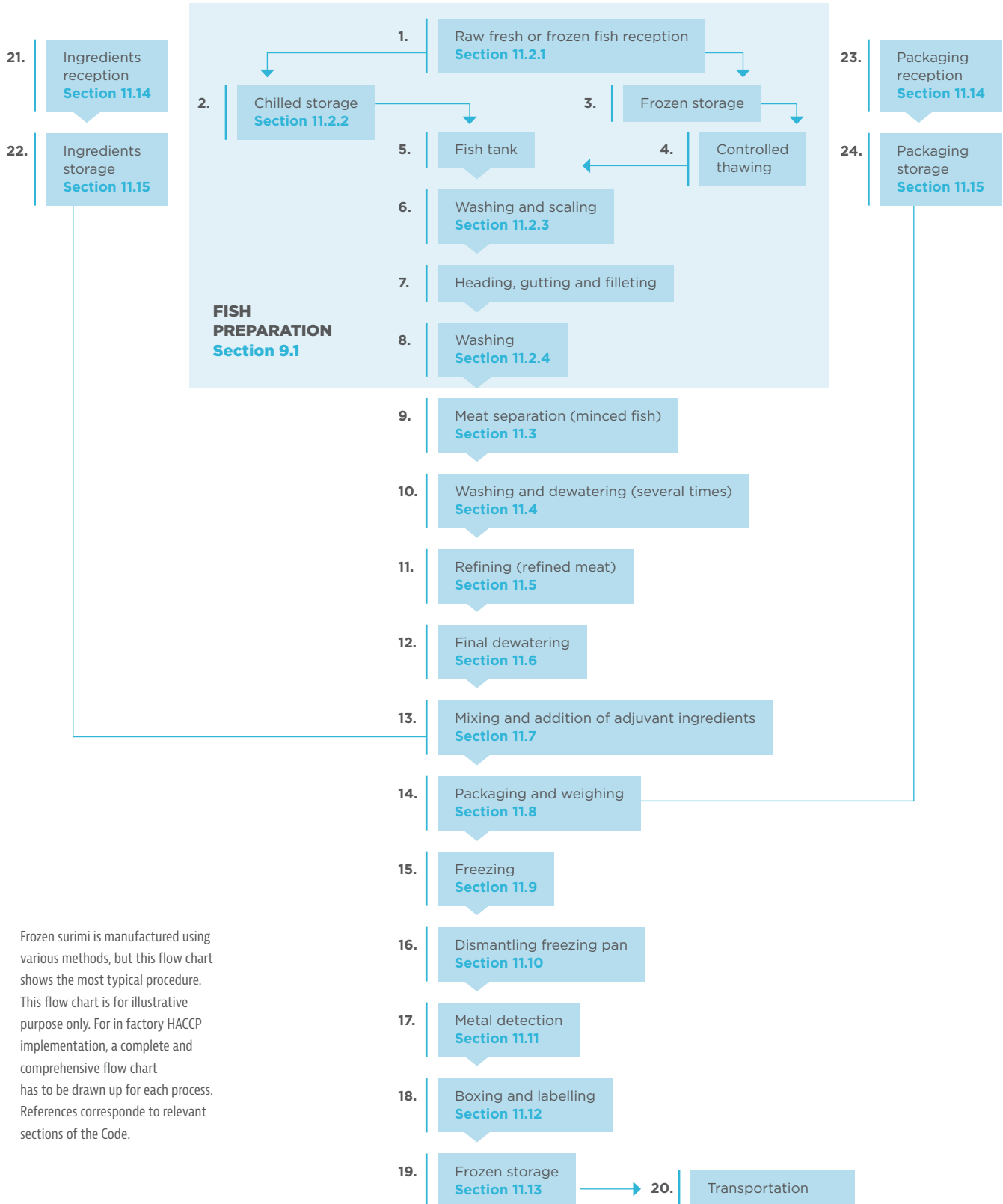
Frozen surimi is an intermediate food ingredient made from myofibrillar fish protein isolated from other constituent fish protein by repeated washing and dewatering of minced fish. Cryoprotectants are added so that the mince can be frozen and will retain the capacity to form gel when heat-treated after thawing. Frozen surimi is usually blended with other components and further processed into surimi-based products such as kamaboko or crab analogues (imitation crab) that utilize its gel forming ability.

The main emphasis of this Section of the Code is to give guidance to the manufacture of frozen surimi processed from marine groundfish such as Alaska pollock and Pacific whiting by mechanized operations that are common in Japan, the United States of America and some other countries in which there are processors under mechanized operation.

The vast majority of frozen surimi is processed from marine groundfish such as Alaska pollock and Pacific whiting. However, technological advances and the change of main raw fish species for frozen surimi production will necessitate revision of this Section of the Code.

²⁵ Refer to Annex II for a comprehensive list of the acronyms used in this Code.

Figure 11.1 Example flow chart of a frozen surimi-production process



Frozen surimi is manufactured using various methods, but this flow chart shows the most typical procedure. This flow chart is for illustrative purpose only. For in factory HACCP implementation, a complete and comprehensive flow chart has to be drawn up for each process. References correspond to relevant sections of the Code.

11.1

General considerations of hazards and defects for frozen surimi production

11.1.1

Hazards

Frozen surimi is an intermediate ingredient that will be further processed into surimi-based products such as kamaboko and crab analogues. Many of the potential food safety hazards will be controlled during subsequent processing. For example, pathogenic bacteria such as *Listeria monocytogenes* and toxin formers such as *C. botulinum* (that becomes a hazard owing to the modified atmosphere packaging (MAP) of the end product) should be controlled during the cooking or pasteurizing steps of final processing. Possible *Staphylococcus aureus* contamination that produces heat-stable enterotoxins should be adequately controlled by the prerequisite programme. Parasites will not be a hazard as the final product will be cooked or pasteurized.

If scombrotoxin-forming fish such as tuna or mackerel or tropical reef fish that may accumulate ciguatera toxin are utilized for surimi, appropriate controls for these hazards should be developed (refer to Section 10 for scombrotoxin control guidance). Likewise, owing to the highly mechanized nature of surimi processing, appropriate controls should be instituted to ensure that metal fragments (e.g. bearings, bolts, washers and nuts) are excluded or eliminated from the end product.

In countries that produce frozen surimi by traditional non-mechanized methods from locally available fish species for local consumption, extensive consideration should be given to prerequisite programmes described in Section 3.

11.1.2

Defects

Certain quality attributes of frozen surimi are important for the successful manufacture of surimi-based products such as kamaboko and crab analogues that meet consumer expectations of quality. Some of these important factors are colour, moisture content, pH or gel strength.

Myxosporidia is a parasite that is common in marine groundfish such as Pacific whiting. This organism contains protease enzymes that chemically separate proteins that can ultimately affect the gel strength of surimi even at very low incidence. If species are used that are known to contain this parasite, protease inhibitors such as beef plasma protein or egg whites may be needed as additives to attain the necessary gel strength capabilities for kamaboko or crab analogue production.

Decomposed fish should not be used as raw material for frozen surimi production. The sensory qualities will not be sufficient to produce acceptable kamaboko or crab analogue end products. It is also necessary to note that decomposed fish should not be used as raw material for production of frozen surimi. This is because proliferation of spoilage bacteria that cause decomposition of the end product will have a negative effect on the gel-forming ability of frozen surimi by denaturing salt-soluble protein.

The washing and dewatering cycle should be sufficient to achieve separation of the water-soluble protein from the myofibrillar proteins. If water-soluble proteins remain in the product, they will negatively affect the gel-forming ability and the long-term frozen storage shelf-life.

Objectionable matter, such as small bones, scales and black belly lining, should be minimized as it negatively affects the usability of frozen surimi for processing into end products.

Owing to the comminuted nature of raw surimi, the use of food additives may be necessary in order to achieve the level of quality that is desired. These additives should be introduced into surimi in accordance to appropriate regulations and manufacturer recommendations in order to avoid quality problems and regulatory actions.

Consideration should be given to the thermal stability of fish proteins. At normal room temperatures, most fish proteins will undergo denaturing that will inhibit the gel-forming ability of the product. Alaska pollock and other coldwater marine fish should not be subjected to temperatures above 10 °C during processing. Warmwater fish may denature at a slower rate and may not be as temperature-sensitive.

In countries that produce frozen surimi by traditional non-mechanized methods from locally available fish species for local consumption, special consideration should be given to several defects. Because the growth of spoilage bacteria that cause decomposition and protein denaturation increases with temperature, the conditions that the raw and processed product are subjected to should be carefully monitored.

11.2 Fish preparation (Processing Steps 1–8)

11.2.1

Refer to Section 9.1 Steps 1–8 for information regarding the preparation of fish for processing. For frozen surimi processing, consideration should be given to the following for each step:

Raw fresh and frozen fish reception (Processing Step 1)

Potential hazards: [scombrotoxin](#)

Potential defects: [decomposition](#), [protein denaturation](#)

Technical guidance:

- Harvested fish intended for frozen surimi processing should preferably be kept at 4 °C or below.
- Consideration should be given to the age and condition of fish used for surimi processing as the factors will affect the final gel strength capability. In particular, care should be taken with raw fish received many hours after harvest. For example, an acceptable period after harvest should be as follows, but processing as fast as possible after harvest will better retain adequate quality of frozen surimi:
 - round - within 14 days after harvest when stored at 4 °C or below;
 - dressed - within 24 hours after dressing when stored at 4 °C or below.
- Date, time of harvesting, origin and harvester or vendor of products received should be properly recorded and identified.
- Presence of decomposition in raw product should not be allowed as it will negatively affect the gel strength capability of the end product. Harvested fish in poor condition may not result in specified colour characteristics.

- Fish that is used for frozen surimi processing should have a flesh for adequate gel strength capability. For example, an aggregate flesh for Alaska pollock (*Theragra chalcogramma*) should have a pH of 7.0 ± 0.5 .
- Fish that are crushed and suffocated owing to abnormally big tow size and duration during harvesting should be removed from the line in order to avoid a negative effect on gel-forming ability.

11.2.2

Chilled storage (Processing Step 2)

Potential hazards: [scombrototoxin](#)

Potential defects: [protein denaturation](#), [decomposition](#)

Technical guidance:

- Chilled storage at the processing facility should be minimized, with prompt processing in order to minimize protein denaturation and loss of gel strength capability.
- Raw fish should preferably be stored at 4 °C or below, and the dates of harvesting and the time of receipt of the fish should identify the lot of fish used for processing.

11.2.3

Washing and scaling (Processing Step 6)

Potential hazards: [unlikely](#)

Potential defects: [protein denaturation](#), [colour](#), [objectionable matter](#)

Technical guidance:

- The epidermis (slime layer), scales and loose pigment should be removed before heading and gutting. This will lessen the level of impurities and extraneous material that can negatively affect the gel strength capability and colour of the end product.

11.2.4

Washing (Processing Step 8)

Potential hazards: [unlikely](#)

Potential defects: [impurities](#), [extraneous materials](#)

Technical guidance:

- Headed and gutted fish should be re-washed. This will lessen the level of impurities and extraneous material that can negatively affect the gel strength capability and colour of the end product.

11.3

Meat separation process (Processing Step 9)

Potential hazards: metal fragments

Potential defects: impurities

Technical guidance:

- Fish flesh is minced using a mechanical separation process. Therefore, metal detection equipment that is capable of sensing product that has become contaminated with metal fragments of the size likely to cause human injury should be installed at the most appropriate place in the process in order to eliminate the hazard.
- Procedures should be established to ensure that chemical contamination of the product is not likely.
- Separated minced meat should be immediately spread into water and transferred to the washing and dewatering step to prevent blood from congealing and causing loss of gel strength capability.

11.4

Washing and dewatering process (Processing Step 10)

Potential hazards: microbiological contamination, scombrototoxin

Potential defects: decomposition, protein denaturation, residual water-soluble protein

Technical guidance:

- Temperature of the water and minced fish flesh in the rotating sieve or wash water should be adequately controlled to prevent the growth of pathogenic microbes.
- Wash water should be 10 °C or below for adequate separation of water-soluble proteins. Wash water for Pacific whiting should be lower than 5 °C because this species will usually have a high protease activity. Some warmwater species may be processed at temperatures up to 15 °C.
- Product should be processed promptly to minimize possible pathogenic microbial growth.
- Minced fish should be spread uniformly in the water to assure dilution of the water-soluble components and effect proper separation from the myofibrillar protein.
- Consideration should be given to the specific design of the washing and dewatering step in regard to the desired yield, quality and fish species.
- A sufficient amount of potable water should be available for washing.
- The pH of wash water should be near 7.0. Wash water should preferably have a total hardness of 100 mg/kg or below in terms of converted CaCO₃.
- Salt or other dewatering aids can be added (less than 0.3 percent salt) in the final stage of washing to enhance dehydration efficiency.
- Food additives should be added in accordance with national regulations and manufacturer instructions, if used in this process.
- Wastewater should be disposed of in a suitable manner.
- Wash water should not be recycled unless there are appropriate controls on its microbial quality.

11.5

Refining process (Processing Step 11)

Potential hazards: [microbiological contamination](#), [scombrototoxin](#), [metal fragments](#)

Potential defects: [objectionable matter](#), [protein denaturation](#), [decomposition](#)

Technical guidance:

- Temperature of the minced fish flesh in the refining process should be adequately controlled to prevent the growth of pathogenic bacteria and scombrototoxin formation.
- For preventing protein denaturation, temperature of minced fish flesh should not exceed 10 °C in the refining process.
- Product should be processed promptly to minimize possible pathogenic microbial growth and scombrototoxin formation.
- Metal detection equipment that is capable of sensing product that has become contaminated with metal fragments of the size likely to cause human injury should be installed at the most appropriate place in the process to eliminate the hazard.
- Objectionable matter, such as small bones, black membranes, scales, bloody flesh and connective tissue, should be removed from washed flesh with appropriate refining equipment before final dewatering.
- Equipment should be properly adjusted to effect efficient product throughput.
- Refined product should not be allowed to accumulate on sieve screens for long periods of time.

11.6

Final dewatering process (Processing Step 12)

Potential hazards: [microbiological contamination](#), [scombrototoxin](#)

Potential defects: [decomposition](#), [protein denaturation](#)

Technical guidance:

- Temperature of the refined fish flesh in the final dewatering process should be adequately controlled to prevent the growth of pathogenic bacteria.
- Temperature of refined fish flesh should not exceed 10 °C for coldwater fish species, such as Alaska pollock. For Pacific whiting, the temperature should not exceed 5 °C because this species will usually have a high protease activity. Some warmwater species may be processed at temperatures up to 15 °C.
- Product should be processed promptly to minimize possible pathogenic microbial growth.
- The moisture level of refined product should be controlled to specified levels with appropriate dewatering equipment (e.g. centrifuge, hydraulic press, screw press).
- Consideration should be given to variations in moisture levels caused by the age, condition or mode of capture of the raw fish. In some cases, dehydration should be performed before refining.

11.7

Mixing and addition of adjuvant ingredients process (Processing Step 13)

Potential hazards: [microbiological contamination](#), [scombrotoxin](#), [metal fragments](#)

Potential defects: [improper use of food additives](#), [protein denaturation](#), [decomposition](#)

Technical guidance:

- Temperature of the product in the mixing process should be adequately controlled to avoid the growth of pathogenic bacteria and scombrotoxin formation.
- Temperature of dehydrated fish flesh during mixing should not exceed 10 °C for coldwater fish species such as Alaska pollock. For Pacific whiting, the temperature should not exceed 5 °C because this species usually will have a high protease activity. Some warmwater species may be processed at temperatures up to 15 °C.
- Product should be processed promptly to minimize possible pathogenic microbial growth and scombrotoxin formation.
- Metal detection equipment that is capable of sensing product that has become contaminated with metal fragments of a size likely to cause human injury should be installed at the most appropriate place in the process to eliminate the hazard.
- Food additives should be the same and comply with the *General Standard for Food Additives* (CXS 192-1995).
- Food additives should be mixed homogeneously.
- Cryoprotectants should be used in frozen surimi. Sugars and/or polyhydric alcohols are commonly used to prevent protein denaturation in the frozen state.
- Food-grade enzyme inhibitors (e.g. egg white, beef protein plasma) should be used for species that exhibit high levels of proteolytic enzyme activity, such as Pacific whiting, that reduce the gel-forming ability of surimi during kamaboko or crab analogue processing. The use of protein plasma should be appropriately labelled.

11.8

Packaging and weighing (Processing Step 14)

Potential hazards: [microbiological contamination](#), [scombrotoxin](#)

Potential defects: [foreign matter \(packaging\)](#), [incorrect net weight](#), [incomplete packaging](#), [denaturation of protein](#), [decomposition](#)

Technical guidance:

- Temperature of the product should be adequately controlled during packaging to avoid the growth of pathogenic bacteria and scombrotoxin formation.
- Product should be packaged promptly to minimize possible pathogenic microbial growth.
- The packaging operation should have procedures established that make possible cross-contamination unlikely.

- Product should be inserted into clean plastic bags or packaged into clean containers that have been properly stored.
- Product should be appropriately shaped.
- Packaging should be conducted rapidly to minimize the risk of contamination, scombrototoxin formation, or decomposition.
- Packaged products should not contain voids.
- The product should meet appropriate standards for net weight.

See also Sections 9.2.1 and 9.4.4.

11.9

Freezing operation (Processing Step 15)

Refer to Section 9.3.1 for general considerations on freezing fish and fishery products.

Potential hazards: [scombrototoxin](#)

Potential defects: [protein denaturation](#), [decomposition](#)

Technical guidance:

- After packaging and weighing, the product should be promptly frozen to maintain the quality of the product, and to prevent scombrototoxin formation.
- Procedures should be established that specify maximum time limits from packaging to freezing.

11.10

Dismantling freezing pan (Processing Step 16)

Potential hazards: [unlikely](#)

Potential defects: [damage to plastic bag and product](#)

Technical guidance:

- Care should be taken to avoid breakage of plastic bag and the product itself in order to avoid deep dehydration during long-term cold storage.

11.11

Metal detection (Processing Step 17)

Refer to Section 9.2.4 for general information.

Potential hazards: [metal fragments](#)

Potential defects: [unlikely](#)

Technical guidance:

- Metal detection equipment that is capable of sensing product that has become contaminated with metal fragments of the size likely to cause human injury should be installed at the most appropriate place in the process to eliminate the hazard.

11.12

Boxing and labelling (Processing Step 18)

Refer to Sections 9.2.3 and 9.4.4.

Potential hazards: unlikely

Potential defects: incorrect label, damage to packaging

Technical guidance:

- Boxing should be clean, durable and suitable for the intended use.
- The boxing operation should be so conducted as to avoid damage to packaging materials.
- Product in damaged boxing should be re-boxed so that it is properly protected.

11.13

Frozen storage (Processing Step 19)

Refer to Section 9.1.3 for general information concerning fish and fishery products.

Potential hazards: scombrotoxin

Potential defects: decomposition, protein denaturation

Technical guidance:

- Frozen surimi should be stored at -20 °C or colder to prevent protein denaturation from taking place. Quality and shelf-life will be maintained more adequately if the product is stored at -25 °C or colder.
- Stored frozen product should have adequate air circulation to ensure that it remains properly frozen. This includes preventing product from being stored directly on the floor of the freezer.

11.14

Raw material reception – packaging and ingredients (Processing Steps 21 and 23)

Refer to Section 9.5.1.

11.15

Raw material storage – packaging and ingredients (Processing Steps 22 and 24)

Refer to Section 9.5.2.





A close-up photograph of a worker's gloved hand holding a metal tray filled with rows of frozen, breaded fish products. The products are golden-brown and appear to be fish sticks or nuggets. The background is a blurred industrial setting, likely a food processing plant. The text '12 Processing of quick-frozen coated fish products' is overlaid on the right side of the image.

12

**Processing
of quick-frozen
coated fish
products**

In the context of recognizing controls at individual processing steps, this section provides examples of potential hazards and defects and describes technological guidelines that can be used to develop control measures and corrective action. At any particular step, only the hazards and defects that are likely to be introduced or controlled at that step are listed. It should be recognized that in preparing a Hazard Analysis Critical Control Point (HACCP)²⁶ and/or defect action point (DAP) plan it is essential to consult Section 5, which provides guidance for the application of the principles of HACCP and DAP analysis. However, within the scope of this Code, it is not possible to give details of critical limits, monitoring, record-keeping and verification for each of the steps as these are specific to particular hazards and defects.

12.1

General – addition – to prerequisite programme

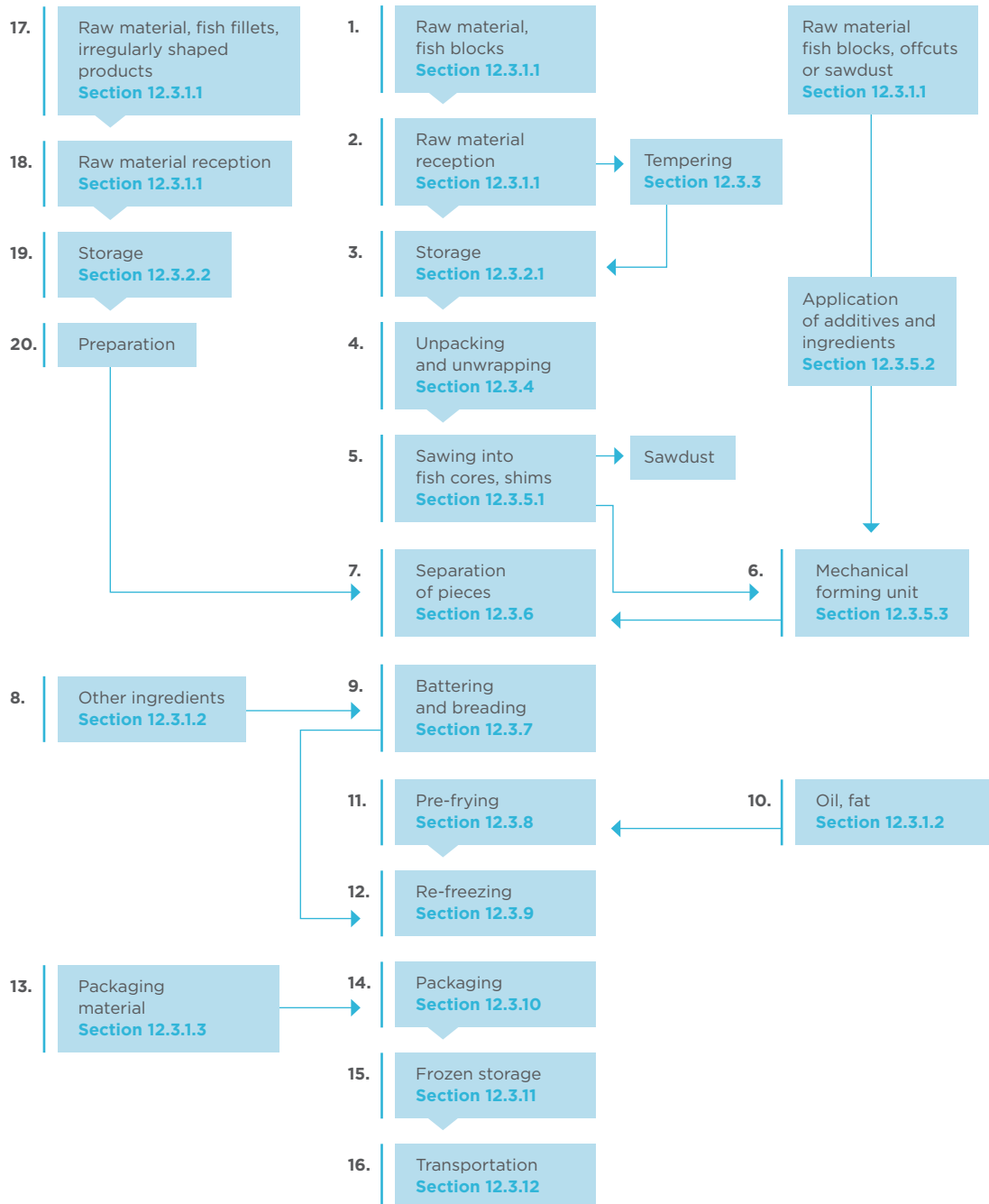
-
- Conveyor systems used to transport uncoated and coated fish should be designed and constructed to prevent damaging and contamination of the products.
 - Shims sawn for formed fish production and held for tempering should be kept at temperatures that will prevent deterioration of the essential quality of the product.
 - If the whole process is run continuously, an adequate number of processing lines should be available to avoid interruptions and batch-wise processing. If the process has to be interrupted, intermediate products have to be stored under deep-frozen conditions until being further processed.
 - Pre-frying baths, freezing cabinets used for re-freezing should be equipped with permanent temperature and belt speed control devices.
 - The proportion of sawdust should be minimized by using appropriate sawing equipment.

Sawdust should be kept well separated from fish cores used for coated products, should be temperature controlled, not stay too long at ambient temperature and should be stored preferably in frozen state prior to further processing into suitable products.

²⁶ Refer to Annex II for a comprehensive list of the acronyms used in this Code.

Figure 12.1 Example flow chart for the processing of coated fish products

This flow chart is for illustrative purpose only. For in factory HACCP implementation, a complete and comprehensive flow chart has to be drawn up for each process. References correspond to relevant sections of the Code.



12.2 Identification of hazards and defects

12.2.1

Refer also to Section 5.3.3.

This Section describes the main hazards and defects specific to quick-frozen coated fish and shellfish.

Hazards

Refer also to Section 5.3.3.1.

The production and storage of batter for application to fish portions, fillets, etc., may involve either rehydration of a commercial batter mix or preparation from raw ingredients. During the preparation of this batter and its use, the potential hazard for the possible growth and toxin production of *Staphylococcus aureus* and *Bacillus cereus* must be controlled.

12.2.2

Defects

Potential defects are outlined in the essential quality, labelling and composition requirements described in the relevant *Standard for Quick Frozen Fish Sticks Fish Fingers*, *Fish Portions and Fish Fillets – Breaded or in Batter* (CXS 166-1989).

12.3 Processing operations

12.3.1

Refer to Figure 12.1 for an example of a flow chart for coated fish product processing.

Reception

12.3.1.1

Fish

Potential hazards: chemical, biochemical and microbiological contamination, scombrototoxin

Potential defects: tainting, block irregularities, water and air pockets, packaging material, foreign matter, parasites, dehydration, decomposition

Technical guidance:

- Temperatures of all incoming lots should be recorded.
- Packaging material of frozen products should be examined for dirt, tearing and evidence of thawing.
- Cleanliness and suitability of the transport vehicle to carry frozen fish products should be examined.
- Use of temperature recording devices with the shipment is recommended.
- Representative samples should be taken for further examination for possible hazards and defects.

12.3.1.2 **Other ingredients**

Potential hazards: chemical, biochemical and microbiological contamination

Potential defects: mould, colour deviations, filth, sand

Technical guidance:

- Breeding and batter should be inspected for broken packaging material, signs of rodent and insect infestations and other damage such as dirt on packaging materials and wetness.
- Cleanliness and suitability of the transport vehicle to carry food products should be examined.
- Representative samples of the ingredients should be taken and examined to ensure that the product is not contaminated and meets specifications for use in the end product.
- Ingredients should be shipped on transportation vehicles that are suitable for handling food products and ingredients. Vehicles that have previously hauled potentially unsafe or hazardous material should not be used for hauling food products or ingredients.

12.3.1.3 **Packaging materials**

Potential hazards: foreign matter

Potential defects: tainting of products

Technical guidance:

- Packaging material used should be clean, sound, durable, sufficient for its intended use and of food-grade material.
- For pre-fried products, it should be impermeable for fat and oil.
- Cleanliness and suitability of the transport vehicle to carry food packaging material should be examined.
- Pre-printed labelling and packaging material should be examined for accuracy.

12.3.2 **Storage of raw material, other ingredients and packaging materials**

12.3.2.1 **Fish (frozen storage)**

Refer to Section 9.1.3.

12.3.2.2 **Fish (chilled storage)**

For storage of non-frozen fish, refer to Section 9.1.2.

12.3.2.3 **Other ingredients and packaging materials**

Potential hazards: biological, physical and chemical contamination

Potential defects: loss of quality and characteristics of ingredients, rancidity

Technical guidance:

- All other ingredients and packaging material should be stored in a dry and clean place under hygienic conditions.
- All other ingredients and packaging material should be stored appropriately in terms of temperature and humidity.
- A systematic stock rotation plan should be developed and maintained to avoid out-of-date materials.
- Ingredients should be protected from insects, rodents and other pests.
- Defective ingredients and packaging material should not be used.

12.3.3 **Frozen fish block/fillet tempering**

Potential hazards: unlikely

Potential defects: incorrect dimension owing to sawing of over-softened fish flesh (applies to fish sticks)

Technical guidance:

- Depending on the use of the fish, the tempering of frozen fish blocks/fillets should be carried out in a manner that will allow the temperature of the fish to rise without thawing.
- Tempering block/fillets of frozen fish in chilled storage is a slow process that usually requires at least 12 hours or more.
- Over-softening of the outer layers is undesirable (poor performance during sawing) and should be avoided. It can be avoided if facilities used for tempering are maintained at a temperature of 0–4 °C and if fish blocks/fillets are stacked in layers.
- Microwave tempering is an alternative method but should also be controlled to prevent softening of outer layers.

12.3.4 **Unwrapping, unpacking**

Potential hazards: microbiological contamination

Potential defects: remaining undetected packaging material, contamination by filth

Technical guidance:

- During unwrapping and unpacking of fish blocks, care should be taken not to contaminate the fish.
- Special attention has to be given to cardboard and/or plastic material partly or fully embedded in the blocks.
- All packaging material should be disposed of properly and promptly.
- Protect wrapped, unwrapped and unpacked fish blocks when cleaning and sanitizing processing lines during breaks and between shifts if the production process is interrupted.

12.3.5 **Production of fish core**

12.3.5.1 **Sawing**

Potential hazards: foreign material (metal or plastic parts of saws)

Potential defects: irregularly shaped pieces or portions

Technical guidance:

- Sawing instruments should be kept in clean and hygienic conditions.
- Saw-blades must be inspected regularly in order to avoid tearing of the product and breakage.
- Sawdust must not collect on the saw-table and must be collected in special containers if used for further processing.
- Sawn shims used to form irregularly shaped fish cores by mechanical pressure should be kept in clean, hygienic conditions until further manufacturing.

12.3.5.2. **Application of additives and ingredients**

Refer also to Section 9.4.3.

Potential hazards: foreign material, microbiological contamination, scombrototoxin

Potential defects: incorrect addition of additives, decomposition

Technical guidance:

- The temperature of the product in the mixing process should be adequately controlled to avoid the growth of pathogenic bacteria, and scombrototoxin formation.

12.3.5.3 **Forming**

Potential hazards: foreign material (metal or plastic from machine) and/or microbiological contamination/scombrototoxin (fish mixture only)

Potential defects: poorly formed fish cores, cores subjected to too much pressure (mushy, rancid), decomposition

Technical guidance:

- Forming of fish cores is a highly mechanized method of producing fish cores for battering and breading. It utilizes either hydraulic pressure to force shims (sawn portions of fish blocks) into moulds that are ejected onto the conveyor belt or mechanical forming of fish mixtures.
- Forming machines should be kept in hygienic conditions.
- Formed fish cores should be examined closely for proper shape, weight and texture.

12.3.6 Separation of pieces

Potential hazards: unlikely

Potential defects: adhering pieces or portions

Technical guidance:

- The fish flesh cores cut from the blocks or fish fillets or other irregular-shaped quick frozen fish material must be well separated from one another and should not adhere to one another.
- Fish cores that are touching one another going through the wet-coating step should be removed and placed back on the conveyor in order to obtain a uniform batter coat and a uniform breading pick-up.
- Cored fish should be monitored for foreign material and other hazards and defects before coating.
- Remove from production any broken, misshapen or out-of-specification pieces.

12.3.7 Coating

In industrial practice, the order and the number of coating steps may differ and, therefore, may deviate considerably from this scheme.

12.3.7.1 Wet coating

Potential hazards: microbiological contamination

Potential defects: insufficient cover or excessive cover of coating

Technical guidance:

- Fish pieces must be well coated from all sides.
- Surplus liquid, which should be reused, must be re-transported under clean and hygienic conditions.
- Surplus liquid on fish pieces should be removed by clean air.
- Viscosity and temperature of hydrated batter mixes should be monitored and controlled within certain parameters to effect the proper amount of breading pick-up.
- To avoid microbiological contamination of the hydrated batter, appropriate means should be adopted to ensure that significant growth does not take place, such as temperature control, dumping liquid contents and regular or scheduled clean-ups and/or sanitation during the manufacturing shift.

12.3.7.2 Dry coating

Potential hazards: microbiological contamination

Potential defects: insufficient coating or excessive coating

Technical guidance:

- Dry coating must cover the whole product and should stick well on the wet coating.
- Surplus coating is removed by blowing away with clean air and/or by vibration of conveyors and must be removed in a clean and hygienic way if further use is intended.

- Flow of breading from the application hopper should be free, even and continuous.
- Coating defects should be monitored and be in accordance with the *Standard for Quick Frozen Fish sticks (Fish Fingers), Fish Portions and Fish Fillets – Breaded or in Batter* (CXS 166-1989).
- The proportion of breading and fish core should be in accordance with the *Standard for Quick Frozen Fish Sticks (Fish Fingers), Fish Portions and Fish Fillets – Breaded or in Batter* (CXS 166-1989).

12.3.8 **Pre-frying**

There are some variations in industrial production for the frying process in so far that quick frozen coated products are completely fried including fish core and re-frozen later. For this case, alternative hazards and defects have to be described and not all statements in this section apply. In some regions, it is common practice to manufacture raw (not pre-fried) coated fish products.

Potential hazards: unlikely

Potential defects: over-oxidized oil, insufficient frying, loosely adhering coating, burnt pieces and portions

Technical guidance:

- Frying oil should have a temperature between approximately 160 °C and 195 °C.
- Coated fish pieces should remain in frying oil for sufficient time depending on the frying temperature in order to achieve a satisfying colour, flavour and structure to adhere firmly to the fish core, but core should be kept frozen throughout the whole time.
- Frying oil has to be changed when its colour becomes too dark or when the concentration of fat degradation products exceeds certain limits.
- Remains from coating that concentrate at the bottom of the frying bath have to be removed regularly to avoid partial dark coloration on coated products caused by upwelling of oil.
- Excessive oil should be removed from coated products after pre-frying by a suitable device.

12.3.9 **Re-freezing – final freezing**

Potential hazards: foreign material

Potential defects: insufficient freezing leads to sticking of units to one another or to walls of freezing equipment and facilitates mechanical removal of breading/batter

Technical guidance:

- The whole product should be re-frozen to -18 °C or below immediately after pre-frying.
- Products should be allowed to stay sufficient time in freezer cabinet to ensure core temperature of products of -18 °C or lower.

- Cryogenic freezers should have sufficient compressed gas flow to effect proper freezing of the product.
- Processors that utilize blast freezers may package the product in the consumer containers before freezing.

12.3.10 **Packaging and labelling**

Refer to Sections 9.2.1, 9.2.3 and 9.4.4.

Potential hazards: [microbiological contamination](#)

Potential defects: [under- or over-packing, improperly sealed containers, wrong or misleading labelling](#)

Technical guidance:

- Packaging should be done without delay after re-freezing under clean and hygienic conditions. If packaging is done later (e.g. batch processing), re-frozen products should be kept under deep-frozen conditions until being packaged.
- Packages should be checked regularly by weight control. End-products should be checked by a metal detector and/or other detection methods as applicable.
- Packaging of cartons or plastic bags to master shipping containers should be done without delay and under hygienic conditions.
- Both consumer packages and shipping containers should be appropriately lot-coded for product tracing in the event of a product recall.

12.3.11 **Storage of end products**

Refer also to Section 9.1.3.

Potential hazards: [unlikely](#)

Potential defects: [texture and flavour deviations owing to fluctuations in temperature, deep freezer burn, cold store flavour, cardboard flavour](#)

Technical guidance:

- All end products should be stored at frozen temperature in a clean, sound and hygienic environment.
- Severe fluctuations in storage temperature (more than 3 °C) have to be avoided.
- Too long storage time (depending on fat content of species used and type of coating) should be avoided.
- Products should be properly protected from dehydration, dirt and other forms of contamination.
- All end products should be stored in the freezer to allow proper air circulation.

12.3.12 **Transportation of end product**

Refer also to Sections 3.6 and 21.

Potential hazards: unlikely

Potential defects: thawing of frozen product

Technical guidance:

- During all transportation steps, deep-frozen conditions should be maintained at $-18\text{ }^{\circ}\text{C}$ (maximum fluctuation $\pm 3\text{ }^{\circ}\text{C}$) until final destination of product is reached.
- Cleanliness and suitability of the transport vehicle to carry frozen food products should be examined.
- Use of temperature-recording devices with the shipment is recommended.

12.4 Processing operations – molluscan shellfish

Coated molluscan shellfish should be manufactured from safe and wholesome molluscs that were subject to the regulation and controls of a shellfish authority having jurisdiction of the harvesting, processing and handling that ensures that they are safe to consume. Shellfish can be cooked or raw prior to the coating process and should not contain significant defects such as sand, cuts, parasites or discoloration that may affect the consumer acceptability of the finished product. The methods depicted in this subsection are typical processing techniques applied to a wide variety of molluscan shellfish that are commonly used. It is assumed that the end product will be cooked thoroughly before consumption.

Refer to Figure 12.2 for an example of a flow chart for coated molluscan shellfish processing.

12.4.1 **Reception**

All incoming raw materials should be subjected to an examination for food safety hazards and defects based on appropriate Codex Alimentarius sampling plans.

12.4.1.1 **Molluscan shellfish**

Refer also to Section 7.

Potential hazards: chemical contamination, biotoxins, microbiological contamination

Potential defects: decomposition, oxidation, freezer burn, parasites, torn or damaged molluscs, packaging material, shells or pieces of shell

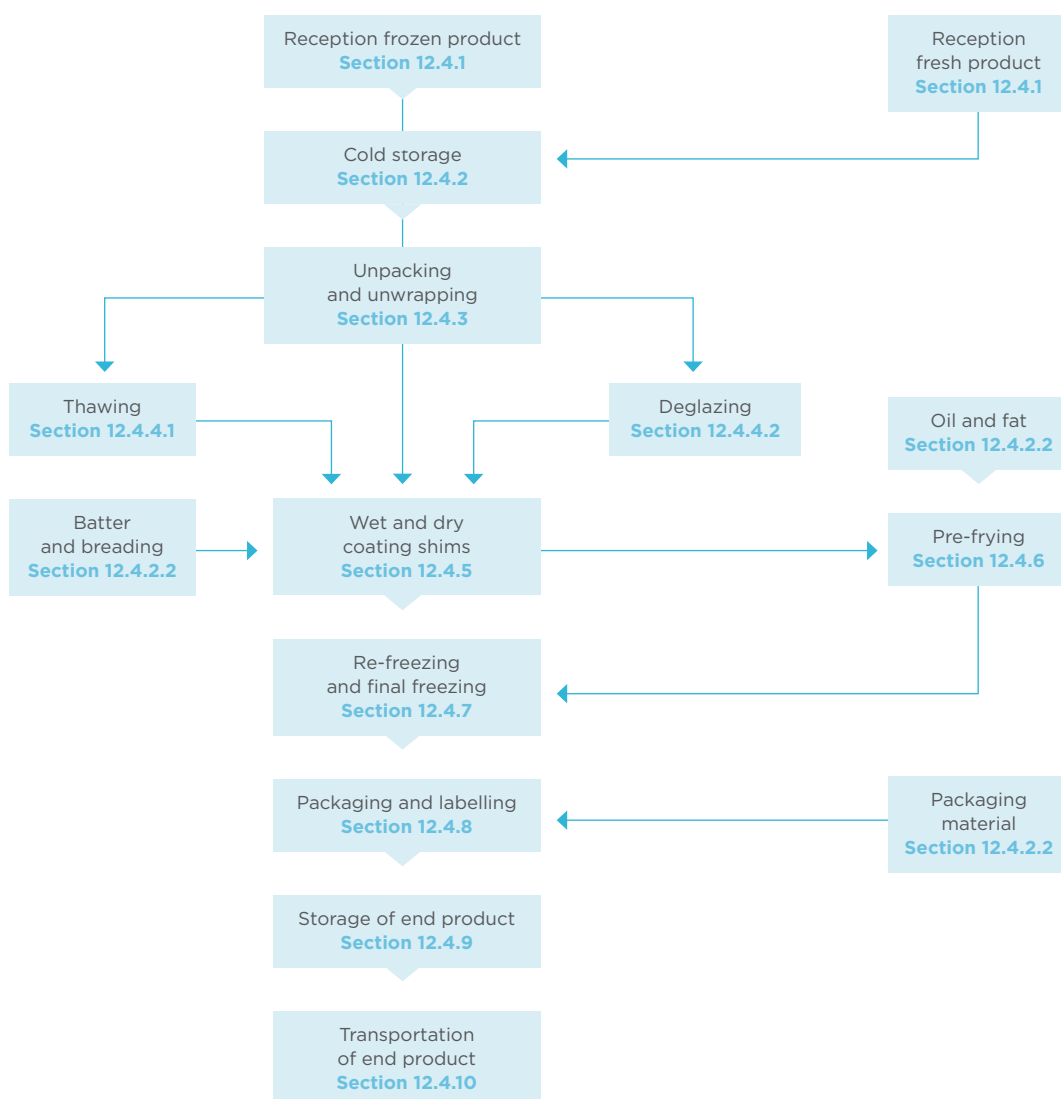
Technical guidance:

- Molluscan shellfish should be obtained from sources that are approved by a shellfish authority to ensure that marine biotoxins are properly controlled and that the product has been handled and processed in accordance with hygienic standards and proper process control to control food safety hazards.

- Temperatures of all incoming lots should be recorded. Frozen product should be -18 °C or lower. Fresh product should not exceed 4 °C.
- Packaging material of frozen products should be examined for dirt, tearing and evidence of thawing.
- Cleanliness and suitability of the transport vehicle to carry fresh and frozen molluscan shellfish products should be examined for each incoming shipment.
- Use of temperature-recording devices with the shipment is recommended.
- Representative samples should be taken to assess the level of possible hazards and defects.

Figure 12.2 Example flow chart of a coated molluscan shellfish-processing line

This flow chart is for illustrative purpose only. For in factory HACCP implementation, a complete and comprehensive flow chart has to be drawn up for each process. References corresponde to relevant sections of the Code.



12.4.1.2 **Other ingredients**

Refer to Section 12.3.1.2.

12.4.1.3 **Packaging materials**

Refer to Section 12.3.1.3.

12.4.2 **Storage of raw material, other ingredients and packaging materials**

12.4.2.1 **Molluscan shellfish (frozen storage)**

Refer to Section 12.3.2.1.

12.4.2.2 **Other ingredients and packaging materials**

Refer to Section 12.3.2.3.

12.4.2.3 **Molluscan shellfish (refrigerated storage)**

Refer also to Section 7.6.5.

Potential hazards: [microbiological, physical and chemical contamination](#)

Potential defects: [decomposition](#)

Technical guidance:

- Raw fresh molluscan shellfish should be stored between 0 °C and 4 °C.
- Raw fresh molluscan shellfish should be properly protected from contamination.

12.4.3 **Unpacking and unwrapping**

Refer to Section 12.3.4.

12.4.4 **Production of coated molluscan shellfish**

12.4.4.1 **Thawing frozen product**

Potential hazards: [microbiological contamination](#)

Potential defects: [decomposition, product damage](#)

Technical guidance:

- Molluscan shellfish that are frozen should be subjected to controlled conditions during the thawing process (below 4 °C) that prevent the growth of pathogenic and spoilage bacteria.
- Sufficient controls should be instituted to ensure that the thawing product is not subjected to conditions that are not hygienic or sanitary.
- Care should be taken to ensure that the raw thawed product is not subjected to conditions that cause tearing and breakage of the product.

12.4.4.2

Deglazing

Potential hazards: contamination from dirty deglazing water

Potential defects: thawing of product, contamination from dirty deglazing water

Technical guidance:

- Controls should be instituted to ensure that immersion to remove ice glaze is not so long as to cause the individual molluscan shellfish to thaw.
- Thaw immersion water should be replaced at sufficient intervals to ensure that the product is not subjected to dirt and other contaminants.

12.4.4.3

Separation of individual molluscan shellfish

Refer to Section 12.3.6.

12.4.5

Coating

Refer to Section 12.3.7.

12.4.5.1

Wet coating

Refer to Section 12.3.7.1.

12.4.5.2

Dry coating

Refer to Section 12.3.7.2.

12.4.6

Pre-frying

Refer to Section 12.3.8.

12.4.7

Re-freezing – final freezing

Refer to Section 12.3.9.

12.4.8

Packaging and labelling

Refer to Section 12.3.10.

12.4.9

Storage of end product

Refer to Section 12.3.11.

12.4.10

Transportation of end product

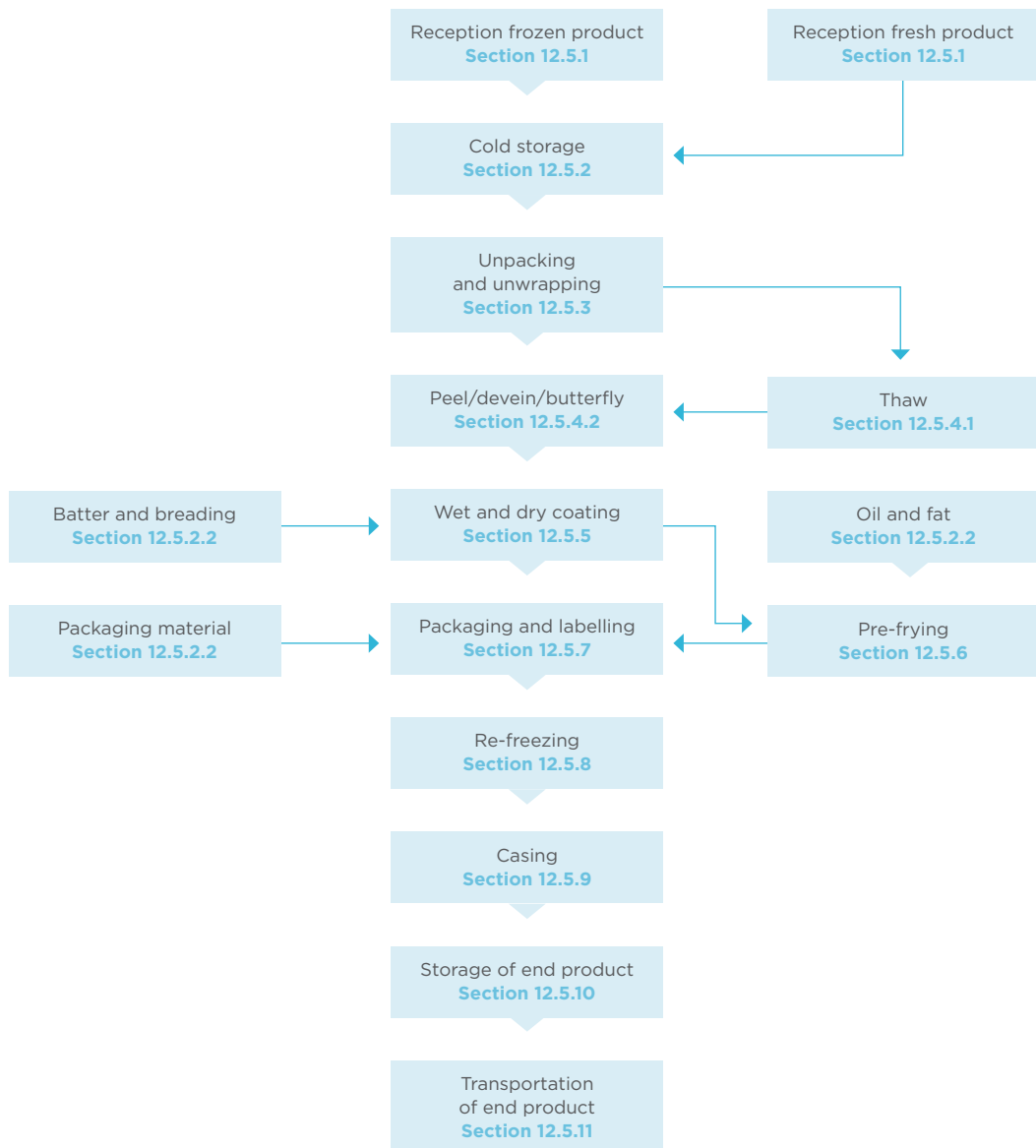
Refer to Section 12.3.12.

12.5 Processing operations – coated shrimps

Coated or breaded shrimps should be manufactured from good-quality shrimps that have been subjected to sanitary conditions and processed under conditions that properly control food safety hazards. Coated shrimps are usually removed from their shells with the exception of the tail (telson) and with the alimentary canal or “vein” removed. They are commonly either split (butterfly style) or are round, then subjected to the wet and dry coating mixtures and further processed. Production methodology of coated shrimps varies widely. The methods depicted below are commonly applied to tropical and subtropical shrimp breeding. It is assumed that the end product will be cooked thoroughly before consumption.

Figure 12.3 Example flow chart of a coated shrimp-processing line

This flow chart is for illustrative purpose only. For in factory HACCP implementation, a complete and comprehensive flow chart has to be drawn up for each process. References corresponde to relevant sections of the Code.



12.5.1 Reception

Refer to Section 16.

All incoming raw materials should be subjected to an examination for food safety hazards and defects based on appropriate Codex sampling plans.

12.5.1.1 Shrimps

Refer also to Section 16.2.1.

Potential hazards: sulphites

Potential defects: blackspot, soft flesh, inadequate head, viscera and leg removal, decomposition

Technical guidance:

- The presence of sulphites applied to the shrimps for the purpose of preventing blackspot enzyme autolysis should be controlled to ensure that the product can be labelled as containing sulphites.
- Sulphites should be used in accordance with manufacturer instructions and good manufacturing practice (GMP).
- Raw shrimps with extensive blackspot damage should be eliminated as an undesirable quality factor.
- Raw shrimps may exhibit soft flesh characteristics that result from bacterial infection that render them unsuitable for further processing. Incoming lots should be checked for this quality factor.
- Raw shrimps should not exhibit large amounts of viscera, head or leg material.
- Raw shrimps should be checked for signs of temperature abuse and decomposition that would be unsuitable in the finished product.
- Temperatures of all incoming lots should be recorded. Frozen product should be $-18\text{ }^{\circ}\text{C}$ or lower. Fresh product should not exceed $4\text{ }^{\circ}\text{C}$.
- Packaging material of frozen products should be examined for dirt, tearing and evidence of thawing.
- Cleanliness and suitability of the transport vehicle to carry fresh and frozen shrimp products should be examined for each incoming shipment.
- Use of temperature recording devices with the shipment is recommended.
- Representative samples should be taken to assess the level of possible hazards and defects.

12.5.1.2 Other ingredients

Refer to Section 12.3.1.2.

12.5.1.3 Packaging material

Refer to Section 12.3.1.3.

12.5.2 **Storage of raw material, other ingredients and packaging materials**

12.5.2.1 **Shrimps (frozen storage)**

Refer to Sections 12.3.2.1 and 16.2.2.

12.5.2.2 **Other ingredients and packaging material**

Refer to Section 12.3.2.3.

12.5.2.3 **Shrimps (refrigerated storage)**

Refer also to Section 12.3.2.2.

Potential hazards: microbiological, physical and chemical contamination

Potential defects: decomposition

Technical guidance:

- Raw fresh shrimps should be stored between 0 °C and 4 °C.
- Fresh shrimps should be properly protected from contamination.

12.5.3 **Unpacking and unwrapping**

Refer to Section 12.3.4.

12.5.4 **Production of coated shrimps**

12.5.4.1 **Thawing frozen product**

Potential hazards: microbiological contamination

Potential defects: decomposition, product damage, physical contamination

Technical guidance:

- Shrimps that are frozen should be subjected to controlled conditions during the thawing process (below 4 °C) that prevent the growth of pathogenic and spoilage bacteria.
- Sufficient controls should be instituted to ensure that the thawing product is not subjected to conditions that are not hygienic or sanitary.
- Care should be taken to ensure that the raw thawed product is not subjected to conditions that cause tearing and breakage of the product.

12.5.4.2 **Peeling, deveining, butterflying**

Potential hazards: microbiological contamination, chemical contamination, metal inclusion

Potential defects: presence of shell, presence of vein, poor cut, damaged flesh

Technical guidance:

- Because peeling of larger shrimps usually used for coating is performed by hand, care should be taken to ensure that pathogenic bacteria are not transmitted from the hands of workers. Careful compliance with Section 3.5 should be ensured.

- Thawed shrimps should be adequately protected from contamination and processed quickly so that the raw flesh does not deteriorate.
- Sufficient amounts of water should be applied to peeled shrimps to ensure that all shell remnants and veins are washed away and removed from the shrimps.
- If veins are removed by hand with a knife, the product should be regularly checked to ensure that the cuts are made to product specifications.
- If the shrimps are butterfly cut by hand, the product should be regularly checked to ensure that the cuts are made to product specifications.
- If the shrimps are butterfly cut by machine, the cutting blades should be regularly inspected so that the cut does not result in damaged shrimps or metal inclusion.

12.5.5 **Coating**

Refer to Section 12.3.7.

12.5.5.1 **Wet coating**

Refer also to Section 12.3.7.1.

Potential hazards: [microbiological contamination and toxin production in rehydrated batter, toxin formation](#)

Potential defects: [improper batter viscosity, foreign material, defective coating](#)

Technical guidance:

- Batter ingredient powders should be checked against buying specification and ideally sieved before use to remove any packaging and extraneous materials.
- Liquid batter preparations should be properly refrigerated or discarded at regular intervals to prevent microbiological growth and toxin formation.
- Batter viscosity should be monitored to ensure the proper pick-up of dry coating material. Batter that is too thin or too thick may result in a coating and flesh ratio that does not meet specifications and regulatory requirements.
- Note that bacterial toxin formation is a possibility in batter mixes. Therefore, usage times and temperatures should be set and cleaning schedules of equipment defined and maintained.
- Bags of dry batter mix should be stripped of their outer layer before being emptied into batter tanks in order to prevent dust and other contaminants from entering the rehydrated batter mix and into the final product.
- Tempura-style batters may be used, in which case additional crumb coatings will probably not be applied. However, frying temperatures and times will be critical to ensuring correct texture.
- Where batter is for adherence of a crumb coating, formulation and viscosity will be different from tempura styles.

12.5.5.2 **Dry coating**

Potential hazards: unlikely

Potential defects: defective coating, improper flesh/coating ratio, foreign material

Technical guidance:

- Breadcrumb formulation and grist, or particle size will need to be checked against buying specification and stored according to supplier instructions to avoid staling.
- Individual shrimps should be well separated during the coating process to ensure complete coating of the product.
- The total coating and flesh percentages should be regularly monitored using recognized methods to ensure that the specified flesh and coating ratio is attained.
- Air blowers that eliminate excess coating from the shrimps should be adjusted and regularly monitored to ensure that the proper coating level is maintained.
- Individual shrimps that exhibit incomplete or defective coating should be removed.
- Bags of dry coating mix should be stripped of their outer layer before being emptied into batter tanks in order to prevent dust and other contaminants from entering the rehydrated batter mix and into the final product.

Refer also to Section 12.3.7.2.

12.5.6 **Pre-frying**

Refer to Section 12.3.8.

12.5.6.1 **Frying**

- While frying is necessary for tempura batter coatings, it may not always be used for crumb coating operations, although it may aid adhesion.
- Fryers should be operated by trained staff. Oil should be turned over on a regular basis to avoid oxidative rancidity.
- Oil temperatures should be controlled to avoid burning crumb or fire risk.

12.5.7 **Packaging and labelling**

Refer to Section 12.3.10.

12.5.8

Re-freezing – final freezing

Potential hazards: unlikely

Potential defects: poor product texture, excessive moisture migration from flesh to coating

Technical guidance:

- Blast freezing should be carried out quickly with the appropriate temperature and air flow parameters routinely monitored, especially when the internal product temperature is between 0 °C and -4 °C, in order to minimize crystallization of the flesh and the moisture migration that will occur from the flesh to the coating.

12.5.9

Casing

Potential hazards: microbiological contamination

Potential defects: product thawing, moisture migration from flesh to coating

Technical guidance:

- Casing of the frozen containers should be carried out quickly to prevent thawing and quality problems such as texture changes of the shrimp flesh and moisture migration from the flesh to the coating.

12.5.10

Frozen storage of end product

Refer to Section 12.3.11.

12.5.11

Transportation of end product

Refer to Section 12.3.12.



A close-up photograph of a hand wearing a white nitrile glove holding a large, thick piece of salmon fillet. The salmon has a vibrant orange-red color and a visible skin side. In the background, numerous other pieces of salmon fillets are stacked in a dark, industrial-looking setting, possibly a processing plant or a storage area. The lighting is focused on the hand and the piece of salmon it is holding, creating a strong contrast with the darker background.

13

Processing of salted and dried salted fish

In the context of recognizing controls at individual processing steps, this section provides examples of potential hazards and defects and describes technological guidelines that can be used to develop control measures and corrective action. At any particular step, only the hazards and defects that are likely to be introduced or controlled at that step are listed. It should be recognized that in preparing a Hazard Analysis Critical Control Point (HACCP)²⁷ and/or defect action point (DAP) plan it is essential to consult Section 5, which provides guidance for the application of the principles of HACCP and DAP analysis. However, within the scope of this Code, it is not possible to give details of critical limits, monitoring, record-keeping and verification for each of the steps as these are specific to particular hazards and defects.

This Section applies to all salted and dried salted fish. The following species belonging to the Gadidae family have the following common and scientific names: Cod (*Gadus morhua*), Pacific cod (*Gadus macrocephalus*), Polar cod (*Boreogadus saida*), Greenland cod (*Gadus ogac*), Saithe (*Pollachius virens*), Ling (*Molva molva*), Blue ling (*Molva dypterygia*), Tusk (*Brosme brosme*), Haddock (*Gadus aeglefinus/Melanogrammus aeglefinus*), Forkbeard (*Phycis blennoides*) and Pollock (*Pollachius pollachius*). Measures to control scombrotoxin are not relevant for species that are not susceptible to scombrotoxin formation, such as species in the Gadidae family.

Salted fish and fish products and dried salted fish and fish products (i.e. klipfish) should be sound and wholesome, well prepared and packaged so that they will be protected from contamination and remain attractive and safe to eat. In order to maintain the quality of fish, it is important to adopt quick, careful and efficient handling procedures.

13.1 General

Refer also to Section 9.1 for general handling prior to processing and Figure 13.1 for an example flow chart of a salted and dried salted fish-processing line. Refer to Section 10 for technical guidelines for the control of scombrotoxin.

- Depending on the species for salting, fish should be completely bled as soon as practical.
- Where appropriate, fresh fish intended for processing salted fish should be checked for visible parasites.
- Frozen fish should not be salted before it has been thoroughly thawed and inspected for suitability.
- Freezing, heating or adequate combination of salt content and storage time can be used as treatment procedures for killing living parasites.
- The salt penetration will depend on fat content, temperature, amount of salt, salt composition, brine concentration, etc.

²⁷ Refer to Annex II for a comprehensive list of the acronyms used in this Code.

- When fish that accumulate histamine are being salted, exposure to temperatures that would support toxin formation by bacteria should be limited at each step in the process.
- To minimize time delays, the processing lines should, where applicable, be designed to be continuous and sequential to permit uniform flow without stoppages or slowdowns and removal of waste.

13.2

Preparing for salting

13.2.1

Splitting, washing and rinsing (Processing Step 7)

Potential hazards: unlikely

Potential defects: improper splitting

Technical guidance:

- Fish should be split by a cut made parallel to the backbone straight down from the throat or nape to the tail and in such a way as to prevent uneven and ragged edges or a loss in recovery. If the backbone is to be removed, the fish should be split so deeply that the remains of the backbone (the tail-bone) lie free. It is important to cut the bone rather than to break it from the flesh.
- Splitting of fish should be carried out expertly so that blood in the nape and blood clots are removed.
- Immediately after splitting, fish should be washed in plenty of running potable water or clean seawater to remove all blood from the fish.
- All impurities, blood and livers should be removed.
- Visible parasites should be removed.
- If the black membrane has to be removed, then it should be done after the splitting step.

13.2.2

Filleting, skinning and trimming (Processing Step 8)

Refer to Section 9.1.6.

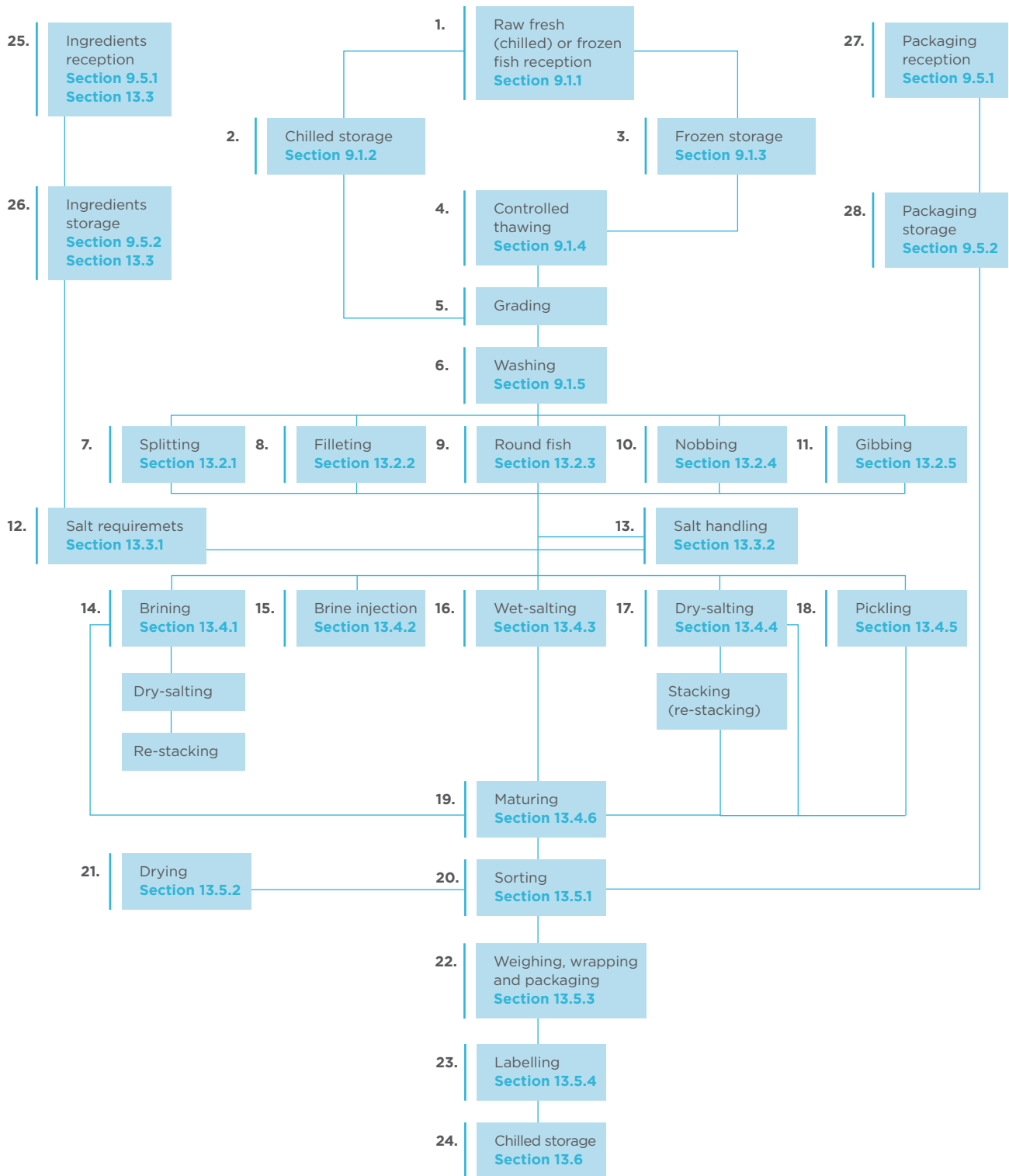
13.2.3

Round fish (Processing Step 9)

Refer to Sections 9.1.1–9.1.5.

Figure 13.1 Example flow chart of a salted- and dried-salted-fish-processing line

This flow chart is for illustrative purpose only. For in factory HACCP implementation, a complete and comprehensive flow chart has to be drawn up for each process. References corresponde to relevant sections of the Code.



13.2.4 **Nobbing (Processing Step 10)**

Potential hazards: scombrototoxin

Potential defects: remaining gut content and intestines other than roe or milt, decomposition

Technical guidance:

Refer to Section 13.2.1, second bullet.

- After nobbing, fish should be checked for remaining intestines.
- After nobbing, fish should be thoroughly washed to remove blood, remaining intestines and scales if appropriate.
- The nobbed fish should be drained and well iced or appropriately chilled in clean containers and stored in specially designated and appropriate areas within the processing facility.

13.2.5 **Gibbing (Processing Step 11)**

Potential hazards: scombrototoxin

Potential defects: remaining gut content, decomposition

Technical guidance:

Refer to Section 13.2.1, second bullet.

- After gibbing, fish should be checked for correct gibbing.
- Fish with incorrect gibbing, should be sorted out and used for other purposes.
- After gibbing, fish should be thoroughly washed to remove blood, remaining undesirable intestines, heart, etc. and scales if appropriate.
- The gibbed fish should be drained and well iced or appropriately chilled in clean containers and stored in specially designated and appropriate areas within the processing facility.

13.3

Salt handling and salt requirements

13.3.1 **Salt requirements (Processing Step 12)**

Potential hazards: chemical and physical contamination

Potential defects: incorrect composition

Technical guidance:

- The quality of salt used in salting of fish should possess an appropriate composition for the product.
- The composition of salt differs according to the origin. Mine salt and solar salt of marine origin contain several other salts such as calcium sulphate, magnesium sulphate and chloride as impurities. Vacuum-processed and refined salt is almost pure sodium chloride.
- A relatively pure salt is needed for the dry-salting of fatty fish, but for some products the presence of small quantities of calcium salts will improve the appearance of the product. Too much calcium may reduce the rate of salt penetration to an extent that spoilage may occur.

- If present at too high a concentration, magnesium salts will give rise to unpleasant bitter flavours and may cause spoilage during the salting operation.
- Salt produced from marine sources may contain halophilic bacteria and mould that continue to live in the salt and dry salted fish and could contribute to spoilage.
- Salt used in salt fish should be inspected to ensure that it is clean, not used before, free from foreign matter and foreign crystals, and shows no visible sign of contamination with dirt, oil, bilge or other extraneous materials.
- The size of the salt granules used should be carefully considered. The use of very fine salt granules could result in the formation of clusters, which is not favourable for ensuring the uniform distribution of salt on the fish. The use of very coarse salt granule could result in damage to the fish flesh during salting and may reduce the rate of maturation.
- Small crystals of salt should be used for dry-salting of fatty fish, and large crystals for lean fish.
- Salt used as an ingredient needs to be of food grade.

13.3.2

Handling (Processing Step 13)

Potential hazards: chemical and physical contamination

Potential defects: bacteria and mould

Technical guidance:

- Salt for salting of fish should be transported and stored dry and hygienically covered in salt bins, storerooms, containers or in plastic sacks.
- In order to minimize the presence and growth of bacteria and moulds in salted fish, such as pink and dun, the reuse of salt should be avoided.

13.4 Salting and maturing

Salted fish should be salt-matured, sound and wholesome. The salting process, including the temperature, should be sufficiently controlled to prevent the development of *C. botulinum*, or the fish should be eviscerated prior to brining. The temperature should also be sufficiently controlled to prevent the formation of histamine in susceptible species.

Salting of fish either by brining, brine injection, wet-salting, dry-salting or pickling should be carried out with full understanding of their effects on the quality of the final product and should be done under strict hygienic conditions and temperature control.

Two particular conditions that can adversely affect the quality of salted fish are the occurrence of bacteria and mould. Both defects can be combated by maintaining a temperature lower than 8 °C (below 4 °C for fish that may form scombrototoxin). Salt produced from marine sources may contain halophilic bacteria, which continue to live in the salt and salted fish. In order to minimize such microbial contamination of salted fish, previously used and/or contaminated salt should be removed from the plant.

Another adverse condition that can affect the quality of salted fish is brown (yellow) discoloration often stemming from rancidity caused by metal catalysts in the salt. The quality of the salt is important, low temperature should be maintained during the process, and light and oxygen should be avoided.

13.4.1 **Brining (Processing Step 14)**

Potential hazards: viable parasites, scombrototoxin, botulinum toxin

Potential defects: decomposition

Technical guidance:

- Only fresh stabilized brine should be used for the salting operations; water quality is important, potable water should be used for preparation of brine.
- The ratio of brine to fish and the concentration of the brine should be adjusted to the desired product; time and temperature (< 4 °C) control is important if the brine concentration is lower than saturated.
- Concentration of brine should be checked at regular intervals and incorrect concentration should be adjusted prior to use.
- To ensure proper salt penetration, fish should be of similar size.

13.4.2 **Brine injection (Processing Step 15)**

Potential hazards: viable parasites, scombrototoxin, injection needle fragment, botulinum toxin

Potential defects: decomposition

Technical guidance:

- Equipment used for brine injection should be cleaned and disinfected at regular intervals.
- Needles of apparatuses should be inspected daily for broken tips, for blocking and deflections of needles.
- Brine injection devices should be operated by trained personnel only.
- Conduct metal detection here or later in the process.
- The reflux of injected brine into the reservoir should be avoided.

13.4.3 **Wet-salting (Processing Step 16)**

Potential hazards: viable parasites, scombrototoxin, botulinum toxin

Potential defects: decomposition

Technical guidance:

- Fish for wet-salting should be salted and carefully arranged in the curing container such that voids channels between the fish are minimized
- Amount of salt, time and temperature should be controlled to obtain the desired product.
- When salting the fish, the salt concentration of the brine should be checked periodically with a salinometer according to specifications.

- After salting, the fish can be stacked. This should not be done before the proper salt/water balance has been reached. In stacked, adequate amounts of salt should be added and evenly distributed over the whole surface of the fish.
- Salted fish should be stored or maintained for a sufficient period under controlled temperatures to ensure proper curing and to prevent deterioration of the product.

13.4.4

Dry-salting (Processing Step 17)

Potential hazards: viable parasites, scombrototoxin, botulinum toxin

Potential defects: decomposition

Technical guidance:

- Fish for dry salting should be carefully arranged such that voids or channels between fish are minimized and that drainage is adequate
- Fish piles should never be placed directly on the floor or in direct contact with the wall.
- Amount of salt, time and temperature should be carefully controlled to obtain the desired product. Sufficient amount of salt is important for the quality of the product.
- Fish should be re-stacked periodically with the top of the pile going to the bottom of the new pile, and with the addition of fresh salt to ensure that sufficient salt will be present to complete the cure.
- If the fish is re-stacked on pallets, the pallet should be clean.
- Fish should not be exposed to freezing temperatures during the salting process.

13.4.5

Pickling (Processing Step 18)

Potential hazards: viable parasites, scombrototoxin, botulinum toxin

Potential defects: decomposition

Technical guidance:

- The amount of salt must be adjusted to the quality of the fatty (primary) fish (fat content). Salt, sugar and spices should be weighed/measured and be evenly distributed.
- During the pickling operation, all fish should be well immersed in the resulting pickle.
- Fish should be allowed to settle in containers and then salt or pickle added before the container is closed.
- Cured fatty fish should be kept in brine or pickle.
- Fatty fish should always be covered with pickle during curing.
- Pickling is primarily used for fatty fish. Under certain conditions, dry-salting of small fatty fish, such as anchovy and small herring, may be used.

13.4.6

Maturing (Processing Step 19)

Potential hazards: viable parasites, microbiological contamination, scombrototoxin, botulinum toxin

Potential defects: decomposition, rancidity and discolouring of the flesh or surface bacteria and mould

Technical guidance:

- Maturing time depends on the fish (species, size and quality), temperature and the amount of salt absorbed by the fish tissues.
- The first part of curing period for fish that accumulate histamine should be done at temperatures between 0 °C and 5 °C to prevent growth of microbial pathogens and development of histamine.
- Fatty fish such as herring may be kept in a temperature range of 5-10 °C during the maturing period provided the salt concentration is sufficient to inhibit scombrototoxin formation. The length of this period will vary from weeks to several months depending on the specific products. If the containers are to be held at lower temperatures, the maturing period will increase.
- When salting fish that accumulate histamine, regular checks should be made of histamine content of the end product.

13.5

Sorting, drying, weighing, packaging, wrapping and labelling

13.5.1

Sorting (Processing Step 20)

Potential hazards: unlikely

Potential defects: incorrect sorting (quality, weight, size, species, etc.) bacteria and mould

Technical guidance:

- Salted fish should be sorted into species, sizes and trade quality categories for the relevant market.
- Loose salt should be removed from the fish before sorting and new salt should be added before packaging.

13.5.2

Drying (Processing Step 21)

Potential hazards: scombrototoxin

Potential defects: decomposition, bacteria and mould

Technical guidance:

- The time and temperature used for drying will depend on fish species, size and the handling and stacking of the fish.
- To ensure proper drying, the fish should be of similar size.
- Use of too high temperature can cause hard texture of the outer layer of the muscle and should be avoided. This could stop the drying process.

Refer also to Sections 9.2.3 and 9.4.4.

13.5.3

Weighing, wrapping and packaging (Processing Step 22)

Potential hazards: microbiological contamination

Potential defects: unlikely

Technical guidance:

- Packaging material should be clean, sound, durable, sufficient for its intended use and of food-grade material.
- Barrels in which fatty fish are ready to be marketed should be clean, whole and hygienic.
- The packaging operation should be conducted to minimize the risk of contamination and decomposition.
- Products should meet appropriate standards for labelling and weights.

13.5.4

Labelling (Processing Step 23)

Refer to Sections 9.2.3 and 9.5.

13.6

**Chilled storage
(Processing
Step 24)**

Potential hazards: unlikely

Potential defects: unlikely

Technical guidance:

- Salt-matured fish should be stored in chilled storage.
- The temperature in the chilled storage should be between 1 °C and 4 °C.
- Temperature and storage time should be monitored and recorded at regular intervals.
- The products should be handled carefully and not be over-stacked.

13.7

**Packaging,
labels and
ingredients
(Processing
Steps 25, 26, 27
and 28)**

Refer to Section 9.5.



A large rack of fish hanging in a smoking chamber, with a close-up of several fish in the foreground. The fish are arranged in rows on a wooden rack, and the background is filled with more fish hanging in a similar manner. The lighting is warm and orange, suggesting a smoking process.

14

Smoked fish, smoke-flavoured fish and smoke-dried fish

14.1 Processing of Smoked Fish

This Section provides examples of potential hazards and defects and describes technological guidance that can be used to develop control measures and corrective actions. At any particular step only the hazards and defects, which are likely to be introduced or controlled at that step, are listed. It should be recognized that in preparing a Hazard Analysis Critical Control Point (HACCP)²⁸ and/or defect action point (DAP) plan it is essential to consult Section 5 which provides guidance for the application of the principles of HACCP and DAP analysis. However, within the scope of this Code of Practice it is not possible to give details of critical limits, monitoring, record keeping and verification for each of the steps since these are specific to particular hazards and defects.

Smoking of fish and dried smoking of fish have a long tradition as preservation methods for fish. As such, experience regarding the potential hazards has been gained over time. New technologies of smoking and smoke-flavouring of fish and storage of smoked products and smoke-flavoured products under refrigeration and frozen conditions have altered the barriers to growth of bacteria. This includes the use of modified atmosphere packaging (MAP) and vacuum-packaging.

Whilst new technologies have been developed for the production of smoke-dried products, the low water activity of the end products has not altered the product stability and safety during storage.

The pre-requisite programme described in Section 3 applies as well as the general considerations for the handling of fresh fish in Section 4, and the description of HACCP and DAP analysis in Section 5.

The recommendations made for the production of fresh fishery products in Section 9 are valid for the preparation of fish used as raw material for the production of fish products covered by this section.

For fish at risk of scombrototoxin formation, the times of product exposure between refrigerated and hot smoking temperatures should be monitored to control histamine formation (refer to Section 10 for technical guidelines on histamine control).

If raw material likely to contain viable parasites is to be used steps must be taken to eliminate this hazard during processing steps, e.g. freezing, heating or salting the product. Alternatively, the final product should be treated in a way to kill parasites (see Annex I of the *Standard for Smoked Fish, Smoke-flavoured Fish and Smoke-dried Fish* (CXS 311-2013).

The topics to be dealt with in this chapter will be those covering the special features of the smoked products, smoked-flavoured products and smoke-dried products as well as the handling of these products. Where the process, packaging or storage conditions of the product are not described in this

²⁸ Refer to Annex II for a comprehensive list of the acronyms used in this Code.

Code, the operator should endeavour to scientifically validate the safety of such a process, packaging or storage of the product so as to eliminate further hazards to the consumer.

Hot smoked products and some cold smoked products, such as smoked salmon are ready to eat without a further cooking preparation stage. For these products, it is necessary to introduce high care practices during the processing, which would include employment of trained staff who handle products in segregated areas, using dedicated equipment. For instance, non-smoked and smoked fish must be kept separate to avoid cross-contamination.

14.1.1 Reception of raw materials

Refer to Section 9.1.1. Refer to Section 10.1 for fish susceptible to scombrototoxin.

14.1.2 Salting

Refer also to Sections 13.3 and 13.4

Potential Hazards: microbiological, chemical and physical contamination, scombrototoxin, presence of metal, broken needles

Potential Defects: decomposition, physical contamination, undesired texture, physical damage

Technical guidance:

- Typically, fish for hot smoking are salted for only a short time to enhance flavour using a low-to-medium-strength salt brine.
- Fish for cold smoking are dry salted, wet salted, combined salted or salted by brine injection of a medium-strength salt brine to enhance flavour and for safety purposes. To ensure a uniform salt distribution throughout the fish, it can be left for up to 24 hours under refrigeration to equilibrate. The equilibration time should be adapted to the salting technique used, to the temperature (e.g. 0–8 °C) and to the fish species.
- Salting time and temperature and fish temperature should be selected so as to control the development of histamine, where fish of susceptible species are concerned (e.g. *Scombridae*, *Clupeidae*, *Engraulidae*, *Coryphaenidae*, *Pomatomidae*, *Scomberesocidae*). Brine should be prepared from food grade salt and water of potable quality.
- Brine should be replaced according to the environmental conditions and the process
- Salt content of the brine should be monitored regularly.
- To control or assist in the control of *Clostridium botulinum* examples of controls may be found in Annex II of *Standard for Smoked Fish, Smoke-flavoured Fish and Smoke-dried Fish* (CXS 311-2013).
- The brine should be kept cooled and the temperature should be monitored.
- Brine should preferably not be reused and if it needs to be recycled, a treatment should be applied to minimize microbiological hazards, e.g. by filtration.

- Where brine is injected, special care should be taken for the maintenance, cleaning and disinfection of the equipment (section 13.4.2).
- To assure proper salting, the fish should be of similar size.
- To avoid histamine formation and potential microbiological contamination, the flow of products should be maintained in such a way as to avoid undue accumulation and, consequently, temperature abuse.
- Vats used for salting should be made of suitable corrosion resistant material and should be constructed to permit easy cleaning and complete draining.
- Injected fish products should be checked for broken needles and metal inclusion.
- Ingredients such as flavours (except smoke flavours) and other additives may be added during the salting process either by soaking, injection or dry application.
- If water added during the salting step is not completely removed during the drying and salting steps, then the resulting water added products should be labelled according to the laws in the country of sale.

14.1.3

Hanging and racking

Potential hazards: microbiological contamination, scombrototoxin

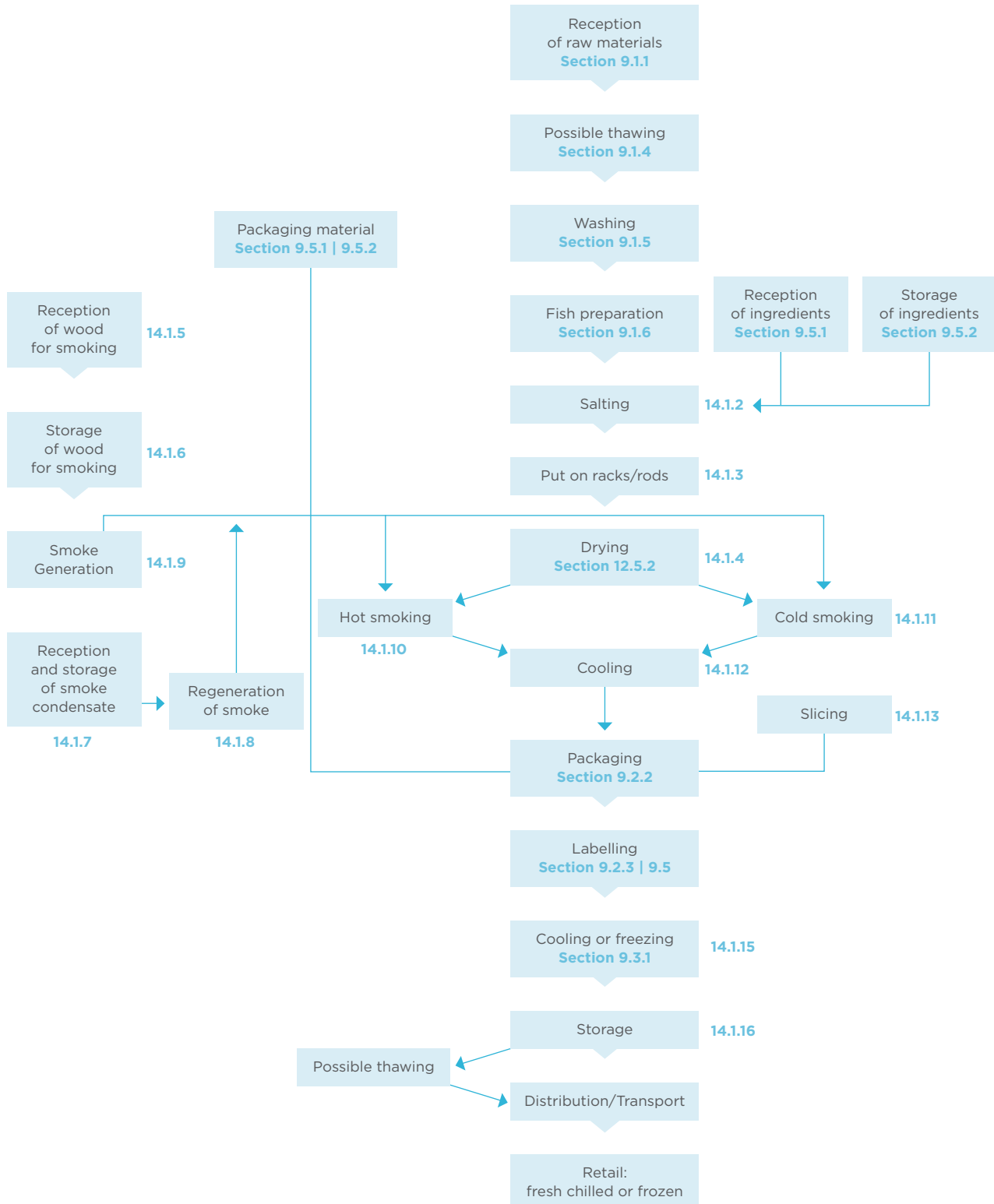
Potential defects: physical damage, drying/smoking defects due to inadequate separation, decomposition

Technical guidance:

- Fish should be hung or racked in a way that ensures that pieces are completely separated from each other allowing an adequate flow of air/smoke.
- The mesh in the racks should be large enough to allow an adequate flow of air/smoke.
- Other pathogens (i.e. *Staphylococcus aureus*) have been given a competitive advantage via brining. A strict adherence to time/temperature and hygiene/sanitation controls should be followed at all steps post-brining (excluding the smoking and refrigeration/freezing steps) to minimize risk of contamination of the product and subsequent microbiological growth.

Figure 14.1 Example flow chart of a hot smoking, cold smoking and smoking by regenerated smoke preparation line, including possible slicing operation in the cold smoking line

This flow chart is for illustrative purpose only. For in factory HACCP implementation, a complete and comprehensive flow chart has to be drawn up for each process.



14.1.4

Drying

Refer also to Section 13.5.2

Potential hazards: microbiological contamination, physical contamination, and scombrototoxin

Potential defects: decomposition, fungal contamination, physical contamination

Technical guidance:

- The drying process should ensure that the fish loses an adequate amount of water to be stable during the smoking process.
- Care should be taken to avoid excessive loss of moisture leading to poor (dry) texture.
- The salting process is usually followed by an air-drying phase to evaporate moisture prior to smoking to facilitate the attainment of final product characteristics.
- Drying should not result in prolonged exposure to ambient temperature as this may lead to unwanted microbiological growth and the formation of histamine in susceptible species.
- Drying should be performed under conditions of controlled temperature, humidity and air flow where applicable.

14.1.5

Reception of wood or plant material for smoking

Potential hazards: natural toxins, chemicals, paint, impregnating material in the wood or plant material

Potential defects: undesirable odours

Technical guidance:

- The wood or plant material should be dry enough for smoking and free from natural toxins, chemicals, paint etc.
- Wood or plant material of species not suitable for smoke production should not be used.
- Wood containing mould or fungus may impart off-flavours and odours and should not be used.

14.1.6

Storage of wood or plant material for smoking

Potential hazards: chemical contamination

Potential defects: undesirable odours

Technical guidance:

- Wood or plant material for smoking should be stored in a dry and protected place.
- Contamination during storage should be avoided.

14.1.7

Reception and storage of smoke condensate

Potential hazards: residues of polycyclic aromatic hydrocarbons (PAHs)

Potential defects: unlikely

Technical guidance:

- Smoke condensate should come from a reputable reliable source and may need to be approved by the competent authority.
- Containers with smoke condensate should be stored in a dry, clean place.
- Containers with smoke condensate should be labelled adequately as such.

14.1.8

Regeneration of smoke

Potential hazards: unlikely

Potential defects: inadequate smoking

Technical guidance:

- The diameter of the spray nozzle tip should be chosen to generate a smoke aerosol having a particle size close to a conventionally generated smoke.
- The settings of the flow of smoke condensate and compressed air should ensure adequate generation of smoke in a desired amount.
- Cleaning should be carried out as needed to maintain regenerated smoke characteristics.

14.1.9

Smoke generation from wood and other plant material

Refer to the *Code of Practice for the Reduction of Contamination of Food with Polycyclic Aromatic Hydrocarbons (PAHs) from Smoking and Direct Drying Processes* (CXC 68-2009).

Potential hazards: formation of excessive amounts of PAHs

Potential defects: inadequate smoking

Technical guidance:

- The amount of smoke entering the chamber should be controlled in line with the instructions of the manufacturer.
- Smoke generation is created by smouldering (pyrolysis) and care should be taken to ensure that there is no flame development.

14.1.10 Hot smoking

Refer also to Section 3.4.

Potential hazards: parasites and microbiological contamination, chemical contamination from smoke

Potential defects: physical contamination (tar, ash), poor colour, flavour and texture

Technical guidance:

- Time and temperature of the smoking process should be monitored to achieve the desired colour, taste and texture, and to ensure control of microbiological contamination, and scombrotoxin formation in susceptible species. Continuous monitoring devices are recommended to ensure that time and temperature conditions are met.
- Time and temperature combination should be controlled, monitored and recorded to ensure effective control of *Listeria monocytogenes* and to damage spores of non-proteolytic *Clostridium botulinum*. Listericidal processes should be validated to ensure that the treatments are effective and can be applied consistently.
- An appropriate time/temperature combination must be used for complete coagulation of proteins (a typical example of hot smoking temperature reaches 65 °C in the thermal centre of the product).
- To achieve the above, the heated air and the smoke should be evenly distributed in the smoking chamber.

14.1.11 Cold smoking

Potential hazards: chemical contamination from smoke, growth of *Clostridium botulinum*, scombrotoxin

Potential defects: physical contamination (tar, ash), poor colour, flavour and texture, decomposition

Technical guidance:

- In the cold smoking process the temperature of the products is kept below the coagulation temperature for the proteins of the flesh of the fish, usually under 30 °C, but can vary between 27 °C and 38 °C. Time and temperature of the smoking process should be monitored to achieve the desired colour, taste and texture. Continuous monitoring devices are recommended to ensure that time and temperature conditions are met.
- Cold smoking should be carried out under microbiologically monitored hygienic conditions in a chamber and using equipment that is subjected to a detailed hygienic schedule. See also Section 3.4. Smoking time should be long enough to reduce the water content of the product sufficiently.
- The total smoking process should be continued until moisture content targets and weight loss targets are reached.

14.1.12 **Cooling**

Potential hazards: [microbiological contamination](#), [scombrototoxin](#)

Potential defects: [poor taste and texture](#), [decomposition](#)

Technical Guidance:

- Cooling should be done in a controlled environment to avoid cross contamination.
- Following smoking, the fish should be cooled rapidly and thoroughly to a temperature that minimizes microbiological growth over the determined shelf-life.

14.1.13 **Slicing**

Refer also to Section 3.4.

Potential hazards: [microbiological contamination](#), [scombrototoxin](#)

Potential defects: [physical contamination](#), [poor slices](#), [decomposition](#)

Technical guidance:

- The smoked fillets may be cold tempered (e.g. partially frozen to -5 °C to -12 °C) for a short time period to stabilize the fish flesh to facilitate mechanical slicing.
- The slicing process and the transport of the conveyer belts are critical to the hygienic condition of the end product.
- The flow of products should be maintained to avoid undue accumulation of products along the processing line.
- The slicing devices should be well maintained for optimal slicing performance.

14.1.14 **Packaging**

Refer also to Sections 9.2 and 9.5

Potential hazards: [microbiological](#), [chemical and physical contamination](#), [scombrototoxin](#)

Potential defects: [physical contamination](#), [decomposition](#)

Technical guidance:

- Smoked products may be chilled or frozen prior to packaging.
- With reduced oxygen packaging (e.g. modified atmosphere, vacuum), or with any product that does not have adequate oxygen permeability, barriers to growth of *Clostridium botulinum* should be used. Such barriers often include freezing or refrigeration, combined with salting and drying to lower water activity. See Annex II of the *Standard for Smoked Fish, Smoke-flavoured Fish and Smoke-dried Fish* (CXS 311-2013).
- In case of modified atmosphere packaging, the composition of the gas mixture should be checked regularly.
- Packaging material should be clean, sound, durable and sufficient for intended use and of food grade material.
- Condensation of water on the surface of the smoked product should be avoided.

14.1.15 **Cooling or freezing**

Refer also to Sections 9.3.1 and 14.1.12

Potential hazards: microbiological contamination, scombrototoxin, survival of parasites

Potential defects: poor taste and texture, decomposition

Technical guidance:

If freezing at this process step is carried out to kill parasites, a time/temperature regime has to be chosen as laid down in Annex I of the *Standard for Smoked Fish, Smoke-flavoured Fish and Smoke-dried Fish* (CXS 311-2013).

14.1.16 **Storage**

Refer also to Sections 9.1.2, 9.1.3 and 16.2.18

Potential hazards: microbiological contamination, scombrototoxin

Potential defects: poor taste and texture, decomposition, freezer burn

Technical guidance:

- For the control of *Clostridium botulinum*, refer to Annex II of the *Standard for Smoked Fish, Smoke-flavoured Fish and Smoke-dried Fish* (CXS 311-2013).
- Temperature should be monitored and recorded in the cold store for both cooled and frozen product to meet shelf-life requirements.
- The maintenance of proper storage temperature (chilled or frozen) for both cold and hot smoked products is of critical importance in controlling microbiological growth, in particular growth of *Listeria monocytogenes*, *Clostridium botulinum* and other pathogens, i.e. *Staphylococcus aureus*.

14.1.17 **Labelling**

Refer also to Sections 9.2.3 and 9.5

Potential hazards: microbiological contamination, undeclared allergens

Potential defects: incorrect labelling

Technical guidance:

- The label should include the storage temperature, shelf-life, other handling and storage conditions for safety and quality. For example, *Clostridium botulinum* can grow in most vacuum packaged products after the product is thawed. Labels for these products should state: "Keep frozen. Thaw under refrigeration directly before use".

14.2 Smoke- flavoured fish

Smoked-flavoured fish is a product produced by applying various combinations of smoke flavours which gives a smoked product taste without the use of smoke.

The smoke flavour can be applied in different ways via different technologies and at different stages of the process. In contrast to the smoking process, the different production steps are not necessarily carried out in a smoking chamber and are not carried out in a fixed order. Heat can be applied at all stages of the process, or the product can be sold uncooked to the final consumer for further preparation (heating).

The unique characteristics of the smoke-flavoured products shall be clearly described on the label so as not to mislead the consumer.

Potential hazards: microbiological, physical and chemical contamination from smoke flavours, growth of *Clostridium botulinum*, scombrototoxin

Potential defects: too little or too much smoke flavour, non-homogenous distribution of smoke flavour, physical contamination, poor colour, flavour and texture, decomposition

Technical guidance:

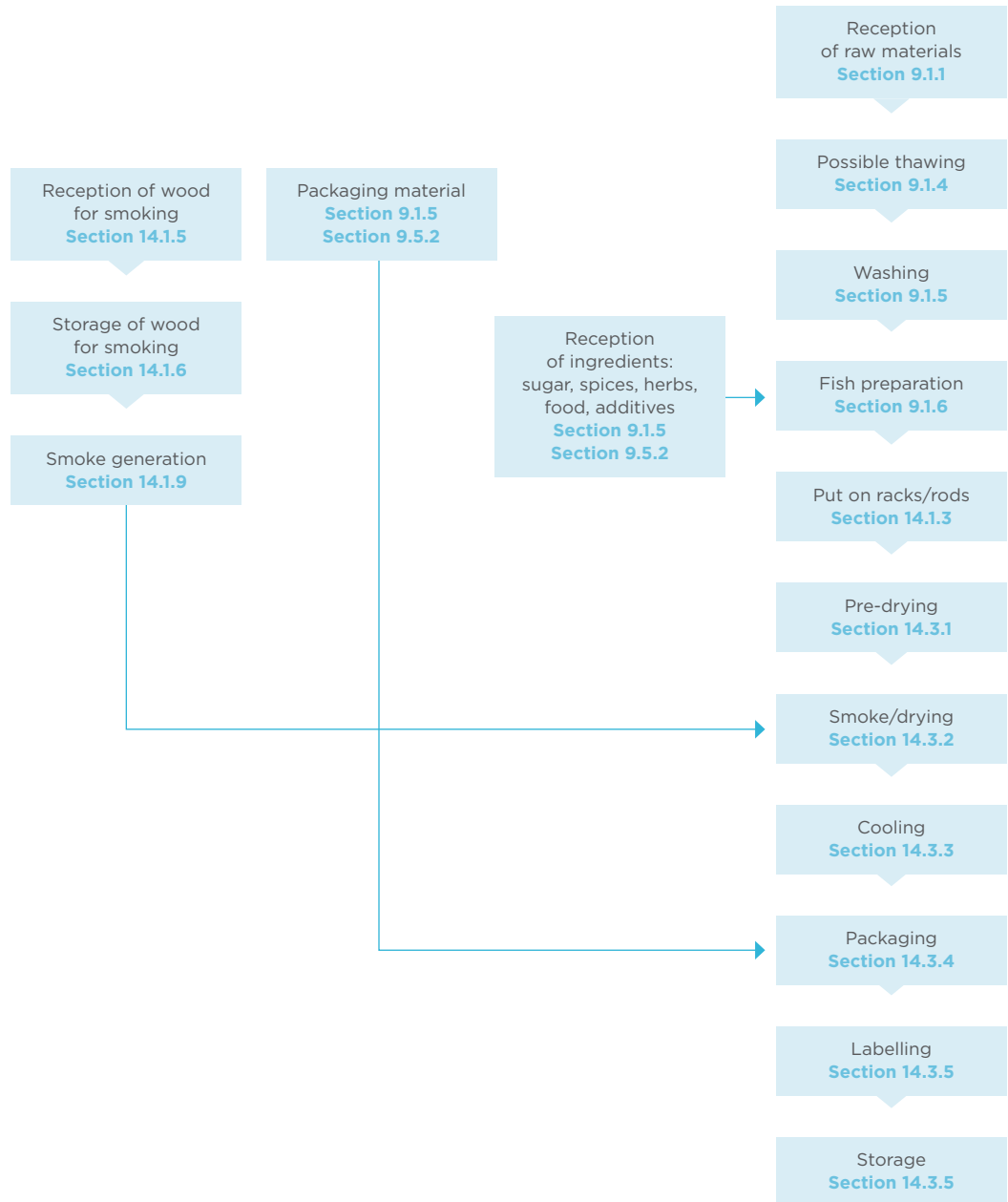
- To prevent scombrototoxin formation during smoke flavour treatment, proper temperature should be maintained.
- Fish used for smoked-flavoured fish should be of good quality and prepared according to good manufacturing practices.
- Smoke flavours should not be used in an attempt to improve poor quality fish.
- Smoke flavours should be applied according to the manufacturer's recommendations.

Smoke flavours should come from a reputable reliable source and may need to be approved by the competent authority.

- Smoke flavours that are diluted prior to application to the fish must be diluted with food grade materials and/or water of potable quality.
- If water is added during smoke flavouring of fish (e.g. injection, dip), then the resulting water added product should be labelled according to the laws of the country of sale.
- Controls should be in place to ensure that smoke flavour mixtures meet pre-determined specifications.

Figure 14.2 Example flow chart of a smoke-dried fish preparation line

This flow chart is for illustrative purpose only. For in factory HACCP implementation, a complete and comprehensive flow chart has to be drawn up for each process. References correspond to relevant sections of the Code.



14.3 Smoke-dried fish

The product may be ready to eat or may be rehydrated, which is generally done by putting the product in boiling water or soup prior to consumption.

14.3.1

Pre-drying

Potential hazards: [microbiological and physical contamination](#), [scombrototoxin](#)

Potential defects: [decomposition](#), [physical contamination](#)

Technical guidance:

- Fish for smoke-drying should be exposed to sun, air or mechanical drying for a period of time in order to reduce the water content of the skin and flesh which should help providing uniform distribution of smoke over product surfaces.

14.3.2

Smoke-drying

Refer also to Section 3.2.2

Potential hazards: [parasites and microbiological contamination](#), [scombrototoxin](#), [chemical contamination from smoke](#)

Potential defects: [physical contamination \(filth\)](#), [burnt parts](#), [poor texture](#), [decomposition](#)

Technical guidance:

- Time and temperature of the smoke-drying process should be monitored to achieve the desired texture and water activity as well as to minimize the risk of generation of components such as PAH.
- To achieve the above, the heated air should reach each part of the product evenly.
- The fish should be far enough away from the fire to prevent any burning of fish parts.
- Contamination of smoke-dried products with sand, ash, dust, filth and rust should be avoided.
- If smoke drying is carried out in a smoking chamber, smoking and drying are done simultaneously in the smoking chamber. Temperature in the chamber should gradually increase from 50 °C to 70 °C. The smoking and drying process are continued until the finished product is completely dried with the final moisture content less than 10 percent or the water activity should be less than 0.75.

14.3.3 **Cooling**

Refer also Section 3.2.2

Potential hazards: unlikely

Potential defects: insect infestation, physical contamination with filth

Technical guidance:

- When smoke-drying is finished, the fish should be allowed to cool to ambient temperature.
- Cooling should be carried out in a dry area under controlled conditions to avoid partial rehydration and cross contamination, respectively.

14.3.4 **Packaging**

Potential hazards: microbiological, chemical and physical contamination

Potential defects: physical contamination, physical damage, rehydration

Technical guidance:

- Packaging material should be dry, clean, sound, durable and sufficient for intended use and of food grade material.
- The packaging should enclose the product to protect it against environmental influences, according to the law and customs in the country where the fish is to be sold.
- The packaging should adequately protect smoke-dried fish from moisture or humidity that could raise the water activity allowing mould and/or pathogen growth.

14.3.5 **Labelling**

Potential hazards: unlikely

Potential defects: incorrect labelling

Technical Guidance:

- The smoke-dried products should be clearly labelled in which manner it has to be prepared prior to consumption.

14.3.6 **Storage**

Potential hazards: unlikely

Potential defects: insect infestation, physical damage

Technical guidance:

- The smoke-dried fish should be handled with care.
- Care should be taken to avoid any rehydration.



A close-up photograph showing a person's hands in bright blue nitrile gloves. The person is holding a dark brown lobster, which is dripping with water. The lobster is being held over a white plastic container. In the background, other lobsters are visible in a similar container. The scene is brightly lit, and the focus is on the hands and the lobster being processed.

15-A

**Processing
of lobsters**

In the context of recognizing controls at individual processing steps, this section provides examples of potential hazards and defects and describes technological guidelines, which can be used to develop control measures and corrective action. At any particular step only the hazards and defects likely to be introduced or controlled at that step are listed. It should be recognized that in preparing a Hazard Analysis Critical Control Point (HACCP)²⁹ and/or defect action point (DAP) plan, it is essential to consult Section 5 which provides guidance for the application of the principles of HACCP and DAP analysis. However, within the scope of this Code of Practice it is not possible to give details of critical limits, monitoring, record keeping and verification for each of the steps since these are particular to each hazard and defect.

This Section applies to lobsters in the genus *Homarus*, rock lobsters, spiny lobsters, slipper lobsters in the genera *Palinurida*, and *Scyllaridea*, squat lobsters in the genera *Cervimunida* and *Pleuronocodes*, and the Norwegian lobster, *Nephrops norvegicus*.

15A.1

General – addition to prerequisite programme

In addition to the prerequisite programme outlined in Section 3 of this Code, processing facility operators are encouraged to evaluate the design and construction of facilities and the maintenance and sanitation of operations with specific regard to the processing of lobsters. Consideration should be given to the following:

15A.1.1

Design and construction of equipment and utensils

- In batch systems, the inactivation tank, cooker and cooling tank should be located adjacent to each other; they may also be equipped with an overhead hoist or gantry to transfer baskets from one to the other.
- Cookers should be designed to provide a constant and adequate supply of heat so that all lobsters undergo the same time/temperature exposure during the cooking operation.

15A.1.2

Hygiene control programme

- Water that has been in contact with lobsters should not be reused unless reconditioned to avoid taint problems.
- It is undesirable for the same workers to handle both raw and cooked products. If this is unavoidable, stringent precautions should be taken to prevent cross-contamination of the cooked product by microorganisms from raw material.

²⁹ Refer to Annex II for a comprehensive list of the acronyms used in this Code.

15A.2

General considerations for the handling of lobsters

15A.2.1.

Refer to Section 4.

Potential hazards and defects associated with lobsters

Refer also to Sections 4.1 and 5.3.3.1.

15A.2.1.1

Potential hazards

Bacteria

Staphylococcus aureus is an aerobic or facultatively anaerobic gram-positive spherical microorganism. It is coagulase-positive and ferments glucose. Some strains can produce enterotoxins.

Staphylococcus is not found in the normal microflora on fish. The natural habitat for this organism is the skin and mucous membranes of animal and man. The presence of *Staphylococcus* on fish is an indication of post-harvest contamination due to poor personal hygiene. The organism is a poor competitor and will not multiply in fish. However, in fish or shellfish products, where the normal flora is reduced or eliminated (i.e. cooked peeled shrimp or crab meat), the presence of staphylococci indicates a potential for food poisoning.

Listeria monocytogenes is widely dispersed in the environment and foods. The organism is not exceedingly heat resistant and is killed by proper cooking. *L. monocytogenes* can grow in the presence or absence of oxygen and can survive in salt concentrations up to 16 percent NaCl. It can also endure frozen storage. An important factor in foodborne listeriosis is that the pathogen can grow to significant numbers at refrigeration temperatures when given sufficient time.

Despite the fact that a wide variety of foods may be contaminated with *L. monocytogenes*, outbreaks and sporadic cases of listeriosis are predominantly associated with ready-to-eat (RTE) foods. Although the data is limited, surveys suggest that RTE seafood such as cooked lobster, cooked crab and smoked fish have been found to contain this bacterium.

Chemical hazards

Veterinary drugs

Medicated feeds or drugs may be used to control the spread of aquatic animal diseases where lobsters are maintained and fed in holding pounds. Residues of veterinary drugs in excess of recommended guidelines should be considered as a potential hazard.

Biotoxins

Paralytic shellfish poisoning (PSP) toxins (saxitoxins) have been identified in the hepato-pancreas of lobsters.

15A.2.1.2 **Potential defects**

Black discoloration

Black discoloration is caused by melanin formation most commonly in the ventral tail segment joints and muscle surrounding the pericardium. It develops in the integumentary tissues and muscle surfaces but does not occur in the muscle meat tissue. The use of sulphating agents to prevent this discoloration is a common practice and may result in unacceptable residues. The potential for residues of sulphating agents leads to labelling requirements because these chemicals are common allergens.

15A.2.2 **Minimize the deterioration of lobster – handling**

Refer also to Section 4.3.

- It is known that, in general, the quality of lobster deteriorates more rapidly than that of fish under similar conditions; care in keeping lobsters alive prior to processing is therefore strongly recommended.
- Since lobster legs and other appendages can be easily broken resulting in damage that risks the infection and weakening of the lobster, care should be taken whenever handling live lobsters.
- Tanks and wells for pounding live lobsters should be so placed and constructed as to maintain lobsters in a live state.
- Live lobsters should be carefully packed in clean tanks, wells, crates, open-weave bags or boxes covered with wet sacking and held at as low a temperature as practicable, as required of according to species.
- Holding tanks are regarded as a better method of storage for long-term handling than well storage.
- The use of clean hessian or jute bags for transport is preferred. Bags made of woven synthetic material should not be used.
- Where open-weave bags are used for transport, precautions should be taken to avoid the suffocation of lobsters due to slime or mud.
- Care should also be taken to maintain adequate humidity when holding lobsters live in bags for transport.
- Species that mutilate each other should have their claws banded as soon as possible after catching.
- If it is not possible to keep lobsters alive until the time of processing, lobsters should be killed. Tails should be carefully separated and cleaned before freezing or cooling down to the temperature of melting ice, which should be done as rapidly as possible.

15A.3 Processing operations

Once a processing facility has established a prerequisite programme (Section 3), the principles of HACCP (Section 5) can be applied to each individual process within that facility.

This Section provides two examples of products derived from lobsters. Special consideration was given to products involving heat treatment because of their potential impact on food safety (such as post processing handling). The products and their respective flow diagrams are as follows: Frozen raw lobster tails (Fig. 15A.1) and Chilled cooked whole lobster/chilled cooked lobster meat (Fig. 15A.2).

15A.3.1 **Frozen raw lobster tail**

15A.3.1.1 **Live lobster reception (Processing Step 1)**

Potential hazards: unlikely

Potential defects: weak or injured lobsters, lobster decomposition

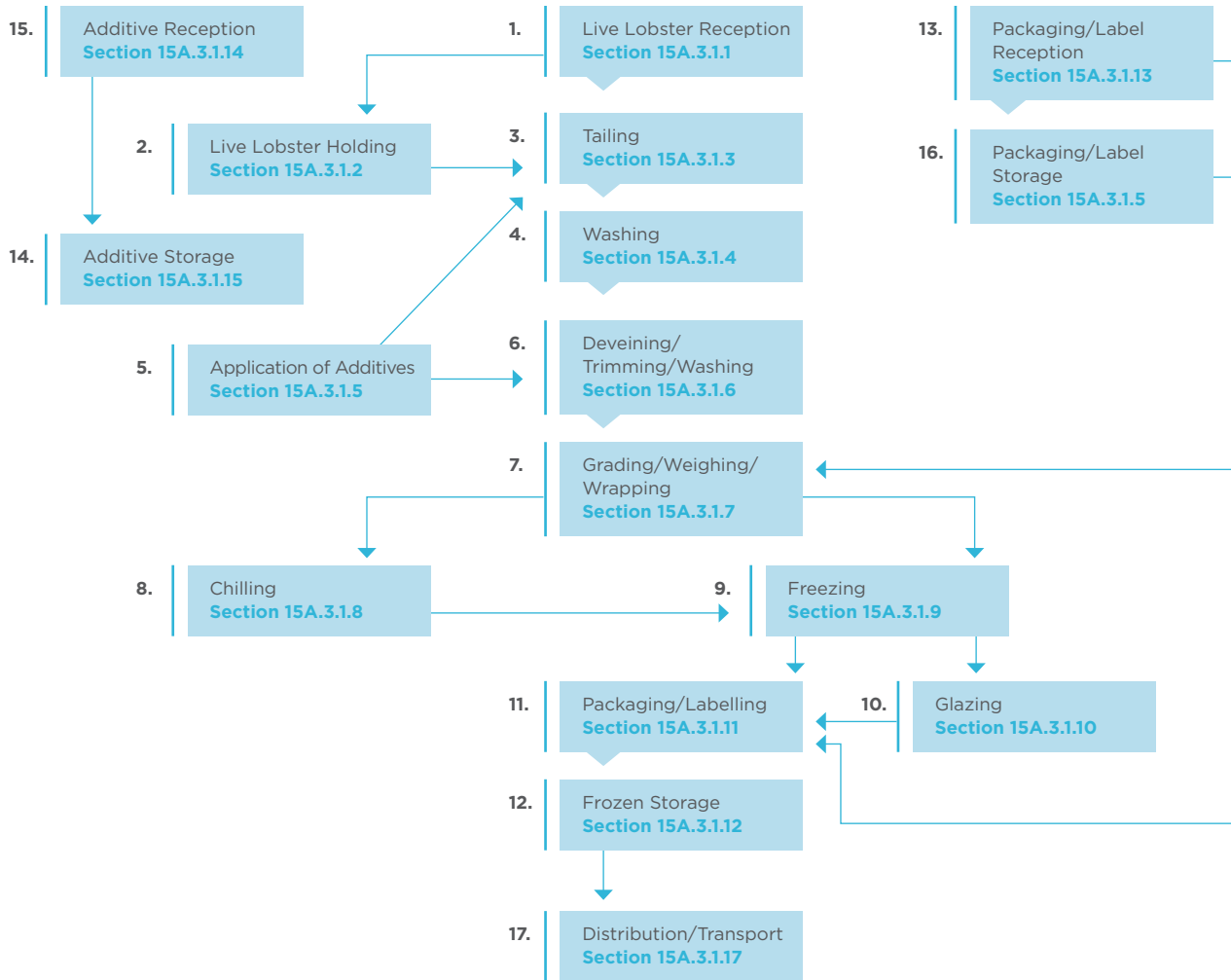
Technical guidance:

- Live lobsters should be inspected upon receipt to ensure that they are alive, which can be demonstrated by active leg movement and the tail of lobsters being curled lightly underneath the body when the lobster is picked up. Dead lobsters have a high probability of decomposition due to a high autolysis rate and should not be processed.
- Weak lobsters should be processed immediately.
- Since lobster legs and other appendages can be easily broken and the damage can cause to risk of infection and weakening of the lobsters, care in handling should be applied to live lobsters at all times. The necessary skills should be acquired by lobster handlers.
- Lobsters should be rejected if they are known to contain harmful or extraneous substances and/or defects which will not be eliminated or reduced to an acceptable level by normal procedures of sorting or preparation. An appropriate assessment should be carried out to determine the reason(s) for loss of control and the HACCP or DAP plan should be modified where necessary.

Figure 15A.1 Example flow chart for the processing of frozen raw lobster

This flow chart is for illustrative purpose only.

For in factory HACCP implementation, a complete and comprehensive flow chart has to be drawn up for each process.



15A.3.1.2 **Live lobster holding (Processing Step 2)**

Refer also to Sections 6.1.2, 6.3.2 and 15.2.2.

Potential hazards: [veterinary drug residues](#)

Potential defects: [lobster decomposition](#)

Technical guidance:

- All live lobsters should be processed as soon as possible.
- Storage time should be monitored where appropriate and should be as short as practical.
- To minimize damage, black discoloration (melanosis) and mortality losses during captivity, especially for the moulting stage of lobsters, overcrowding should be avoided and this can be achieved by controlling the stocking density.
- For short-term storage, live lobsters should be held in suitable containers and in land-based tanks and wells that should be supplied with running seawater, or in dry crates.
- Dead whole lobsters should not be processed and should be rejected and disposed in a proper manner. An appropriate assessment should be carried out to determine the reason(s) for loss of control and the DAP plan should be modified where necessary.
- If drugs are used, appropriate withdrawal times must be followed.

15A.3.1.3 **Tailing (Processing Step 3)**

Potential hazards: [microbiological contamination](#)

Potential defects: [microbiological contamination](#)

Technical guidance:

- When lobsters are not landed alive, the tail and cephalothorax should be separated immediately after catching. This practice is strongly recommended as they are brought on board. Tails should be carefully separated and cleaned before freezing or cooling down to the temperature of melting ice, which should be done as rapidly as possible.
- Tailing should be carried out as rapidly as possible.

15A.3.1.4 **Washing (Processing Step 4)**

Refer also to Section 9.1.5.

Potential hazards: [unlikely](#)

Potential defects: [poor cleaning](#)

Technical guidance:

- Lobster tails should be washed in ample running potable water, clean seawater or water as outlined in 15.1.2 to remove all impurities.

15A.3.1.5 **Application of additives to lobster tails (Processing Step 5)**

Potential hazards: The use of non-approved additives, incorrect application of sulphites³⁰

Potential defects: Physical contamination, black spots due to inadequate application of sulphites³⁰, incorrect application of phosphates³⁰

Technical guidance:

- Mixing and application of appropriate additives should be carried out by trained operators.
- Regular checks of the additive levels should be carried out.
- Tails with black spots should be discarded.
- Non-approved additives should not be allowed in the processing facility.
- Sulphites should be used in accordance with manufacturer's instructions and good manufacturing practice.

15A.3.1.6 **De-veining/trimming/washing (Processing Step 6)**

Refer also to Section 9.1.5.

Potential hazards: microbiological contamination

Potential defects: incomplete de-veining, decomposition, dark membrane attached to the shell, physical contamination

Technical guidance:

- The intestine should be removed immediately; potential methods include ejection by water pressure or vacuum and physical removal by appropriate utensils such as scissors, knives or extractors.
- Skills should be acquired by lobster handlers, with particular attention to the removal of membrane and blood from the front end of the tail where the meat is exposed.
- An adequate supply of clean water or potable water should be available for the washing of de-veined and trimmed lobster tails to ensure that no remnants of the gut or its contents remain.
- The de-veined or trimmed lobster tails should be washed, well iced or appropriately chilled in clean containers, and stored in specially designated and appropriate areas within the processing facility.
- The de-veining process should be carried out quickly to prevent product spoilage. Tails awaiting de-veining should be kept on ice or refrigerated at 4 °C or below.

³⁰ List of additive names for "sulphites" and "phosphates" can be found in the *Standard for Quick Frozen Lobsters* (CXS 95-1981).

15A.3.1.7 **Grading/weighing/wrapping (Processing Step 7)**

Potential hazards: microbiological contamination

Potential defects: incorrect net weight, inadequate wrapping, inappropriate packaging material, incorrect grading

Technical guidance:

- Lobster tails should be graded into species, sizes and weights for the relevant market, to assure the economic integrity of the final product.
- Calibrated balances should be provided for accurate grading.
- Balances should be calibrated periodically with a standardized weight to ensure accuracy.
- Packaging material should be clean, sound, durable, appropriate for its intended use and of food grade material.
- The wrapping and packaging operation should be conducted in a sanitary manner to avoid contamination of the product.
- Care should be taken to ensure that the front end of tail where the meat is exposed is completely wrapped to protect against dehydration.
- Weights of finished packages should be monitored at regular intervals to assure that they are the proper net weight.

15A.3.1.8 **Chilling (Processing Step 8)**

Refer also to Section 4.1.

Potential hazards: microbiological contamination

Potential defects: decomposition

Technical guidance:

- For lobster tails, chilling in refrigerated seawater is not recommended because excessive salt penetration into the muscle will take place rapidly. However, refrigerated clean water systems can be used for rapid pre-cooling before freezing or storage in ice.
- Chilling should take place as rapidly as possible to prevent microbiological growth and deterioration.

15A.3.1.9 **Freezing (Processing Step 9)**

Refer to Section 9.3.1.

Potential hazards: unlikely

Potential defects: poor texture

Technical guidance:

- Air blast, liquid nitrogen, or other freezing methods should be rapid to produce high quality tails and to ensure that the textural qualities of the product are retained.

15A.3.1.10 **Glazing (Processing Step 10)**

Refer also to Section 9.3.2.

Potential hazards: [microbiological contamination](#)

Potential defects: [incomplete glaze, foreign matter](#)

Technical guidance:

- Glaze water should be replaced regularly to ensure that a high bacterial load does not occur and to prevent build-up of foreign material.
- Chilling of glaze water will result in a more uniform application of glaze that will better protect the product.

15A.3.1.11 **Final Packaging/Labelling (Processing Step 11)**

Refer also to Section 9.2.3.

Potential hazards: [absence of labelling of allergenic additives](#)

Potential defects: [subsequent dehydration, incorrect labelling](#)

Technical guidance:

- Packaging material should be clean, sound, durable, sufficient for its intended use and of food grade material.
- Care should be taken to ensure that the front end of tail where the meat is exposed is completely wrapped to protect against dehydration.
- Where sulphites were used in the process, care should be taken to ensure that this additive is properly declared on the label.

15A.3.1.12 **Frozen storage (Processing Step 12)**

Refer also to Section 9.1.3.

Potential hazards: [unlikely](#)

Potential defects: [freezer burn, dehydration](#)

Technical guidance:

- Products should be properly packaged to protect against freezer burn and dehydration.
- Glaze is recommended as a further measure to ensure against dehydration.

15A.3.1.13 **Packaging and label reception (Processing Step 13)**

Refer also to Section 9.5.1.

Potential hazards: [unlikely](#)

Potential defects: [contaminated packaging, incorrect labels](#)

Technical guidance:

- Packaging materials should be examined for signs of defects and contamination.
- Labels should be examined for accuracy and to adherence to applicable regulations.

15A.3.1.14 **Additives reception (Processing Step 15)**

Refer also to Section 9.5.1.

Potential hazards: biological, chemical and physical contamination

Potential defects: contamination, mislabelling

Technical guidance:

- Additive shipments should be examined to ensure that they are not contaminated and that the container integrity is adequate.
- It should be verified that additive shipments contain the correct chemicals and meet purchase specifications.

15A.3.1.15 **Additives, packaging and label storage (Processing Steps 14 and 16)**

Refer also to Section 9.5.2.

Potential hazards: unlikely

Potential defects: contaminated additives or packaging material

Technical guidance:

- Food additives and packaging material should be protected from dust, dirt and other sources of contaminants.
- Pests and insects should be excluded from the packaging storage area.

15A.3.1.16 **Distribution and transport (Process Step 17)**

Refer to Section 21.

15A.3.2 **Chilled and frozen cooked whole lobster and cooked lobster meat**

This Section is designed with additional operation steps pertaining specifically to cooked whole lobster and cooked lobster meat.

15A.3.2.1 **Live lobster reception (Processing Step 1)**

Refer to Section 15A.3.1.1.

15A.3.2.2 **Live lobster holding (Processing Step 2)**

Refer to Section 15A.3.1.4.

15A.3.2.3 **Drowning or pacifying (Processing Step 3)**

Potential hazards: unlikely

Potential defects: unlikely

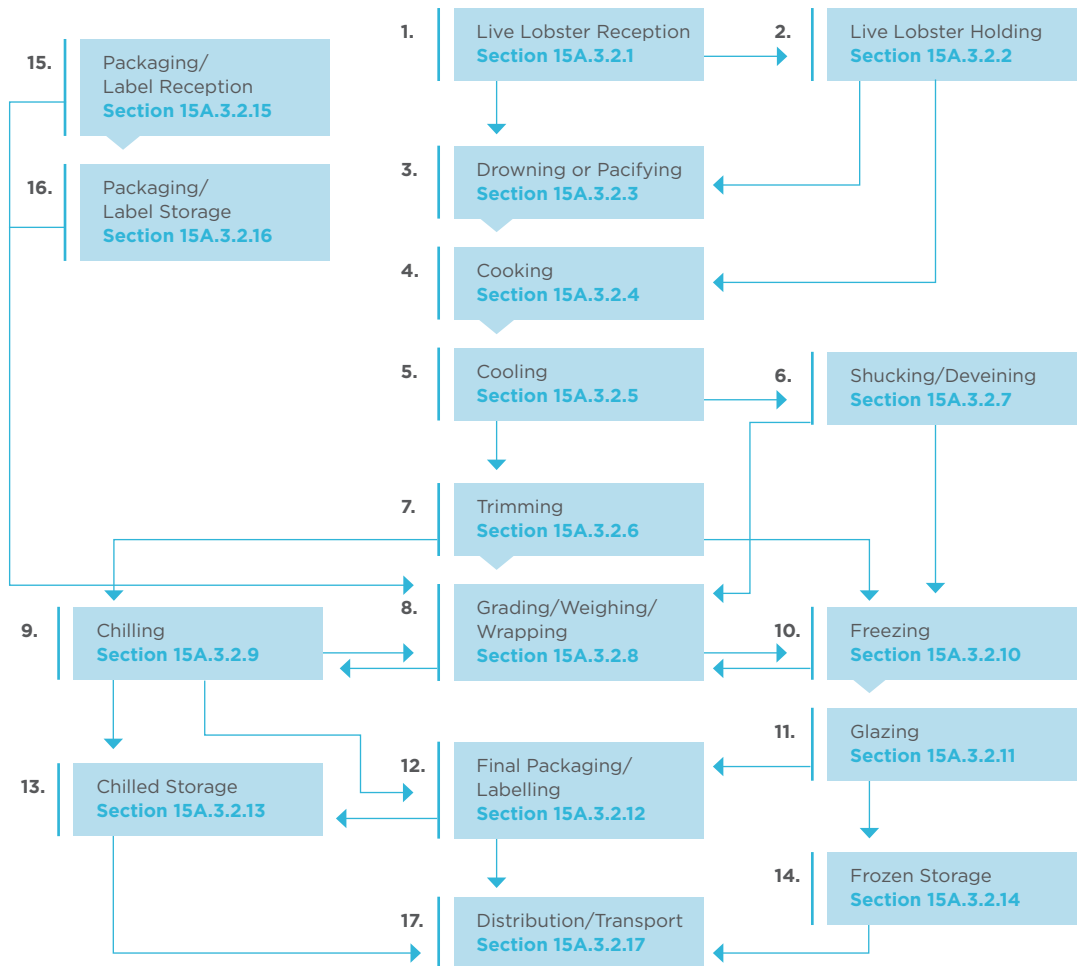
Technical guidance:

- Some species (not *Homarus*) are prepared for cooking by drowning/suffocation in clean water with a low oxygen content or by immersing in chilled clean water.
- Another possible process is an electric shock (pulse) in potable water, clean water or brine.

Figure 15A.2 Example flow chart for the processing of cooked lobster

This flow chart is for illustrative purpose only.

For in factory HACCP implementation, a complete and comprehensive flow chart has to be drawn up for each process.



15A.3.2.4 **Cooking (Processing Step 4)**

Potential hazards: microbiological contamination

Potential defects: over-/under-cooking

Technical guidance:

- A cooking schedule for boiling or steaming should be designed to take into consideration the appropriate parameters such as cooking time and temperature and size of the lobster.
- Cooking should be carried out by appropriately trained personnel who have acquired the necessary skills to monitor and ensure that all lobsters are given the same time/temperature exposure and adequate heat penetration during the operation.
- Each cooker should be equipped with a suitable thermometer to show the cooking operation temperature. Fitting of a recording thermometer is strongly recommended. A simple device to indicate time of cooking should be supplied.
- Lobsters should be cooked according to size until the shell is uniformly orange-red in colour, and depending on the product, until the meat can be easily removed from the shell. Overcooking causes the meat to shrink excessively which lowers yield, while undercooking makes it difficult to remove the meat from the shell.

15A.3.2.5 **Cooling (Processing Step 5)**

Potential hazards: microbiological contamination

Potential defects: unlikely

Technical guidance:

- Cooling times should be kept as short as possible and every effort should be made to avoid contamination of the product during this period.
- Cooling should be done properly, immediately after cooking, to ensure uniform cooling of the batch and to avoid holding at temperatures that encourage the growth of bacteria.
- Cooling should be done using cold circulated air, running potable water or clean seawater.
- Where lobsters are cooked on a continuous basis, cooling is also best done on a continuous basis.
- Cooling water should be used only once.
- Shell removal should be performed only when the product has adequately cooled.
- Care should be taken to prevent that cross contamination of cooked lobsters does not occur.
- Cooked lobsters should be handled as a ready-to-eat product that has its normal microflora destroyed which can allow pathogens to proliferate.

15A.3.2.6 **Trimming (Processing Step 7)**

Potential hazards: microbiological contamination

Potential defects: unlikely

Technical guidance:

- An adequate supply of clean seawater, potable water or water as outlined in Section 15.1.2 should be available to remove adhering coagulate protein. Spray washing on a conveyor is sometimes sufficient but it may be necessary to brush by hand. These methods can be combined.
- All surfaces and brushes should be frequently cleaned during the operation in order to minimize the microbial contamination.

15A.3.2.7 **Shucking, de-veining and washing (Processing Step 6)**

Potential hazards: microbiological contamination

Potential defects: presence of shell fragments

Technical guidance:

- The shucking and de-veining of cooked lobsters should be done quickly and carefully, in order to provide an attractive product.
- Care should be taken to prevent cross-contamination of cooked product with raw lobster or any questionable material.
- Depending on the vessel or processing facility product flow pattern and where a prescribed critical limit for staging time and temperature regime has been established for the control of hazards, the shucked or de-veined cooked lobster should be washed and appropriately chilled in clean containers and stored in specially designated and appropriate areas within the processing facility.
- Lobster meat should be thoroughly washed on all surfaces in cold potable water, clean seawater or water as outlined in Section 15.1.2.

15A.3.2.8 **Grading/weighing/wrapping (Processing Step 8)**

Potential hazards: microbiological contamination

Potential defects: incorrect grading, inadequate wrapping, inappropriate packaging material, incorrect net weight

Technical guidance:

- Lobsters should be graded into species, sizes and weights for the relevant market, to assure the economic integrity of the final product.
- Lobster meats should be uniform in size.
- Calibrated balances should be provided for accurate grading.
- Balances should be calibrated periodically with a standardized weight to ensure accuracy.
- Wrapping material should be food grade, clean, sound, durable and appropriate for its intended use.

15A.3.2.9 **Chilling (Processing Step 9)**

Refer also to Section 4.2.

Potential hazards: [microbiological contamination](#)

Potential defects: [deterioration](#)

Technical guidance:

- Chilling should take place as rapidly as possible to prevent microbiological growth and deterioration.
- Refrigerated clean water systems can be used for rapid pre-cooling before freezing or storage in ice.
- Chilling lobsters in refrigerated seawater is not recommended because excessive salt penetration into muscle will take place rapidly.

15A.3.2.10 **Freezing (Processing Step 10)**

Refer also to Section 9.3.1.

Potential Hazards: [unlikely](#)

Potential Defects: [unlikely](#)

Technical Guidance:

- Quick-freezing methods, such as air blast, liquid nitrogen or other freezing methods should be applied immediately to maintain high quality whole lobster and lobster meats of good textural quality.

15A.3.2.11 **Glazing (Processing Step 11)**

Refer to Section 15A.3.1.10.

15A.3.2.12 **Final packaging/labelling (Processing Step 12)**

Refer also to Section 9.2.3.

Potential hazards: [absence of labelling of allergenic additives](#)

Potential defects: [subsequent dehydration, incorrect labelling](#)

Technical guidance:

- Packaging material should be food grade, clean, sound, durable and appropriate for its intended use.
- Care should be taken to ensure that exposed lobster meats are completely wrapped to protect against dehydration.

15A.3.2.13 **Chilled storage (Processing Step 13)**

Refer also to Section 9.1.2.

Potential hazards: [microbiological contamination](#)

Potential defects: [decomposition, foreign matter](#)

Technical guidance:

- Temperatures in chilled storage should be 4 °C or less.
- Product should be properly protected to avoid contamination by condensates and splashing water.

15A.3.2.14 **Frozen storage (Processing Step 14)**

Refer to Section 15A.3.1.12.

15A.3.2.15 **Packaging/label reception (Processing Step 15)**

Refer to Section 15A.3.1.13.

15A.3.2.16 **Packaging/label storage (Processing Step 16)**

Refer also to Section 9.5.2.

Potential hazards: unlikely

Potential defects: contaminated packaging material


Technical guidance:

- Packaging material should be protected from dust, dirt and other sources of contaminants.
- Packaging storage area should be free from pests and insects.

15A.3.2.17 **Distribution/Transportation (Process Step 17)**

Refer to Section 21.





15-B
**Processing
of crabs**

In the context of recognising controls at individual processing steps, this section provides examples of potential hazards and defects and describes technological guidelines, which can be used to develop control measures and corrective action. At any particular step only the hazards and defects, which are likely to be introduced or controlled at that step, are listed. It should be recognized that in preparing a Hazard Analysis Critical Control Point (HACCP)³¹ and/or defect action point (DAP) plan it is essential to consult Section 5 which provides guidance for the application of the principles of HACCP and DAP analysis. However, within the scope of this Code of Practice it is not possible to give details of critical limits, monitoring, record keeping and verification for each of the steps since these are specific to particular hazards and defects.

This section applies, generally, to commercial crabs of the Cancer species, king crab related species (*Lithodes* and *Paralithodes*), swimming crabs (*Portunidae*), Geryon species and snow crab species (e.g. *Chionoectes* and *Opilio*) as well as other species of marine and freshwater crabs which are similar in physical structure to the above mentioned.

15B.1

General – addition to prerequisite programme

In addition to the prerequisite programme outlined in Section 3 of this Code, processing facility operators are encouraged to evaluate the design and construction of their facility and the maintenance and sanitation of their operation with specific regard to the processing of crabs. Consideration should be given to the following:

15B.1.1 **Design and construction of equipment and utensils**

Refer to Section 15A.1.1.

15B.1.2 **Hygiene control programme**

Refer to Section 15A.1.2.

³¹ Refer to Annex II for a comprehensive list of the acronyms used in this Code.

15B.2

General considerations for the handling of crabs

15B.2.1

Refer also to Section 4.

Potential hazards and defects associated with crabs

Refer also to Sections 4.1 and 5.3.3.1.

15B.2.1.1

Potential hazards

Bacteria

Refer to Section 15A.2.1.1.

Chemical hazards

Veterinary Drugs

Refer to Section 15A.2.1.1.

Parasites

The foodborne trematode *Paragonimus* sp. is present in certain species of freshwater crabs that are eaten raw.

Biotoxins

Biotoxins such as PSP, DSP, ASP, AZA, Tetrodotoxin and Palytoxin may be found in the viscera of certain species of crabs in certain geographical regions.

The hazards of toxins in crabs are associated with consumption of brown meat. When brown meat is suspected of being associated with biotoxin contamination e.g. through phytoplankton monitoring or/and shellfish flesh testing, then testing of the brown meat may be carried out.

15B.2.1.2

Potential Defects

Blue discoloration

Blue discoloration is a defect in canned crab meat. It may also develop in crab meat several hours after boiling and cooling. The blue colour appears more often on the surface of the shoulder and other joint meats and in the claw meat. It appears in canned horse hair crab (“kegani”) more often than in king crab. It is believed to be the result of copper containing hemocyanin in the blood (hemolymph) and may be avoided by eliminating the blood to the extent practicable in the cooking and canning process.

Another form of discoloration is known as “black mat” caused by fungal infection, particularly of snow crabs. While light infections may be physically removed, crabs with heavy infections should be culled as the shells cannot be completely cleaned and because there is tissue penetration of colourless fungal hyphae that can affect the meat quality.

Other defects

Barnacles and other commensals including marine leeches are common defects in various crab species.

Struvites (magnesium ammonium phosphate) crystallizes from natural constituents in pasteurized crabmeat. Crystals are most likely established during the cooling step of pasteurization, and subsequently grow during storage. Pasteurized crabmeat may be treated with sodium acid pyrophosphate,

which prevents struvite crystal formation by chelating magnesium. When an additive-free product is preferred, it is essential that cooling immediately after cooking be rapid enough to minimize struvite formation.

15B.2.2 **Minimize the deterioration of crabs — handling**

Refer also to Section 4.2.

- It is generally known that under similar conditions, the quality of crabs deteriorate more rapidly than fish and therefore care in maintaining the crabs live prior to processing is strongly recommended;
- Since crab legs and other appendages can be easily broken and the damage can cause the risk of infection and weakening of the crab, care should be taken to handle live crabs at all times;
- Tanks and wells for pounding live crab should be so placed and constructed as to ensure survival of the crab;
- Time control is one of the most effective methods in controlling crab product processing. It is strongly recommended that all operations in crab product processing be achieved as rapidly as possible;
- Good quality of crab butchered sections can be maintained by immediate cooking and chilling or freezing;
- Live crabs should be carefully packed in clean tanks, wells, crates, open-weave bag, or in boxes covered with wet sacking and held at a temperature as close as possible to 0 °C.
- Holding tanks are regarded as a better method of storage for long-term handling than well storage;
- The use of clean hessian or jute bags, for transport, is preferred. Bags made of woven synthetic material should not be used;
- Where bags open weave are used for transport, precautions should be taken to avoid suffocation of crabs due to slime or mud;
- Care also should be taken to maintain the necessary humidity in holding the crabs live in bags for transport;
- Species, which mutilate each other, should have the claws banded as soon as possible after catching;
- If it is not possible to keep crabs alive until the time of processing, crabs should be butchered. Sections should be carefully separated and cleaned before freezing or cooling down to the temperature as close as possible to 0 °C, which should be done as rapidly as possible.

15B.3 Processing operations

Once a processing facility has established a prerequisite programme (Section 3) the principles of HACCP (Section 5) can be applied to each individual process within that facility.

This section provides two examples of products derived from crabs. Special consideration was given to products involving heat treatment because of their potential impact on food safety (such as post-processing handling). The products and their respective flow diagrams are as follows: Chilled Pasteurized Crab Meat (Fig. 15B.1) and Chilled and Frozen Cooked Crabs (Figure 15B.2).

15B.3.1 Chilled pasteurized crab meat

15B.3.1.1 Live crab reception (Processing Step 1)

Potential hazards: biotoxins (for certain species)

Potential defects: weak or injured crab, crab mortality, ecto-parasites, black shell

Technical guidance:

- Live crabs should be inspected upon receipt to ensure that they are alive, which can be demonstrated by active leg movement.
- Training in species identification and communication in product specification should be provided to crab handlers and appropriate personnel to ensure a safe source of incoming crabs.
- Where marine biotoxins are likely to be present at unsafe levels in crab species in an area, susceptible species should be identified and kept segregated from other crabs. Risk reduction strategies (e.g. testing or evisceration) should be undertaken prior to processing. Live crabs should be sorted to remove those with defects such as ecto-parasites and black shell.
- In factories which process crabs, any dead crabs should be discarded. Where sections are processed, any defective or deteriorated parts should be removed from the lot and disposed of in a proper manner.
- Weak crabs should be processed immediately.

15B.3.1.2 Live crab holding (Processing Step 2)

Refer also to Sections 6.1.2 and 15A.3.1.2.

Potential hazards: unlikely

Potential defects: crab mortality

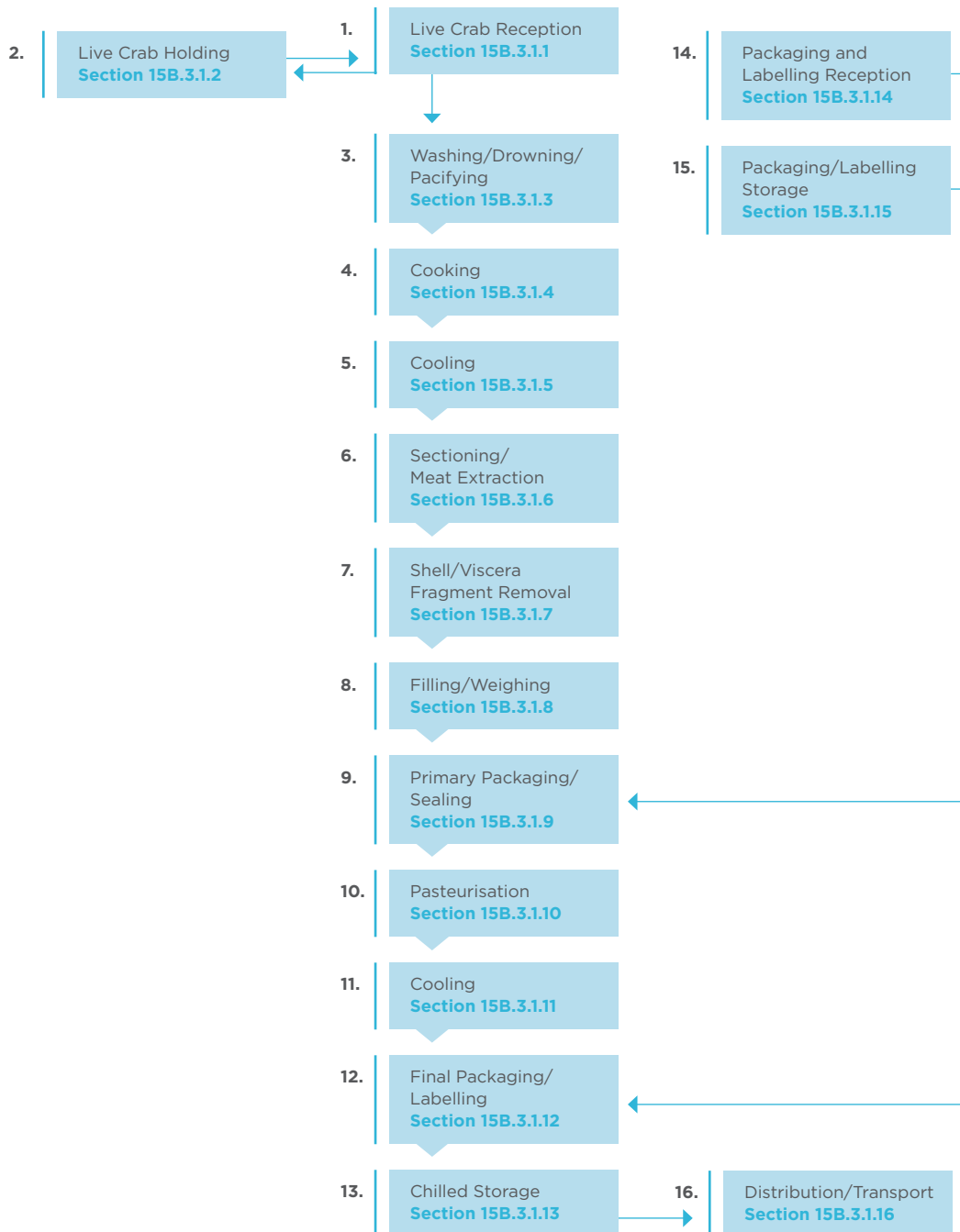
Technical guidance:

- Live crabs should be stored in circulated seawater and fresh water, as appropriate at temperatures of their natural environment or slightly lower, depending on the species. Some species (e.g. *Ucides cordatus cordatus*) can be stored, during short periods, without water and with or without refrigeration.
- Dead crabs should not be processed and should be rejected and disposed in a proper manner.

Figure 15B.1 Example flow chart for the processing of chilled pasteurized crabmeat

This flow chart is for illustrative purpose only.

For in factory HACCP implementation, a complete and comprehensive flow chart has to be drawn up for each process.



15B.3.1.3 **Washing and drowning or pacifying (Processing Step 3)**

Potential hazards: unlikely

Potential defects: loss of legs and claws, deterioration

Technical guidance:

- Crabs should be washed in plenty of running potable water or clean seawater or as defined in Section 15A.1.2 to remove all impurities. For some species, scrubbing by brush may be necessary. These methods can be combined.
- Crabs should be pacified or killed immediately prior to cooking so as to prevent the loss of legs or claws. This may be accomplished by the following methods:
 - cooling the crabs to 0 °C or lower, depending on the species;
 - immersion of the crabs in potable water or clean seawater which is approximately 10–15 °C warmer than the natural environment of the species;
 - piercing of the two nerve centres by means of a stainless steel skewer or rod. A rod is inserted through one of the eyes and through the vent;
 - stunning the crabs by passing a weak electric current through seawater or freshwater in which the crabs are immersed;
 - since dead crabs spoil rapidly, any delay prior to cooking may reduce the meat quality. Crabs that are rendered insensible or killed should be cooked immediately.

15B.3.1.4 **Cooking (Processing Step 4)**

Potential hazards: parasites, microbiological contamination

Potential defects: poor texture due to overcooking, bluing discoloration due to undercooking

Technical guidance:

- Adequate uniform cooking is essential because overcooking causes excessive meat shrinkage, moisture loss, lower yields and poor texture, and undercooking makes it difficult to remove the meat from the shell and may cause blue discoloration.
- In most cases, the cooking of crabs in boiling water is preferred to steaming. Steaming has a tendency to dry the meat, resulting in the flesh adhering to the shell. Cooking utilizing continuous conveyors is recommended.
- In general, it is difficult to specify cooking times and temperatures due to the differences in size, structure and physiology of the different species of crabs.
- Cooking time and temperatures should be sufficient to kill trematode parasites.
- Where the final product is to be marketed as cooked crabs in-shell or as shucked meat, the product should be chilled to a temperature approaching 4 °C or less and either passed into the distribution chain or processed within 18 hours.

- Cooking should be carried out by trained personnel who have acquired the necessary skills to monitor and ensure that all crabs are given the same time/temperature exposure during the operation.
- Staff involved in the operations of cooked and uncooked crabs should take steps to minimize cross-contamination.

15B.3.1.5 **Cooling (Processing Step 5)**

Potential hazards: microbiological contamination

Potential defects: unlikely

Technical guidance:

- Cooling should be done in cold circulated air, running potable water, refrigerated brine, or clean seawater.
- Cooling should be completed as quickly as possible.
- The process of cooling should be done in a place without direct contact with the raw product. Care should be taken to ensure that cross contamination of cooked crabs does not occur, e.g.:
 - crab cooling baskets should not be placed on the floor;
 - when cooling, crabs should be covered or otherwise be protected from condensation; and
 - product contact surfaces should be washed and/or sanitized at regular intervals to avoid bacterial build up and contamination.
- Cooked crabs should be handled as a ready-to-eat product that has had its normal microflora destroyed, which can allow pathogens to proliferate.
- The same water should not be used for cooling more than one batch;
- In some species, the body cavity contains a considerable amount of water, so that adequate drainage, in an area set aside for the purpose, is desirable.

15B.3.1.6 **Sectioning/meat extraction (Processing Step 6)**

Potential hazards: microbiological contamination, biotoxins

Potential defects: presence of gills and viscera or foreign material

Technical guidance:

- After butchering, any remaining viscera and gills should be removed. Proper cleaning at this stage particular for species at risk of biotoxins, is strongly recommended since it eliminates the risk of foreign material being included in the finished product.
- Staff involved in operations with cooked and uncooked crabs, should take steps to minimize cross-contamination.
- Picking or shaking operations should be carefully controlled to prevent contamination from bacteria and/or foreign materials.
- All types of meat should be picked, packaged and either chilled (internal temperature of 4 °C/or less) or frozen within two hours.

- Depending on the vessel or processing facility product flow pattern and where a prescribed critical limit for staging time and temperature regime has been established for the control of hazards, the crab meat should be appropriately chilled in clean containers and stored in specially designated and appropriate areas within the processing facility.
- Claws, leg tips and shell parts containing recoverable meat should be continuously separated, rapidly and efficiently, from waste material during the picking operation and should be kept chilled and protected from contamination.
- Shell removal or sectioning should not be performed until the product has adequately cooled.
- Recovery and chilling of extracted meat should be carried out continuously.

15B.3.1.7 **Shell- and viscera-fragment removal (Processing Step 7)**

Potential hazards: microbiological contamination, foreign material and shell fragments (in some circumstances)

Potential defects: presence of viscera fragments, foreign material and shell fragments

Technical guidance:

- Particular care should be taken to ensure that shell fragments, viscera fragments, and foreign material are removed from crab meat since they are very objectionable to consumers and in some circumstances they may be dangerous.
- To minimize time delays, the design of the meat extraction and shell fragment removal line should be continuous to permit a uniform flow without stoppages or slow-downs and removal of waste.
- Depending on the vessel or processing facility product flow pattern and where a prescribed critical limit for staging time and temperature regime has been established for the control of hazards, the crab meat should be appropriately chilled in clean containers and stored in specially designated and appropriate areas within the processing facility.
- The use of an ultraviolet light could improve the detection of shell fragments in crab meat. If the ultraviolet light is used it should be in compliance with the requirements of the official authorities having jurisdiction.

15B.3.1.8 **Filling and weighing (Processing Step 8)**

Potential hazards: overfilling of cans which can lead to survival of *Clostridium botulinum* spores

Potential defects: underweight cans

Technical guidance:

- Net weight of the crab contents should not exceed the critical parameters specified in the scheduled process.
- Care should be taken to ensure that minimum net weights on the label declaration are met.

15B.3.1.9 **Primary-packaging/sealing (Processing Step 9)**

Refer also to Sections 9.2.3 and 18.4.2.

Potential hazards: [microbiological contamination](#)

Potential defects: [incorrect labelling](#)

Technical guidance:

- packaging material should be clean, sound, durable, sufficient for its intended use and of food grade material;
- the operation, maintenance, regular inspection and adjustment of sealing machines should receive particular care;
- the sealing operation should be conducted by qualified and trained personnel;
- packaging integrity of the finished product should be inspected at regular intervals by appropriately trained personnel to verify the effectiveness of the seal and the proper operation of the packaging machine.

15B.3.1.10 **Pasteurization (Processing Step 10)**

Potential hazards: [microbiological contamination](#)

Potential defects: [deterioration](#)

Technical guidance:

- Pasteurization should be performed by appropriately trained personnel who have acquired the necessary skills to monitor and ensure that all packages are given the same time/temperature exposure during the operation.
- Pasteurization should be carried out in hermetically sealed containers.
- To prevent any possible deterioration of the product, the crab meat should be pasteurized immediately after picking and packaging. It is preferable that the meat be at a temperature of approximately 18 °C when the containers are hermetically sealed to provide a slight vacuum after chilled storage temperatures.
- A time and temperature regime for the pasteurization of different crab products should be established and should take into consideration the pasteurization equipment and capacity, the physical properties of the crab and packaging container including their thermal conductivity, thickness, shape and temperature, to ensure that adequate heat penetration has been achieved for all containers in the lot.
- Each container of crab meat should be exposed to a scheduled time and temperature that will inactivate microorganisms of public health concern that could grow during refrigerated storage, including non-proteolytic *Clostridium botulinum*.
- The water bath should be preheated to a temperature sufficient to ensure that scheduled time/temperature parameters are carried out. Special concern should be given to proper water circulation within the bath and around each individual container being pasteurised. Hot water bath temperature should remain constant until processing is completed.

- Once proper times and temperatures or scheduled processes are established, they should be closely adhered to and pasteurization processes should be standardized using calibrated thermocouple measuring equipment. It is recommended that new equipment be calibrated after installation and re-calibrated on an annual basis or when difficulties are experienced; calibration and appropriate maintenance of temperature recording equipment should be performed on a regular basis to ensure accuracy.

15B.3.1.11 **Cooling (Processing Step 11)**

Potential hazards: microbiological contamination

Potential defects: unlikely

Technical guidance:

- The pasteurized container of meat should be immediately cooled after processing.
- Cooling is best accomplished in an ice water bath. The size of the cooling water bath should be sufficient to allow for the addition of ice to cool the product to an internal temperature of 4 °C or below as quickly as possible after pasteurization in order to prevent the growth of *Clostridium botulinum* spores. No water agitation is required since adequate convection currents are created by the difference between bath and product temperatures.
- The water used in the cooling operation should not re-contaminate the product.

15B.3.1.12 **Final packaging/labelling (Processing Step 12)**

Refer to Section 9.2.3.

15B.3.1.13 **Chilled storage (Processing Step 13)**

Potential hazards: formation of *Clostridium botulinum* toxin

Potential defects: unlikely

Technical guidance:

- Pasteurized crab meat should be moved to the chilled storage facility without undue delay.
- Pasteurized product is perishable and unless it is kept chilled at a minimum temperature of 3 °C, there is a possibility that *Clostridium botulinum* may grow and produce toxins.
- The chill room should be equipped with a calibrated indicating thermometer. Fitting of a recording thermometer is strongly recommended.
- Crates used to hold container in chilled storage should allow free passage of air currents in order to complete the cooling cycle.
- The processing facility should implement a traffic control system that will ensure that the unpasteurised product cannot be mixed with any pasteurized product.

15B.3.1.14 **Packaging and labelling reception (Processing Step 14)**

Refer to Section 9.5.1.

15B.3.1.15 **Packaging/labelling storage (Processing Step 15)**

Refer to Section 9.5.2.

15B.3.1.16 **Distribution/transportation (Processing Step 16)**

Refer to Section 21.

15B.3.2 **Chilled and frozen cooked crab**

15B.3.2.1 **Live-crab reception (Processing Step 1)**

Refer to Section 15B.3.1.1.

15B.3.2.2 **Live-crab holding (Processing Step 2)**

Refer also to Section 15B.3.1.2.

15B.3.2.3 **Washing and drowning or pacifying (Processing Step 3)**

Refer to Section 15B.3.1.3.

15B.3.2.4 **Cooking (Processing Step 4)**

Potential hazards: microbiological contamination, parasites

Potential defects: over/under-cooking

Technical guidance:

- A cooking schedule for boiling or steaming should be designed which takes into consideration the appropriate parameters that may affect cooking, such as time/temperature and size of the crabs.
- Cooking should be carried out by appropriately trained personnel who have acquired the necessary skills to monitor and ensure that all crabs are given the same time/temperature exposure and adequate heat penetration during the operation.
- Each cooker should be equipped with a suitable thermometer to show the cooking operation temperature. Fitting of a recording thermometer is strongly recommended. A simple device to indicate time of cooking should be supplied.
- Crabs should be cooked according to size, and depending on the product, until the meat can be easily removed from the shell. Overcooking causes the meat to shrink excessively and lower yields and undercooking makes it difficult to remove the meat from the shell.
- Staff involved in the operations with cooked and uncooked crabs should take steps to minimize cross-contamination.
- Cooking time and temperatures should be sufficient to kill trematode parasites.

15B.3.2.5 **Cooling (Processing Step 5)**

Potential hazards: microbiological contamination

Potential defects: unlikely

Technical guidance:

- Cooling should be performed in cold circulated air, running potable water, refrigerated brine or clean seawater.
- Cooling should be completed as quickly as possible.
- Cooling should be carried out in a place without direct contact with the raw product.
- Care should be taken to ensure that cross-contamination of cooked crabs does not occur, e.g.:
 - crab-cooling basket should not be placed on the floor;
 - cooling crabs should not be covered or should otherwise be protected from condensation; and
 - product contact surfaces should be washed and/or sanitized at regular intervals to avoid bacterial build-up and contamination;
- cooked crabs should be handled as a ready-to-eat product that has had its normal microflora destroyed, which can allow pathogens to proliferate;
- the same water should not be used for cooling more than one batch; and
- for those species in which the body cavity contains a considerable quantity of water, adequate drainage, in an area set aside for the purpose, is advised.

15B.3.2.6 **Sectioning (Processing Step 6)**

Potential hazards: microbiological contamination

Potential defects: presence of gills and viscera, foreign materials

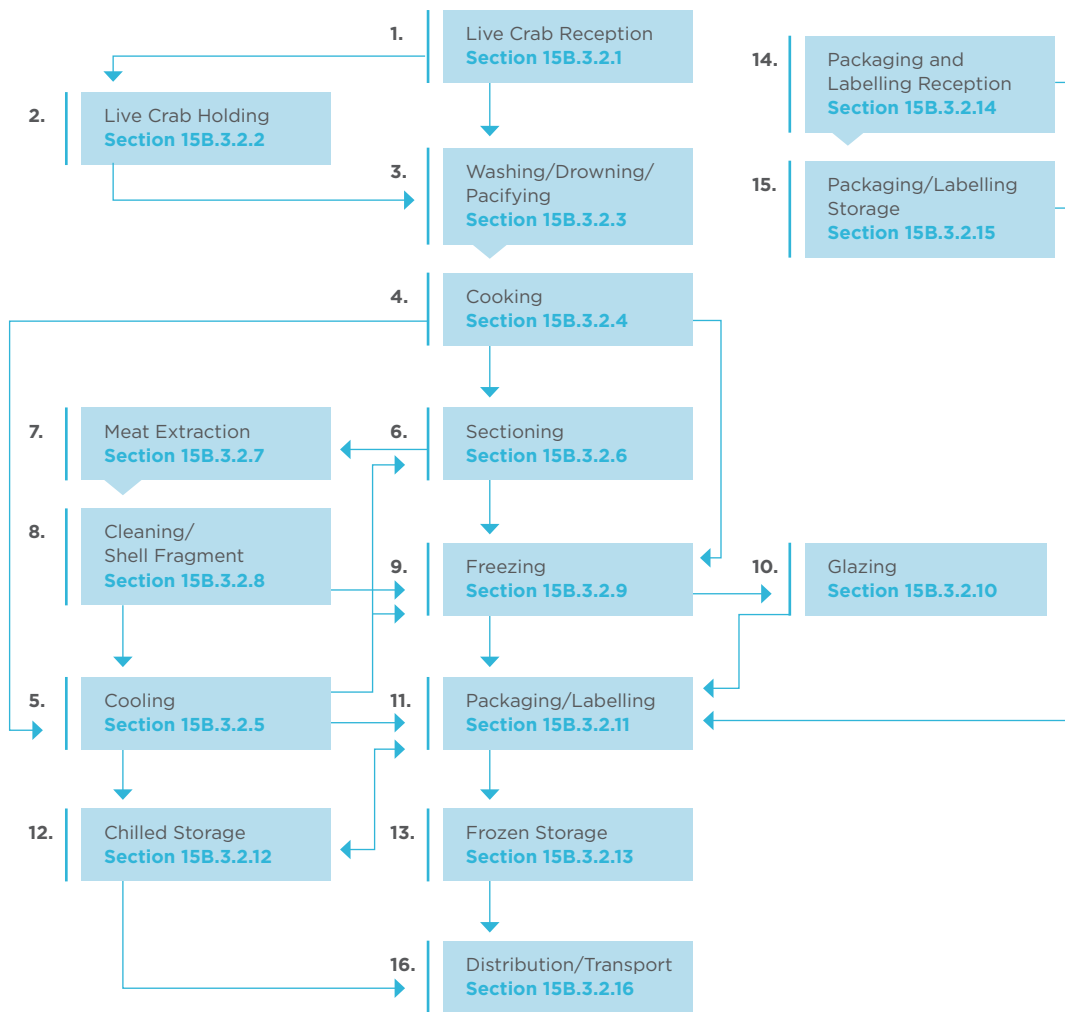
Technical guidance:

- After butchering, any remaining viscera and gills should be removed. Proper cleaning at this stage is strongly recommended since it eliminates the risk of foreign material being included in the finished product.
- Staff involved in the operations with cooked and uncooked crabs should take steps to minimize cross-contamination.
- Shell removal or sectioning should not be performed until the product has adequately cooled.

Figure 15B.2 Example flow chart for the processing of chilled and frozen cooked crab

This flow chart is for illustrative purpose only.

For in factory HACCP implementation, a complete and comprehensive flow chart has to be drawn up for each process.



15B.3.2.7 **Meat extraction (Processing Step 7)**

Potential hazards: microbiological contamination

Potential defects: presence of gills, viscera or foreign material

Technical guidance:

- Staff involved in operations with cooked and uncooked crabs, should take steps to minimize cross-contamination.
- Picking or shaking operations should be carefully controlled to prevent contamination from bacteria and/or foreign materials.
- It is recommended that all types of meat are picked, packaged and either chilled (internal temperature of 4 °C or less) or frozen within two hours.
- Depending on the vessel or processing facility product flow pattern and where a prescribed critical limit for staging time and temperature regime has been established for the control of hazards, the crab meat should be appropriately chilled in clean containers and stored in specially designated and appropriate areas within the processing facility.
- Claws, leg tips and shell parts containing recoverable meat should be continuously separated, rapidly and efficiently, from waste material during the picking operation and should be kept chilled and protected from contamination.

15B.3.2.8 **Shell fragment removal/cleaning (Processing Step 8)**

Refer to Section 15B.3.1.7.

15B.3.2.9 **Freezing (Processing Step 9)**

Refer to Section 9.3.1.

Potential hazards: unlikely

Potential defects: unlikely

Technical guidance:

- Appropriate freezing equipment should be used to quickly freeze the product and minimize the crystallization of moisture in the flesh (e.g. cryogenic, blast or brine freezing systems).
- Brine media in brine freezing systems should be replaced regularly to prevent the build-up of contaminants, excess salt and foreign matter.
- Do not overload brine tank with excess product.

15B.3.2.10 **Glazing (Processing Step 10)**

Refer to Section 9.3.2.

15B.3.2.11 **Packaging/labelling (Processing Step 11)**

Refer to Section 15B.3.1.12

15B.3.2.12 **Chilled storage (Processing Step 12)**

Refer to Section 9.1.2.

15B.3.2.13 **Frozen storage (Processing Step 13)**

Refer to Section 9.1.3.

15B.3.2.14 **Packaging/labelling reception (Processing Step 14)**

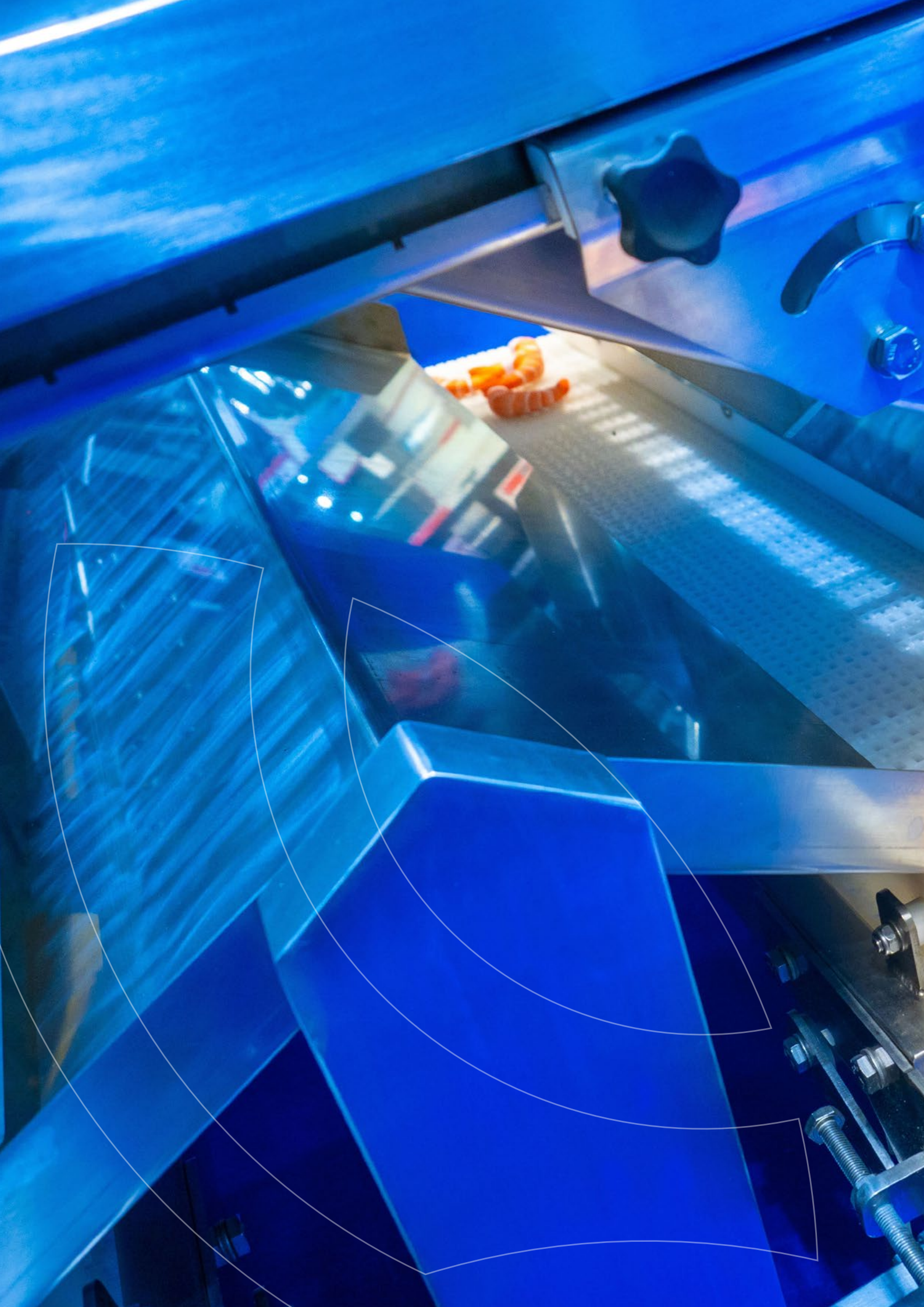
Refer to Section 15B.3.1.14.

15B.3.2.15 **Packaging/labelling storage (Processing Step 15)**

Refer to Section 15B.3.1.15.

15B.3.2.16 **Distribution/Transportation (Processing Step 16)**

Refer to Section 21.



16

**Processing
of shrimps
and prawns**



Scope: Shrimps frozen for further processing may be whole, head-off or de-headed or raw headless, peeled, peeled and deveined or cooked on board harvest or processing vessels or at onshore processing plants.

In the context of recognizing controls at individual processing steps, this section provides examples of potential hazards and defects and describes technological guidelines that can be used to develop control measures and corrective action. At any particular step, only the hazards and defects that are likely to be introduced or controlled at that step are listed. It should be recognized that in preparing a Hazard Analysis Critical Control Point (HACCP)³² and/or defect action point (DAP) plan it is essential to consult Section 5, which provides guidance for the application of the principles of HACCP and DAP analysis. However, within the scope of this Code, it is not possible to give details of critical limits, monitoring, record-keeping and verification for each of the steps since these are particular to each hazard or defect.

16.1

Frozen shrimps and prawns – general

- Shrimps for frozen product originate from a wide variety of sources as varied as deep, cold seas to shallow, tropical, inshore waters and rivers through to aquaculture in tropical and semi-tropical regions.
- The methods of catching, or harvesting, and processing are as equally varied. Species in northern regions may be caught by freezer vessels, cooked, individually quick frozen (IQF) and packaged on board in their final marketing form. However, more often, they will be raw IQF on board for further processing at onshore plants, or even landed chilled on ice. Shrimps of these species are invariably precooked at onshore plants through in-line integrated process lines, followed by mechanical peeling, cooking, freezing, glazing and packing. A much larger product line is produced in tropical and subtropical countries from wild caught and cultivated *Penaeus* species: whole, headless (head-off), peeled, peeled and deveined raw and/or cooked products presented in different marketing forms (easy-peel, tail-on, tail-off, butterfly, stretched, sushi shrimps). This wide range of products is prepared at shrimp processing plants that may be small and use manual techniques or be large with fully mechanized equipment. Cooked shrimp products are generally peeled after cooking.
- Warmwater shrimps may also be subject to further added-value processes such as marinating and batter and crumb coatings.
- As some raw shrimp products, as well as cooked ones, may be consumed without further processing, safety considerations are paramount.
- The processes described above are captured on the flow chart in Figure 16.1, but it must be appreciated that, because of the diverse nature of production methods, individual HACCP/DAP plans must be devised for each product.

³² Refer to Annex II for a comprehensive list of the acronyms used in this Code.

- Other than the previous description of on-board cooking, there is no reference to processing of shrimps at sea or in farms. It is assumed that product will be correctly handled and processed in line with the relevant sections in the Code and that where appropriate some element of pre-preparation, such as deheading, will have taken place prior to receipt at processing plants.

16.2

Shrimp preparation (Processing Steps 15.2.1 to 15.2.18)

16.2.1

Raw fresh and frozen shrimp reception (process steps)

Potential hazards: phytotoxins (e.g. paralytic shellfish poisoning), microbiological contamination, antioxidants, sulphites, pesticides, fuel oil (chemical contamination)

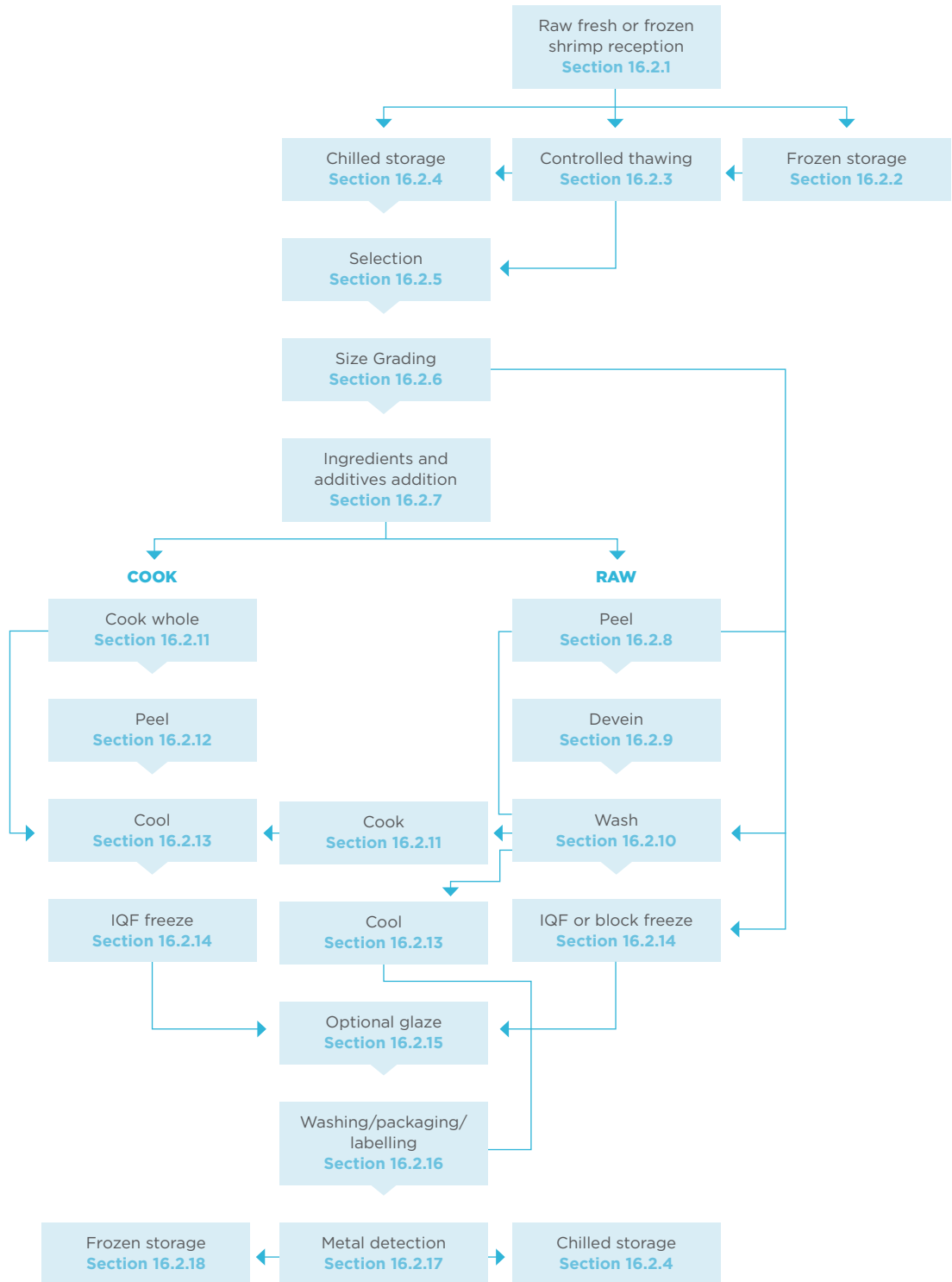
Potential defects: variable batch quality, mixed species, taints, blackspot, softening from head enzymes, decomposition

Technical guidance:

- Inspection protocols should be devised to cover identified quality, HACCP and DAP plan parameters together with appropriate training for inspectors to undertake these tasks.
- Shrimps should be inspected upon receipt to ensure that they are well iced or deep frozen and properly documented to ensure product tracing.
- The origin and previous known history will dictate the level of checking that may be necessary, for example, for phytotoxins in sea-caught shrimps (specifically for head-on products), for potential antibiotics presence in aquaculture shrimps, particularly if there is no supplier assurance certification. In addition, other chemical indicators for heavy metals, pesticides and indicators of decomposition such as total volatile basic nitrogen (TVBN) may be applied.
- Shrimps should be stored in suitable facilities and allocated “use by” times for processing to ensure quality parameters are met in end products.
- Incoming lots of shrimps should be monitored for sulphites at harvesting.
- A sensory evaluation should be performed on incoming lots to ensure that the product is of acceptable quality and not decomposed.
- It is necessary to wash fresh shrimps after reception in adequate equipment with a series of low-velocity sprays with chilled clean water.

Figure 16.1 Example flow chart of a shrimp and prawn processing line

This flow chart is for illustrative purpose only. For in factory HACCP implementation, a complete and comprehensive flow chart has to be drawn up for each process. References correspond to relevant sections of the Code.



16.2.2 **Frozen storage**

Potential hazards: unlikely

Potential defects: protein denaturation, dehydration

Technical guidance:

- Protective packaging should be undamaged, otherwise repackage to exclude possibilities of contamination and dehydration.
- Cold storage temperatures should be suitable for storage with minimum fluctuation.
- Product should be processed within the “best before” time on the packaging, or before as dictated at reception.
- The cold storage facility should have a temperature-monitoring device, preferably a continuous recording unit to monitor and record ambient temperature properly.

16.2.3 **Controlled thawing**

Potential hazards: microbiological contamination, contamination from wrapping

Potential defects: decomposition

Technical guidance:

- Thawing processes may be undertaken from block frozen or IQF shrimps depending on the raw material source. The outer and inner packaging should be removed prior to defrosting in order to prevent contamination and extra care should be taken on block frozen prawns where inner wax or polyethylene packaging may be entrapped with blocks.
- Thawing tanks should be purpose designed and allow for “counter current” water defrosting where necessary to maintain lowest possible temperatures. However, water reuse is discouraged.
- Clean seawater or water and ice of potable quality should be used for thawing with a water temperature no higher than 20 °C (68 °F) by use of additional ice to achieve a defrosted product at a temperature cooler than 4 °C.
- Thawing should be achieved as quickly as possible to maintain quality.
- It is desirable that the exit conveyor, leading from the defrost tanks, be equipped with a series of low-velocity sprays to wash the shrimps with chilled clean water.
- Immediately after thawing, the shrimps should be re-iced or held in chill to avoid temperature abuse before further processing.

16.2.4 **Chilled storage**

Refer to Section 9.1.2 for general information concerning fish and fishery products.

Potential hazards: microbiological contamination

Potential defects: decomposition

Technical guidance:

- Chilled storage, preferably under ice in chill rooms at less than 4 °C after reception.
- The chilled storage facility should have a temperature-monitoring device (preferably a continuous recording unit) to monitor and record ambient temperatures properly.
- Unnecessary delays should be avoided during chilled storage in order to prevent quality deterioration.

16.2.5**Selection****Potential hazards:** unlikely**Potential defects:** decomposition**Technical guidance:**

- Shrimps may be selected for different quality grades according to specification requirements. This should be undertaken with minimum of delay followed by re-icing of the shrimps.

16.2.6**Size grading****Potential hazards:** microbiological contamination**Potential defects:** decomposition**Technical guidance:**

- Size grading of shrimps is undertaken through mechanical graders of various degrees of sophistication and manually. There is a possibility of shrimps becoming trapped in the bars of the graders. Hence, regular inspection is required to prevent “carryover” of old prawns and bacteriological contamination.
- Shrimps should be re-iced and stored in chill prior to further processing.
- The grading process should be carried out promptly to prevent unnecessary microbiological growth and product decomposition.

16.2.7**Addition of ingredients and use of additives****Potential hazards:** chemical and microbiological contamination, sulphites**Potential defects:** decomposition, improper use of additives**Technical guidance:**

- According to specification and legislation, certain treatments may be applied to shrimps to improve organoleptic quality, preserve yield or preserve them for further processing.
- Examples would include sodium metabisulphite to reduce shell blackening, sodium benzoate to extend shelf-life between processes, and sodium polyphosphates to maintain succulence through processing and prevent blackspot after peeling, while common salt would be added as brine for flavour.

- These ingredients and additives can be added at various stages; for example, common salt and sodium polyphosphates at defrost stages or chilled brine as a flume conveyor between cooking and freezing, or as glaze.
- At whatever stage ingredients and additives are added, it is essential to monitor the process and product to ensure that any limits set by legislative standards are not exceeded, quality parameters are met and that where dip baths are used, the contents are changed on a regular basis according to drawn-up plans.
- Chill conditions should be maintained throughout.
- Sulphites used to prevent blackspot formation autolysis should be used in accordance with manufacturer instructions and good manufacturing practice (GMP).

16.2.8 **Full and partial peeling**

Potential hazards: microbiological contamination

Potential defects: decomposition, shell fragments, foreign matter

Technical guidance:

- This process applies mainly to warmwater prawns and could be as simple as inspecting and preparing whole large prawns for freezing and downgrading blemished prawns for full peeling.
- Other peeling stages could include full peeling or partial peeling leaving tail swimmers intact.
- Whatever the process, it is necessary to ensure that the peeling tables are kept clear of contaminated shrimps and shell fragments using water jets and the shrimps are rinsed to ensure no carryover of shell fragments.

16.2.9 **Deveining**

Potential hazards: microbiological contamination, metal contamination

Potential defects: objectionable matter, decomposition, foreign matter

Technical guidance:

- The vein is the gut, which may appear as a dark line in the upper dorsal region of prawn flesh. In large warmwater prawns, this may be unsightly, gritty and a source of bacterial contamination.
- Removal of the vein is by razor, cutting longitudinally along the dorsal region of the shrimp with a razor slide and removing the vein by pulling. This may be partially achieved with head-off, shell-on shrimps as well.
- This operation is considered to be a mechanical though labour-intensive process so that:
 - cleaning and maintenance schedules should be in place and cover the need for cleaning before, after and during processing by trained operatives; and
 - in addition, it is essential to ensure that damaged and contaminated shrimps are removed from the line and that no debris builds up.

16.2.10

Washing

Potential hazards: microbiological contamination

Potential defects: decomposition, foreign matter

Technical guidance:

- Washing of peeled and deveined shrimps is essential to ensure that shell and vein fragments are removed.
- Shrimps should be drained and chilled without delay prior to further processing.

16.2.11

Cooking processes

Potential hazards: microbiological contamination owing to insufficient cooking, microbiological cross-contamination

Potential defects: overcooking

Technical guidance:

- The cooking procedure, in particular time and temperature, should be fully defined according to the specification requirements of the final product, for example, whether it is to be consumed without further processing, and the nature and origin of the raw shrimps and uniformity of size grading.
- The cooking schedule should be reviewed before each batch, and where continuous cookers are in use, constant logging of process parameters should be available.
- Only potable water should be used for cooking, whether in water or via steam injection.
- The monitoring methods and frequency should be appropriate for the critical limits identified in the scheduled process.
- Maintenance and cleaning schedules should be available for cookers and all operations should only be undertaken by fully trained staff.
- Adequate separation of cooked shrimps exiting the cooking cycle utilizing separate equipment is essential in order to ensure no cross-contamination.

16.2.12

Peeling of cooked shrimps

Potential hazards: microbiological contamination

Potential defects: presence of shell

Technical guidance:

- Cooked shrimps have to be properly peeled through mechanical or manual peeling in line with cooling and freezing processes.
- Cleaning and maintenance schedules should be available and implemented by fully trained staff in order to ensure efficient and safe processing.

16.2.13

Cooling

Potential hazards: [microbiological contamination and toxin formation](#)

Potential defects: [unlikely](#)

Technical guidance:

- Cooked shrimps should be cooled as quickly as possible to bring the temperature of the product to a temperature range limiting bacteria proliferation or toxin production.
- Cooling schedules should enable the time-temperature requirements to be met and maintenance and cleaning schedules should be in place and complied with by fully trained operatives.
- Only cold/iced potable water or clean water should be used for cooling and it should not be used for further batches, although for continuous operations a top-up procedure and maximum run-length will be defined.
- Raw/cooked separation is essential.
- After cooling and draining, the shrimps should be frozen as soon as possible, avoiding any environmental contamination.

16.2.14

Freezing processes

Potential hazards: [microbiological contamination](#)

Potential defects: [slow freezing – textural quality and clumping of shrimps](#)

Technical guidance:

- The freezing operation will vary considerably according to the type of product. At its simplest, raw whole or head-off shrimps may be block- or plate-frozen in purpose-designed cartons into which potable water is poured to form a solid block with protective ice.
- At the other extreme, cooked and peeled *Pandalus* coldwater prawns tend to be frozen through fluidized bed systems, while many warmwater shrimp products are IQF frozen either on trays in blast freezers or in continuous belt freezers.
- Irrespective of the freezing process, it is necessary to ensure that the freezing conditions specified are met and that, for IQF products, there is no clumping, i.e. pieces frozen together. Putting product into a blast freezer before it is at operating temperature may result in glazed, slow-frozen product and contamination.
- Freezers are complex machines requiring cleaning and maintenance schedules operated by fully trained staff.

16.2.15

Glazing

Potential hazards: [microbiological contamination](#)

Potential defects: [inadequate glaze, excessive glaze, spot welding, incorrect labelling](#)

Technical guidance:

- Glazing is applied to frozen shrimps to protect against dehydration and maintain quality during storage and distribution.

- Freezing shrimps in blocks of ice is the simplest form of glazing, followed by dipping and draining frozen shrimps in chilled potable water. A more sophisticated process is to pass frozen size-graded shrimps under cold-water sprays on vibratory belts so that the shrimps pass at a steady rate and receive an even and calculable glaze cover.
- Ideally, glazed shrimps should receive a secondary re-freezing prior to packing; otherwise, they should be packaged as quickly as possible and moved to cold storage. If this is not achieved, the shrimps may freeze together and “spot weld” or clump as the glaze hardens.
- There are Codex methods for the determination of glaze.

16.2.16 **Weighing, packaging and labelling of all products**

Refer to Sections 9.4.4 and 9.5.

Potential hazards: sulphites

Potential defects: incorrect labelling, decomposition

Technical guidance:

- All wrappings for products and packaging, including glues and inks, should have been specified to be food grade, odourless, with no risk of substances likely to be harmful to health being transferred to the packaged food.
- All food products should be weighed in packaging with scales appropriately tared and calibrated to ensure correct weight.
- Where products are glazed, checks should be carried out to ensure the correct compositional standards to comply with legislation and packaging declarations.
- Ingredient lists on packaging and labelling should declare presence of ingredients in the food product in descending order by weight, including any additives used and still present in the food.
- All wrapping and packaging should be carried out in such a manner as to ensure that the frozen products remain frozen and that temperature rises are minimal before transfer back to frozen storage.
- Sulphites should be used in accordance with manufacturer instructions and GMP.
- Where sulphites were used in the process, care should be taken that they are properly labelled.

16.2.17 **Metal detection**

Potential hazard: presence of metal

Potential defect: unlikely

Technical guidance:

- Products in their final packaging should undergo metal detection using equipment set to the highest sensitivity possible.
- Since larger packs will be detected at a lower sensitivity than smaller packs, consideration should be given to testing the product prior to packaging. However, unless potential re-contamination prior to packaging can be eliminated, it remains more prudent to perform metal detection once packaged.

16.2.18 **Frozen storage of end-product**

Refer to Section 9.1.3 for general information concerning fish and fishery products.

Potential hazard: unlikely

Potential defects: texture and flavour deviations caused by fluctuations in temperature, deep freezer burn, cold store flavour, cardboard flavour

Technical guidance:

- Frozen products should be stored at frozen temperature in a clean, sound and hygienic environment.
- The facility should be capable of maintaining the temperature of the shrimps at or below -18 °C with minimal temperature fluctuations ($\pm 3\text{ °C}$).
- The storage area should be equipped with a calibrated, indicating thermometer. Fitting of a recording thermometer is strongly recommended.
- A systematic stock rotation plan should be developed and maintained.
- Products should be properly protected from dehydration, dirt and other forms of contamination.
- All end-products should be stored in the freezer to allow proper air circulation.





A worker wearing a blue protective suit, a white surgical mask, and a blue hairnet is focused on their task. They are wearing blue gloves and are positioned at a long, industrial conveyor belt. The conveyor belt is filled with numerous small, clear plastic trays, each containing a portion of a cephalopod. The worker is carefully inspecting or packaging these trays. The background shows a clean, industrial environment with large windows and various pieces of machinery, including a camera on a table. The overall scene is brightly lit, emphasizing the sterile and professional nature of the food processing facility.

17

Processing of cephalopods

In the context of recognizing controls at individual processing steps, this Section provides examples of potential hazards and defects and describes technological guidelines that can be used to develop control measures and corrective action. At any particular step, only the hazards and defects that are likely to be introduced or controlled at that step are listed. It should be recognized that in preparing a Hazard Analysis Critical Control Point (HACCP)³³ and/or defect action point (DAP) plan it is essential to consult Section 5, which provides guidance for the application of the principles of HACCP and DAP analysis. However, within the scope of this Code, it is not possible to give details of critical limits, monitoring, record-keeping and verification for each of the steps as these are specific to particular hazards and defects.

This Section applies to fresh and processed cephalopods including cuttlefish (*Sepia* and *Sepiella*), squid (*Alloteuthis*, *Berryteuthis*, *Dosidicus*, *Illex*, *Loliguncula*, *Loligo*, *Loliolus*, *Nototodarus*, *Ommastrephes*, *Onychoteuthis*, *Rossia*, *Sepioloa*, *Sepioteuthis*, *Symplectoteuthis* and *Todarodes*) and octopuses (octopus and *Eledone*) intended for human consumption.

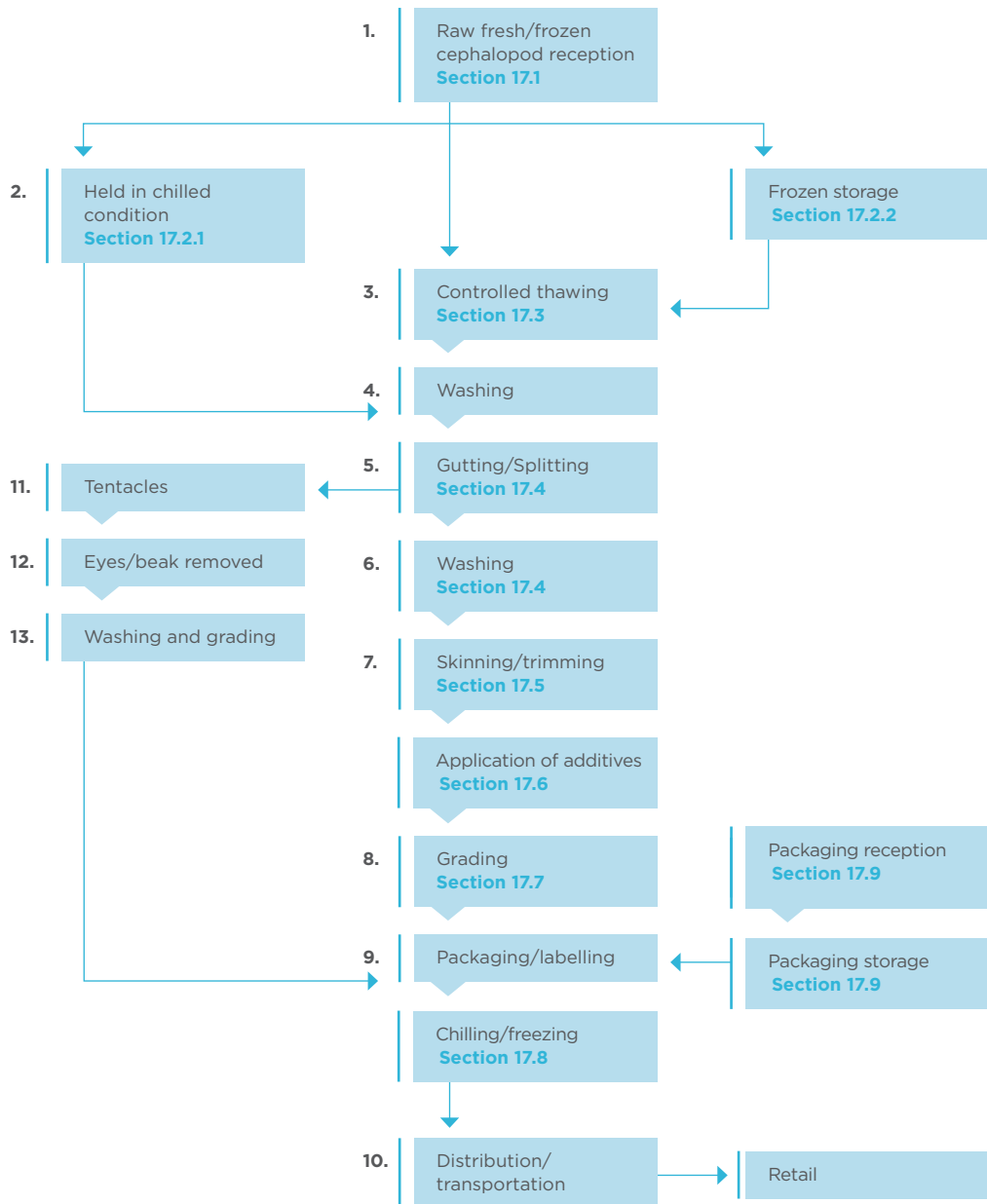
Fresh cephalopods are extremely perishable and should be handled at all times with great care and in such a way as to prevent contamination and inhibit the growth of microorganisms. Cephalopods should not be exposed to direct sunlight or to the drying effects of winds, or any other harmful effects of the elements, but should be carefully cleaned and cooled down to the temperature of melting ice, 0 °C (32 °F), as quickly as possible.

This Section gives an example of cephalopod processing. Figure 17.1 lists the steps associated with receiving and processing fresh squid. It should be noted that there are a variety of processing operations for cephalopods and this process has been used for illustrative purposes only.

³³ Refer to Annex II for a comprehensive list of the acronyms used in this Code.

Figure 17.1 Example of a possible squid processing line

This flow chart is for illustrative purpose only. For in factory HACCP implementation, a complete and comprehensive flow chart has to be drawn up for each process. References correspond to relevant sections of the Code.



17.1

Reception of cephalopods (Processing Step 1)

Potential hazards: microbiological contamination,
chemical contamination, parasites

Potential defects: damaged products, foreign matter

Technical guidance:

- The processing facility should have in place a programme for inspecting cephalopods on catching or arrival at the factory. Only sound product should be accepted for processing.
- Product specifications could include:
 - organoleptic characteristics, such as appearance, odour and texture, that can also be used as indicators of fitness of consumption;
 - chemical indicators of decomposition and/or contamination, e.g. total volatile basic nitrogen (TVBN), heavy metals (cadmium);
 - microbiological criteria;
 - parasites, e.g. *Anisakis*, foreign matter; and
 - the presence of lacerations, breakages and discoloration of the skin, or a yellowish tinge spreading from the liver and digestive organs inside the mantle, which are indicative of product deterioration.
- Personnel inspecting product should be trained and experienced with the relevant species in order to recognize any defects and potential hazards.

Further information can be found in Section 9 and *Guidelines for Sensory Evaluation of Fish and Shellfish in Laboratories* (CXG 31-1999).

17.2

Storage of cephalopods

17.2.1

Chilled storage (Processing Steps 2 and 10)

Potential hazards: microbiological contamination

Potential defects: decomposition, physical damage

Technical guidance:

Refer to Section 9.1.2.

17.2.2

Frozen storage (Processing Steps 2 and 10)

Potential hazards: heavy metals, e.g. cadmium migration from the gut

Potential defects: freezer burn

Technical guidance:

Refer to Section 9.1.3.

- Consideration needs to be given to the fact that when there are high cadmium levels in the gut contents, there may be migration of this heavy metal into the flesh.
- Products should be properly protected from dehydration by sufficient packaging or glaze.

17.3

Controlled thawing (Processing Step 3)

Potential hazards: [microbiological contamination](#)

Potential defects: [decomposition, discoloration](#)

Technical guidance:

- The thawing parameters should be clearly defined and include time and temperature. This is important to prevent the development of pale-pink discoloration.
- Critical limits for thaw time and temperature should be developed. Particular attention should be paid to the volume of product being thawed in order to control discoloration.
- If water is used as the thawing medium, then it should be of potable quality.
- If re-circulated water is used, then care must be taken to avoid the build-up of microorganisms.

Refer also to Section 9.1.4.

17.4

Splitting, gutting and washing (Processing Steps 4, 5, 6, 11, 12 and 13)

Potential hazards: [microbiological contamination](#)

Potential defects: [presence of gut contents, parasites, shells, ink discolouration, beaks, decomposition](#)

Technical guidance:

- Gutting should remove all intestinal material and the cephalopod shell and beaks, if present.
- Any by-product of this process that is intended for human consumption, such as tentacles or mantle, should be handled in a timely and hygienic manner.
- Cephalopods should be washed in clean seawater or potable water immediately after gutting to remove any remaining material from the tube cavity and to reduce the level of microorganisms present on the product.
- An adequate supply of clean seawater or potable water should be available for the washing of whole cephalopods and cephalopod products.

17.5

Skinning, trimming (Processing Step 7)

Potential hazards: [microbiological contamination](#)

Potential defects: [presence of objectionable matter, bite damage, skin damage, decomposition](#)

Technical guidance:

- The method of skinning should not contaminate the product nor should it allow the growth of microorganisms, e.g. enzymatic skinning or hot water techniques should have defined time/temperature parameters to prevent the growth of microorganisms.
- Care should be taken to prevent waste material from cross-contaminating the product.
- An adequate supply of clean seawater or potable water should be available for the washing of product during and after skinning.

17.6

Application of additives

Potential hazards: [physical contamination, non-approved additives, non-fish allergens](#)

Potential defects: [physical contamination, additives exceeding their regulatory limits](#)

Technical guidance:

- The mixing and application of appropriate additives should be carried out by trained operators
- It is essential to monitor the process and product to ensure that regulatory standards are not exceeded and quality parameters met.
- Additives should comply with requirements of the *General Standard for Food Additives* (CXS 192-1995).

17.7

Grading/ packaging/ labelling (Processing Steps 8 and 9)

Refer to Section 9.2.3.

Potential hazards: [chemical or physical contamination from packaging](#)

Potential defects: [incorrect labelling, incorrect weight, dehydration](#)

Technical guidance:

- Packaging material should be clean, suitable for the intended purpose and manufactured from food-grade materials
- Grading and packaging operations should be carried out with minimal delay to prevent deterioration of the cephalopod.
- Where sulphites have been used in the process, care should be taken to ensure that they are properly labelled.

17.8

Freezing (Processing Step 10)

Potential hazards: parasites

Potential defects: freezer burn, decomposition, loss of quality owing to slow freezing

Technical guidance:

Cephalopods should be frozen as rapidly as possible to prevent deterioration of the product and a resulting reduction in shelf-life caused by microbial growth and chemical reactions.

- The time/temperature parameters developed should ensure rapid freezing of product and take into consideration the type of freezing equipment, capacity, the size and shape of the product, and production volume. Production should be geared to the freezing capacity of the processing facility.
- If freezing is used as a control point for parasites, then the time/temperature parameters need to be established to ensure that the parasites are no longer viable.
- The product temperature should be monitored regularly to ensure the completeness of the freezing operation as it relates to the core temperature.
- Adequate records should be kept for all freezing and frozen storage operations.

For further guidance, refer to Section 9.3.1 and Annex 1 on parasites.

17.9

Packaging, labels and ingredients – reception and storage

Consideration should be given to the potential hazards and defects associated with packaging, labelling and ingredients. It is recommended that users of this Code consult Section 9.5.







18

**Processing
of canned fish,
shellfish and
other aquatic
invertebrates**

This Section applies to fish, shellfish, cephalopods and other aquatic invertebrates.

In the context of recognizing controls at individual processing steps, this Section provides examples of potential hazards and defects and describes technological guidelines that can be used to develop control measures and corrective action. At any particular step, only the hazards and defects that are likely to be introduced or controlled at that step are listed. It should be recognized that in preparing a Hazard Analysis Critical Control Point (HACCP)³⁴ and/or defect action point (DAP) plan it is essential to consult Section 5, which provides guidance for the application of the principles of HACCP and DAP analysis. However, within the scope of this Code, it is not possible to give details of critical limits, monitoring, record-keeping and verification for each of the steps as these are specific to particular hazards and defects.

This Section concerns the processing of heat processed sterilized canned fish and shellfish products that have been packed in hermetically sealed containers³⁵ and are intended for human consumption.

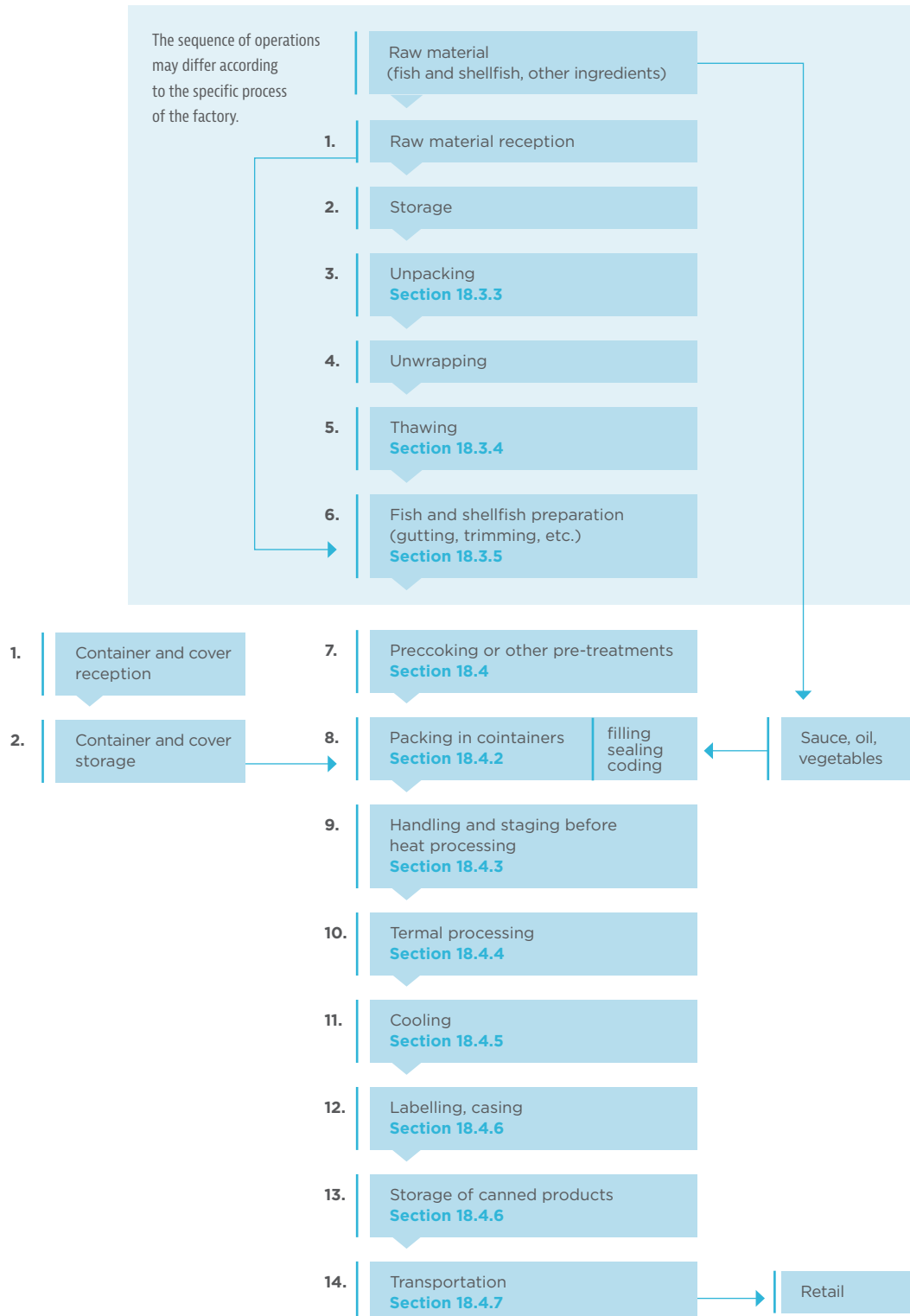
As stressed by this Code, the application of appropriate elements of the prerequisite programme (Section 3) and HACCP principles (Section 5) at these steps will provide the processor with reasonable assurance that the essential quality, composition and labelling provisions of the appropriate Codex standard will be maintained and food safety issues controlled. The example flow chart (Figure 18.1) provides guidance on some of the common steps involved in a canned fish or shellfish preparation line.

³⁴ Refer to Annex II for a comprehensive list of the acronyms used in this Code.

³⁵ Aseptic filling is not covered by this Code.

Figure 18.1 Example flow chart for the processing of canned fish and shellfish

This flow chart is for illustrative purpose only. For in factory HACCP implementation, a complete and comprehensive flow chart has to be drawn up for each process. References correspond to relevant sections of the Code.



18.1

General – addition to prerequisite programme

Section 3 gives the minimum requirements for good hygienic practices for a processing facility prior to the application of hazard and defect analyses.

For fish and shellfish canneries, further requirements in addition to the guidelines described in Section 3 are necessary because of the specific technology involved. Some of them are listed below, but reference should also be made to the *Code of Hygienic Practice for Low and Acidified Low Acid Canned Foods* (CXC 23-1979) for further information.

- Design, working and maintenance of baskets and handling and loading devices aimed at retorting should be appropriate for the kinds of containers and materials used. These devices should prevent any excessive mishandling of the containers.
- An adequate number of efficient sealing machines should be available to avoid undue delay in processing.
- Retorts should have a suitable supply of energy, vapour, water and/or air so as to maintain in them sufficient pressure during the heat treatment of sterilization; their dimensions should be adapted to the production to avoid undue delays.
- Every retort should be equipped with an indicating thermometer, a pressure gauge and a time and temperature recorder.
- An accurate, clearly visible clock should be installed in the retorting room.
- Canneries using steam retorts should consider installing automatic steam-controller valves.
- Instruments used to control and monitor, in particular, the thermal process should be kept in good condition and should be regularly verified or calibrated. Calibration of instruments used to measure temperature should be made in comparison with a reference thermometer, which should itself be regularly calibrated. Records concerning the calibration of instruments should be established and kept.

18.2

Identification of hazards and defects

Refer also to Section 4.1.

This Section describes the main potential hazards and defects specific to canned fish and shellfish.

18.2.1

A

A1

Hazards

Biological hazards

Naturally occurring marine toxins

Biotoxins such as tetrodotoxins or ciguatoxins are known to be generally heat stable, hence, knowledge of the identity of the species and/or the origin of fish intended for processing is important.

Phycotoxins such as diarrhetic shellfish poisoning (DSP), paralytic shellfish poisoning (PSP) or amnesic shellfish poisoning (ASP) are also heat stable, hence, it is important to know the origin and the status of the area of origin of molluscan shellfish or other affected species intended for processing.

A2

Scombrototoxin

Histamine

Since histamine is heat stable, it remains intact in containers following fish processing at high temperatures. Good practices for the conservation and handling from capture to retorting are essential to prevent histamine production. Refer to Section 10 for further information about histamine control. For some fish species, Codex adopted maximum levels for histamine in standards.

A3

Microbiological toxins

Clostridium botulinum

The botulism risk usually appears following inadequate heat processing and inadequate container integrity. The toxin is heat sensitive. On the other hand, the destruction of *C. botulinum* spores, in particular from proteolytic strains, requires high sterilization values. The effectiveness of the heat processing depends on the contamination level at the time of the treatment. It is therefore advisable to limit proliferation and contamination risks during processing. A higher risk of botulinum could result from any of the following: inadequate heat processing, inadequate container integrity, unsanitary post-process cooling water or unsanitary wet conveying equipment.

Staphylococcus aureus

Toxins from *Staphylococcus aureus* can be present in a highly contaminated raw material or can be produced by bacterial proliferation during processing. After canning, there is also the potential risk of post-process contamination with *Staphylococcus aureus* if the warm wet containers are handled in an unsanitary manner. These toxins are heat resistant, so they have to be taken into account in the hazard analysis.

B

Chemical hazards

Care should be taken to avoid contamination of the product from components of the containers (e.g. lead) and chemical products (e.g. lubricants, sanitizers, detergents).

C

Physical hazards

Containers prior to filling may contain materials such as metal or glass fragments.

18.2.2

Defects

Potential defects are outlined in the essential quality, labelling and composition requirements described in the relevant Codex standards. Where no Codex standard exists, reference should be made to national regulations and/or commercial specifications.

18.3 Processing operations

Processors can also refer to the *Code of Hygienic Practice for Low and Acidified Low Acid Canned Foods* (CXC 23-1979) to obtain detailed advice on canning operations.

18.3.1 Reception of raw material, containers, covers and packaging material and other ingredients

18.3.1.1 Fish and shellfish (Processing Step 1)

Potential hazards: chemical and biochemical contamination (DSP, PSP, scombrototoxin, heavy metals, etc.)

Potential defects: species substitution, decomposition, parasites

Technical guidance:

Refer to Section 9.1.1 (and Section 10.4.1 for scombrototoxin-forming fish), and other relevant sections; and also:

- When live shellfish (crustaceans) are received for canning processing, an inspection should be carried out in order to discard dead or badly damaged animals.

18.3.1.2 Containers, covers and packaging materials (Processing Step 1)

Potential hazards: microbiological contamination

Potential defects: tainting of the product

Technical guidance:

Refer to Section 9.5.1; and also:

- Containers, covers, and packaging materials should be suitable for the type of product, the conditions provided for storage, the filling, sealing and packaging equipment and the transportation conditions.
- The containers in which fish and shellfish products are canned should be made from suitable material and constructed so that they can be easily closed and sealed to prevent the entry of any contaminating substance.
- Containers and covers for canned fish and shellfish should meet the following requirements:
 - they should protect the contents from contamination by microorganisms or any other substance;
 - their inner surfaces should not react with the contents in any way that would adversely affect the product or the containers;
 - their outer surfaces should be resistant to corrosion under any likely conditions of storage; and
 - they should be sufficiently durable to withstand the mechanical and thermal stresses encountered during the canning process and to resist physical damage during distribution.

18.3.1.3 Other ingredients (Processing Step 1)

Refer to Section 9.5.1.

18.3.2 **Storage of raw material, containers, covers and packaging materials**

18.3.2.1 **Fish and shellfish (Processing Step 2)**

Refer to Sections 9.1.2, 9.1.3 and 7.6.2.

18.3.2.2 **Containers and packaging (Processing Step 2)**

Potential hazards: unlikely

Potential defects: foreign matter

Technical guidance:

Refer to Section 9.5.2; and also:

- All materials for containers or packages should be stored in satisfactorily clean and hygienic conditions.
- During storage, empty containers and covers should be protected from dirt, moisture and temperature fluctuations in order to avoid condensation on containers and, in the case of tin cans, the development of corrosion.
- During loading, stowing, transportation and unloading of empty containers, any shock should be avoided. Containers should not be stepped on. These precautions become more important when containers are put in bags or on pallets. Shocks can deform the containers (can body or flange), which may compromise tightness (shocks on the seam, deformed flange) or be prejudicial to appearance.

18.3.2.3 **Other ingredients (Processing Step 2)**

Refer to Section 9.5.2.

18.3.3 **Unwrapping, unpacking (Processing Steps 3 and 4)**

Potential hazards: scombrotoxin

Potential defects: foreign matter, decomposition

Technical guidance:

- During unwrapping and unpacking operations, precautions should be taken to limit product contamination and the introduction of foreign matter into the product. To avoid microbial proliferation, waiting periods before further processing should be minimized.

18.3.4 **Thawing (Processing Step 5)**

Refer to Section 9.1.4.

18.3.5 **Fish and shellfish preparatory processes (Processing Step 6)**

18.3.5.1 **Fish preparation (gutting, trimming, etc.)**

Potential hazards: microbiological contamination, scombrotoxin

Potential defects: objectionable matter (viscera, skin, scales, etc. in certain products), off-flavours, decomposition, presence of bones, parasites, etc.

Technical guidance:

Refer to Sections 9.1.5, 9.1.6, and 10 and:

- When fish are skinned by soaking in soda solution, particular care should be taken to carry out an appropriate neutralization.

18.3.5.2

Preparation of molluscs and crustaceans

Potential hazards: microbiological contamination, hard shell fragments

Potential defects: objectionable matter

Technical guidance:

Refer to Section 7.7, and:

- When live shellfish are used, an inspection should be carried out in order to discard dead or badly damaged animals.
- Particular care should be taken to ensure that shell fragments are removed from shellfish meat.

18.4

**Precooking
and other
treatments**

18.4.1

Precooking

Potential hazards: chemical contamination (polar components of oxidized oils), microbiological contamination, scombrototoxin

Potential defects: water release in the final product (for products canned in oil), abnormal flavours, decomposition

Technical guidance:

18.4.1.1

General considerations

- Methods used to precook fish or shellfish for canning should be designed to bring about the desired effect with minimum delay and handling; the choice of method is usually strongly influenced by the nature of the treated material. For products canned in oil, such as sardines or tunas, precooking should be sufficient in order to avoid excessive release of water during heat processing.
- Means should be found to reduce the amount of handling subsequent to precooking, wherever practical.
- If eviscerated fish are used, then the fish should be arranged in the belly-down position for precooking to allow for the drainage of fish oils and juices, which may accumulate and affect product quality during the heating process.
- Where appropriate, molluscan shellfish, lobsters and crabs, shrimps and prawns and cephalopods should be precooked according to technical guidance laid down in Sections 7 (Processing of live and raw bivalve molluscs), 15A and 15B (Processing of lobsters and crabs), 16 (Processing of shrimps and prawns) and 17 (Processing of cephalopods).
- Care should be taken to prevent temperature abuse of scombrototoxic species before precooking.

18.4.1.1.2 **Precooking schedule**

- The precooking method, particularly in terms of time and temperature, should be clearly defined. The precooking schedule should be checked.
- Fish precooked together in batches should be very similar in size. It also follows that they should all be at the same temperature when they enter the cooker.

18.4.1.1.3 **Control of quality of precooking oils and other fluids**

- Only good-quality vegetable oils should be used in precooking fish or shellfish for canning (see the *Standard for Named Vegetable Oils* (CXS 210-1999), *Standard for Olive Oils and Olive Pomace Oils* (CXS 33-1981) and *Standard for Edible Fats and Oils Not Covered by Individual Standards* (CXS 19-1981)).
- Cooking oils should be changed frequently in order to avoid the formation of polar compounds. Water used for precooking should also be changed frequently in order to avoid contaminants.
- Care must be taken to ensure that the oil or the other fluids used, such as vapour or water, do not impart an undesirable flavour to the product.

18.4.1.1.4 **Cooling**

- Except for products that are packed when still hot, cooling of precooked fish or shellfish should be done as quickly as possible to bring the product temperatures into a range limiting proliferation or toxin production, and under conditions where contamination of the product can be avoided.
- Where water is used to cool crustaceans for immediate shucking, it should be potable water or clean seawater. The same water should not be used for cooling more than one batch.

18.4.1.2 **Smoking**

Refer to Section 14.

18.4.1.3 **Use of brine and other dips**

Potential hazards: [microbiological and chemical contamination by the dip solution](#)

Potential defects: [adulteration \(additives\), abnormal flavours](#)

Technical guidance:

- Where fish or shellfish are dipped or soaked in brine or in solutions of other conditioning or flavouring agents or additives in preparation for canning, solution strength and time of immersion should both be carefully controlled to bring about the optimal effect.
- Dip solutions should be replaced and dip tanks and other dipping apparatus should be thoroughly and frequently cleaned.
- Care should be taken to ascertain whether or not the ingredients or additives used in dips would be permitted in canned fish and shellfish by the related Codex standards and in the countries where the product will be marketed.

18.4.2 **Packing in containers (filling, sealing and coding) (Processing Step 8)**

18.4.2.1 **Filling**

Potential hazards: microbiological contamination and scombrototoxin (waiting period or, after heat processing owing to incorrect filling or defective containers)

Potential defects: incorrect weight, foreign matter, decomposition

Technical guidance:

- A representative number of containers and covers should be inspected immediately before delivery to the filling machines or packing tables to ensure that they are clean, undamaged and without visible flaws.
- If necessary, empty containers should be cleaned. It is also a wise precaution to have all containers turned upside down to make certain that they do not contain any foreign matter before being used.
- Care should also be taken to remove defective containers, which may jam a filling or sealing machine, or cause trouble during heat processing (e.g. inadequate sterilization, leaks).
- Empty containers should not be left on the packing tables or in conveyor systems during the cleaning of premises so as to avoid contamination or splashes.
- Where appropriate, to prevent microbial proliferation, containers should be filled with hot fish and shellfish (e.g. > 63 °C for fish soups) or should be filled as soon as possible upon the completion of pre-treatment.
- If the fish and shellfish must be held for an extended period of time before packing into containers, they should be chilled.
- Containers of canned fish and shellfish should be filled as directed in the scheduled process.
- Mechanical or manual filling of containers should be checked to ensure compliance with the filling rate and the headspace specified in the adopted sterilization schedule. A regular filling is important not only for economic reasons, but also because heat penetration and container integrity can be affected by excessive filling changes.
- The necessary amount of headspace will depend partly on the nature of the contents. The filling should also take into account the heat processing method. Headspace should be allowed as specified by the container manufacturer.
- Furthermore, containers should be filled such that the end product meets the regulatory provisions or the accepted standards concerning weight of contents.
- Where canned fish and shellfish are packed by hand, there should be a steady supply of fish, shellfish and, eventually, other ingredients. Build-up of fish, shellfish and filled containers at the packing table should be avoided.
- The operation, maintenance, regular inspection, calibration and adjustment of filling machines should receive particular care. The instructions provided by the machine manufacturer should be carefully followed.

- The quality and the amount of other ingredients such as oil, sauce, vinegar, etc. should be carefully controlled to bring about the optimal desired effect.
- If fish has been brine-frozen or stored in refrigerated brine, the amount of salt absorbed should be taken into consideration when salt is added to the product for flavouring.
- Filled containers should be inspected:
 - to ensure that they have been properly filled and will meet accepted standards for weight of contents; and
 - to verify product quality and workmanship just before they are closed.
- Manual-filled products such as small pelagic fish should be carefully checked by the operators to verify that container flanges or closure surface have no product residues, which could impede the formation of a hermetic seal. For automatic-filled products, a sampling plan should be implemented.

18.4.2.2 **Sealing**

Sealing the container and covers is one of the most essential processes in canning.

Potential hazards: subsequent contamination owing to a bad seam

Potential defects: unlikely

Technical guidance:

- The operation, maintenance, regular inspection and adjustment of sealing machines should receive particular care. The sealing machines should be adapted and adjusted for each type of container and each closing method used. Whatever the type of sealing equipment, the instructions provided by the manufacturer or equipment supplier should be followed meticulously.
- Seams and other closures should be well formed with dimensions within the accepted tolerances for the particular container.
- Qualified personnel should conduct this operation.
- If a vacuum is used during packing, it should be sufficient to prevent the containers from bulging under any condition (high temperature or low atmospheric pressure) likely to be encountered during the distribution of the product. This is useful for deep containers or glass containers. It is difficult and hardly necessary to create a vacuum in shallow containers that have relatively large flexible covers.
- An excessive vacuum may cause the container to panel, particularly if the headspace is large, and may also cause contaminants to be sucked into the container if there is a slight imperfection in the seam.
- To find the best methods for creating a vacuum, competent technologists should be consulted.
- Regular inspections should be made during production to detect potential external defects on containers. In order to guarantee a closure in accordance with specifications, at sufficiently close intervals, the operator, the supervisor of the closure or any other competent person should examine

the seams or the closure system for the other types of containers that are used. Inspections should consider, for example, vacuum measurements and seam teardown. A sampling plan should be used for the checks.

- In particular, each time the production line is started and at each change in container dimensions, after a jamming, a new adjustment or a restarting after a prolonged stop of the sealing machine, a check should be carried out.
- All appropriate observations should be recorded.

18.4.2.3 **Coding**

Potential hazards: subsequent contamination owing to damaged containers

Potential defects: loss of traceability owing to an incorrect coding

Technical guidance:

- Each container of canned fish and shellfish should bear indelible code markings from which integral information concerning its manufacture (type of product, cannery where the canned fish or shellfish was produced, production date, etc.) can be determined.
- Coding equipment must be carefully adjusted so that the containers are not damaged and the code remains legible.
- Coding may sometimes be carried out after the cooling step.

18.4.3 **Handling of containers after closure – staging before heat processing (Processing Step 9)**

Potential hazards: microbiological contamination and scombrototoxin (waiting period or owing to damaged containers)

Potential defects: decomposition

Technical guidance:

- After closure, containers should always be handled carefully in such a way as to prevent any damage that may cause defects and microbiological recontamination.
- If necessary, filled and sealed metal containers should be thoroughly washed before heat processing to remove grease, dirt and fish or shellfish stains on their outside walls.
- To avoid microbial proliferation, the waiting period should be as short as possible.
- If the filled and sealed containers must be held for a long time before heat processing, the product should be held at temperature conditions that minimize microbial growth.
- Every cannery should develop a system that will prevent non-heat-processed canned fish and shellfish from being accidentally taken past the retorts into the storage area.

18.4.4 **Thermal processing (Processing Step 10)**

Heat processing is one of the most essential operations in canning.

Canners can refer to the *Code of Hygienic Practice for Low and Acidified Low Acid Canned Foods* (CXC 23-1979) for detailed advice on heat processing. In this Section, only some essential elements are pointed out.

Potential hazards: survival of spores of *C. botulinum*

Potential defects: survival of microorganisms responsible for decomposition

Technical guidance:

18.4.4.1 **Sterilization schedule**

- To determine the sterilization schedule, first, the heat process required to obtain commercial sterility should be established, taking into account a number of factors (microbial flora, dimensions and nature of the container, product formulation, etc.). A sterilization schedule is established for a certain product in a container of a given size.
- Proper heat generation and temperature distribution should be ensured. Standard heat processing procedures and experimentally established sterilization schedules should be checked and validated by an expert to confirm that the values are appropriate for each product and retort.
- Before any changes are made to operations (initial temperature of filling, product composition, size of containers, fullness of the retort, etc.), competent technologists should be consulted as to the need for re-evaluation of the process.

18.4.4.2 **Heat processing operation**

- Only qualified and properly trained personnel should operate retorts. Retort operators should therefore control the processing operations and ensure the sterilization schedule is closely followed, including meticulous care in timing, monitoring temperatures and pressures, and in maintaining records.
- It is essential to comply with the initial temperature described in the schedule process to avoid under-processing. If the filled containers have been held at refrigerated temperatures because of an excessively long waiting period before heat processing, the sterilization schedule should take into account those temperatures.
- In order for the heat processing to be effective and to ensure control of process temperature, air must be evacuated from the retort through a venting procedure that is deemed efficient by a competent technologist. Container size and type, retort installation and loading equipment and procedures should be considered.
- The timing of the heat processing should not commence until the specified heat processing temperature has been reached, and the conditions to maintain uniform temperature throughout the retort achieved, in particular, until the minimum safe venting time has elapsed.
- For other types of retort (water, steam/air, flame, etc.), refer to the *Code of Hygienic Practice for Low and Acidified Low Acid Canned Foods* (CXC 23-1979).

- If canned fish and shellfish in different sized containers are processed together in the same retort load, care must be taken to ensure that the process schedule used is sufficient to provide commercial sterility for all container sizes processed.
- When processing fish and shellfish in glass containers, care must be taken to ensure that the initial temperature of the water in the retort is slightly lower than that of the product being loaded. The air pressure should be applied before the water temperature is raised.

18.4.4.3 **Monitoring of heat processing operation**

- During the application of heat processing, it is important to ensure that the sterilization process and factors such as container filling, minimal internal depression at closing, retort loading and initial product temperature are in accordance with the sterilization schedule.
- Retort temperatures should always be determined from the indicating thermometer, never from the temperature recorder.
- Permanent records of the time, temperature and other pertinent details should be kept concerning each retort load.
- The thermometers should be tested regularly to ensure that they are accurate; calibration records should be maintained; and the recording thermometer readings should never exceed the indicating thermometer reading.
- Inspections should be made periodically to ensure that retorts are equipped and operated in a manner that will provide thorough and efficient heat processing, and that each retort is properly equipped, filled and used, so that the whole load is brought up to processing temperature quickly and can be maintained at that temperature throughout the whole of the processing period.
- The inspections should be made under the guidance of a competent technologist.

18.4.5 **Cooling (Processing Step 11)**

Potential hazards: recontamination owing to a bad seam and contaminated water

Potential defects: formation of struvite crystals, buckled containers, scorch

Technical guidance:

- After heat processing, canned fish and shellfish should, wherever practical, be water cooled under pressure to prevent deformations, which could result in a loss of tightness. Where water is recycled, potable water should always be chlorinated (or other appropriate treatments used) for this purpose. The residual chlorine level in cooling water and the contact time during cooling should be checked in order to minimize the risk of post-processing contamination. The efficiency of the treatment other than chlorination should be monitored and verified.
- In order to avoid organoleptic defects in canned fish and shellfish, such as scorch or overcooking, the internal temperature of containers should be lowered as quickly as possible.

- For glass containers, the temperature of the coolant in the retort should be, at the outset, lowered slowly in order to reduce the risks of breaking owing to thermal shock.
- Where canned fish and shellfish products are not cooled in water after heat processing, they should be stacked in such a way that they will cool rapidly in air.
- Heat-processed canned fish and shellfish should not be touched by hand or articles of clothing unnecessarily before they have cooled and thoroughly dried. They should never be handled roughly or in such a way that their surfaces, and in particular their seams, are exposed to contamination.
- Rapid cooling of canned fish and shellfish avoids the formation of struvite crystals.
- Every cannery should develop a system to prevent unprocessed containers being mixed with processed containers.

18.4.5.1

Monitoring after heat processing and cooling

- Canned fish and shellfish should be inspected for faults and for quality assessment soon after they are produced and before labelling.
- Representative samples from each code lot should be examined to ensure that the containers do not exhibit external defects and the product meets the standards for weight of contents, vacuum, workmanship and wholesomeness. Texture, colour, odour, flavour and condition of the packing medium should be assessed.
- If desired, stability tests could be made in order to verify, in particular, the heat processing.
- This examination should be made as soon as practical after the canned fish and shellfish have been produced, to allow for any faults owing to failings on the part of cannery workers or canning equipment to be corrected without delay. Segregating and properly disposing of all defective units or lots that are unfit for human consumption should be ensured.

18.4.6

Labelling, casing and storage of finished products (Processing Steps 12 and 13)

Refer to Section 9.2.3.

Potential hazards: subsequent recontamination owing to container damage or exposure to extreme conditions

Potential defects: incorrect labelling

Technical guidance:

- The materials used for labelling and casing canned fish and shellfish should not be conducive to corrosion of the container. Cases should be of adequate dimensions to accommodate containers and prevent damage thereto by any movement inside. Cases and boxes should be of appropriate size and strong enough to protect the canned fish and shellfish during distribution.
- Code marks appearing on containers of canned fish and shellfish should also be shown on the cases in which they are packed.

- Storage of canned fish and shellfish should be done in such a way as not to damage the containers. In particular, pallets of finished products should not be stacked excessively high and forklift trucks should be operated in a proper manner.
- Canned fish and shellfish should be stored in such a way as to keep them dry and prevent their exposure to extremes of temperature.

18.4.7

Transportation of finished products (Processing Step 14)

Potential hazards: subsequent recontamination owing to container damage or exposure to extreme conditions

Potential defects: unlikely

Technical guidance:

Refer to Section 21, and:

- Transportation of canned fish and shellfish should be done in such a way as to avoid damage to containers. In particular, the forklift trucks used during the loading and unloading should be operated in a proper manner.
- Cases and boxes should be completely dry: since moisture affects the mechanical characteristics of boxes, the protection of containers against damage during transportation may not be sufficient.
- Metal containers should be kept dry during transportation in order to avoid corrosion and/or rust.



19

Processing of fish sauce



This Section has been developed primarily for use as a guideline to improve the processing practices of fish sauce to meet international requirements. The application of good manufacturing practice (GMP)³⁶ and Hazard Analysis Critical Control Point (HACCP) and defect action point (DAP) analysis for this traditional product should be promoted to ensure consumer health and safety as well as fish sauce quality. Fish sauce is a translucent, not turbid liquid product with salty taste and fish flavour obtained from the fermentation of a mixture of fish and salt at an appropriate ratio, and the optional addition of other ingredients. In general, the size of fish used as raw material in fish sauce processing is small, not greater than 12 cm in length. Traditional fish sauce fermentation relies on endogenous enzymes and indigenous bacteria of raw materials. For non-traditional fermentation, parts of fish (by-product) and other ingredients may be used in the fermentation process. Raw fish and parts of fish shall be in a good condition, suitable for human consumption. Salt is an essential ingredient in fish sauce production in order to support the growth of halophilic microorganisms that produce effective fermentation and prevent growth of bacterial pathogens and other undesirable microbial activity, yielding a high quality, safe fish sauce product.

This Section addresses the general processing steps and technical guidance to be employed by fish sauce manufacturers, which may vary by country. Potential hazards and defects at each processing step, starting from the reception of raw material and ending with final product distribution, are identified. In addition, each processing step includes technical guidance for controlling the identified hazards and defects that help ensure consumer safety and product quality. Nevertheless, consistent with HACCP principles, each processor should conduct a hazard analysis of its own operations and product to ensure all hazards are identified and properly controlled.

³⁶ Refer to Annex II for a comprehensive list of the acronyms used in this Code..

General considerations of hazards and defects

Hazards

The raw material used in the fermentation to make fish sauce may include both freshwater and marine fish. Some marine fish, such as mackerel, sardines or anchovies, pose a risk of scombrototoxin formation: for these it is necessary to refer to Section 10 of this Code. Fish may be contaminated with undesirable microorganisms, including pathogenic bacteria, thus it is necessary to control raw material on the harvest vessel in compliance with Sections 3, 4 and 10 of this Code.

Icing or refrigeration shortly after death of the fish is a common means of preventing undesirable microbial growth and activity on harvest vessels and prior to achieving adequate salt penetration and concentration in the fish at the processing facility. However, immediate salting of fish on board the harvest vessel along with icing or refrigeration may be used for the control of microbiological contamination and decomposition.

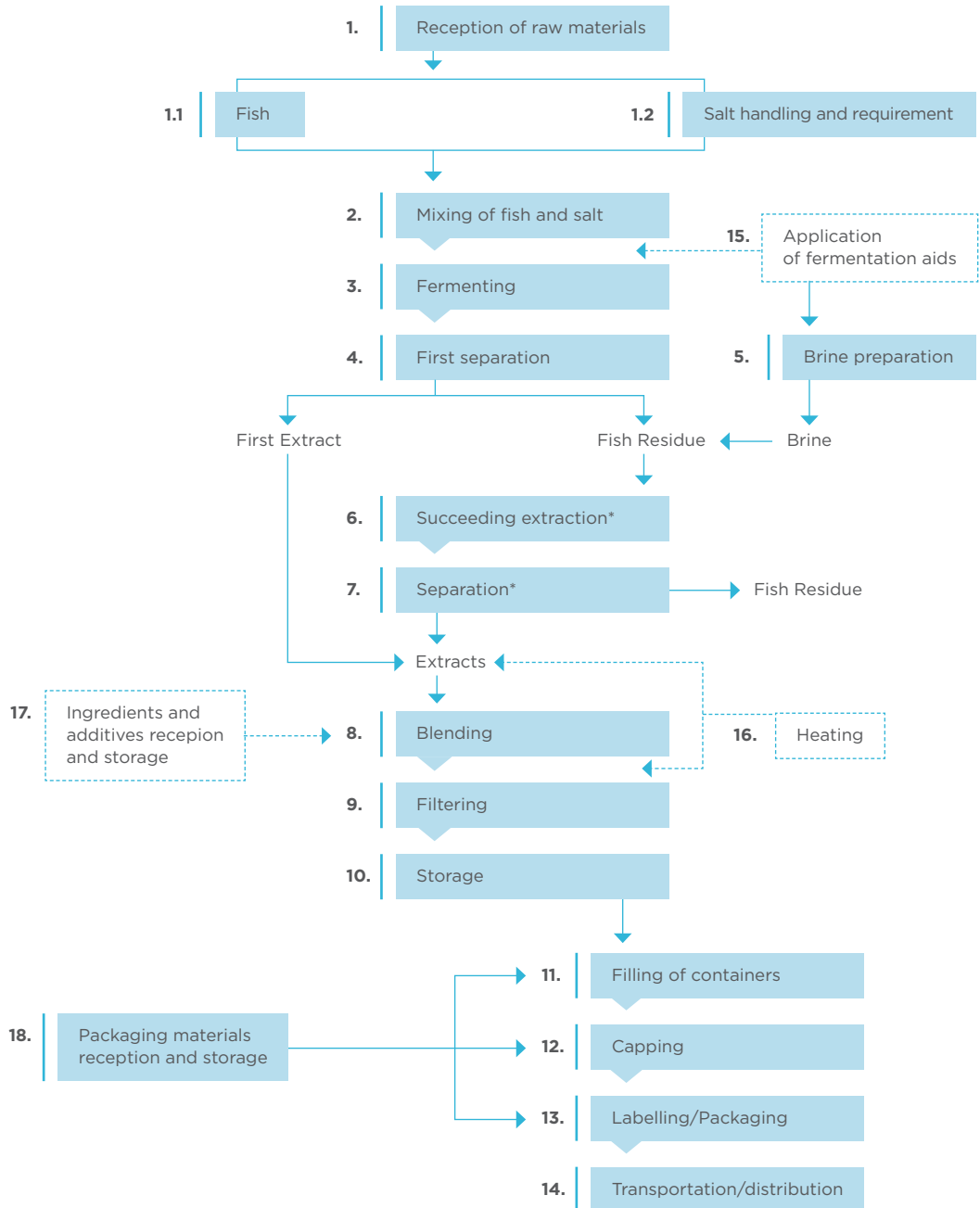
A large amount of salt is used in fish sauce processing. Water Phase Salt concentrations of 20 percent or higher should be achieved and maintained throughout the fermentation to prevent growth and activity of undesirable microorganisms, including pathogens.

Defects

The odour and taste of fish sauce depends on the free amino acids generated from the fermentation process and the optional addition of extracts that contain water with fewer amino acids. The level of free amino acids generated from the fermentation process varies according to type of fish used, ratio of fish to salt, temperature during fermentation, and fermentation time. Controls of these factors and proper blending of brine extracts and other ingredients are therefore necessary to obtain fish sauce products with desirable odour and taste.

Figure 19.1 Example flow chart for the processing of fish sauce

This flow chart is for illustrative purpose only. For in factory HACCP implementation, a complete and comprehensive flow chart has to be drawn up for each process. References correspond to relevant sections of the Code.



* Could be done one or more times

- - - - - Dashed lines indicate an optional step

19.1 Reception of raw materials

19.1.1

Fish

Potential hazards: scombrototoxin (histamine), microbiological contamination, biotoxins, chemical contamination (including pesticides and veterinary drug residues), physical contamination

Potential defects: decomposition, physical contamination

Technical guidance:

- Raw materials receiving controls should include the following characteristics where applicable to the identified hazards and defects:
 - For the control of microbial pathogens, scombrototoxin fish poisoning and decomposition;
 - As appropriate, harvest vessel, transportation and storage records documenting that the fish were chilled and maintained at 3 °C or below; or
 - As appropriate, harvest vessel and transportation records documenting that the fish were chilled and maintained between 3 °C and 10 °C with the combination of mixing with salt to ensure water phase salt at 10 percent or higher;
 - Histamine analysis;
 - Histamine verification sampling should be periodically performed using a sample size large enough to provide some assurance (other than documentary records) that harvest vessel cooling and/or salting controls are effective;
 - Organoleptic characteristics, (e.g. appearance, odour, texture) and chemical criteria (e.g. total volatile basic nitrogen (TVBN));
 - Chemical contaminant criteria (e.g. heavy metals, pesticide residues and nitrates);
 - Microbiological criteria (to prevent the processing of raw material containing microbiological toxins) for fish with risk;
 - Veterinary drug residues criteria (when the raw fish material is from aquaculture); and
 - Foreign matter.
- Skills should be acquired by fish handlers and appropriate personnel in sensory evaluation techniques to ensure that raw fish meet essential quality provisions of the relevant Codex standard and sorting of fish species that pose a risk of biotoxins, such as ciguatoxin in large carnivorous tropical and subtropical reef fish.
- To control the *Clostridium botulinum* hazard, in addition to the chilling or salting controls above, unviscerated fish greater than 12 cm in length that have not been gutted on the harvest vessel, should be gutted upon arrival at the processing facility:
 - Fish should be gutted efficiently, without delay and with care to avoid contamination;

- Gutting is considered complete when the intestinal tract and internal organs have been removed; and
- Clean seawater or potable water should be used.
- After reception, raw material should remain chilled until salted.
- Fish should be rejected if there is evidence that they may contain harmful, decomposed or extraneous substances unable to be reduced or eliminated to an acceptable level by normal procedures of sorting or preparation.
- Information about the harvesting area should be recorded.

19.1.2

Salt handling and requirements

Potential hazards: chemical and physical contamination

Potential defects: incorrect composition

Technical guidance:

- Salt used should be food grade, in accordance with the *Standard for Food Grade Salt* (CXS 150-1985).
- The composition of salt differs according to the origin. Mine salt and solar salt of marine origin contain several other salts such as calcium sulphate, magnesium sulphate and chloride as impurities. Solar salt may be stored at least two months before using to obtain a good taste of fish sauce.
- Salt used should be inspected to ensure that it is clean, not previously used, and free of foreign matter or crystals, and that it shows no visible signs of contamination with dirt, oil, bilge or other extraneous materials.
- The size of the salt granules used should be carefully considered. Medium-sized salt crystals should be used. If the crystal size used is too small, the outer skin of fish will rapidly lose moisture and salt burn can occur, which will prevent salt penetration into the fish; consequently, the inside of the fish can undergo decomposition. If the crystal size is too large, salt will penetrate too slowly and the fish may undergo decomposition before the preservative effect of salt takes effect.
- Salt should be transported and stored dry and hygienically covered in salt bins, storerooms, containers or plastic sacks.

19.2

Mixing of fish and salt

Potential hazards: scombrototoxin (histamine), microbiological contamination (*Clostridium botulinum* and *Staphylococcus aureus* toxins), metal inclusion

Potential defects: decomposition, physical contamination

Technical guidance:

- Fish and salt should be mixed thoroughly by trained personnel or machines to ensure the proper contact between salt and fish to prevent the growth of pathogens and decomposition during fermentation.
- All the apparatus used to mix fish and salt should be easy to clean, rust-free and resistant to salt. Mechanical mixers should not introduce unapproved substances or metal fragments.

- To prevent spoilage and growth of pathogenic bacteria, the concentration of salt should not be less than 20 percent by weight. The common ratios of fish to salt by weight are 3:1, 5:2 and 3:2.
- Fish should attain 20 percent water phase salt, or ≤ 0.85 water activity in the centre of the largest fish within the appropriate time period for the target pathogen and at ambient temperature.
- Refer to Section 13 for further information about salting fish.

19.3 Fermenting

Potential hazards: physical and chemical contamination
(including heavy metals)

Potential defects: undesirable odour and taste, incomplete fermentation

Technical guidance:

- Care should be taken to ensure the cleanliness of the fermentation area and tanks.
- Fermentation tanks should be designed and constructed to permit easy cleaning and disinfection before each use.
- Fermenting tanks should be made from non-hazardous material and be able to prevent product contamination, such as by being resistant to rust and corrosion due to salt that may cause heavy metal contamination.
- Fermentation period at ambient or controlled temperature typically ranges from 6 to 18 months to attain good quality fish sauce from natural fermentation in a tropical region. When fermentation aids are used, the period may be shorter.
- Colour, clarity, aroma (odour) and taste criteria, along with chemical criteria, may be monitored to determine the end of the fermentation process.

19.4 First separation

Potential hazards: unlikely

Potential defects: incorrect separation (e.g. objectionable matter, turbidity)

Technical guidance:

- Liquid and solid (fish residue) should be completely separated.
- The extract (liquid) should be translucent, not turbid.

19.5 Brine preparation

Potential hazards: unlikely

Potential defects: undesirable odour and taste

Technical guidance:

- Brine used for brine extractions of fish residues should be freshly prepared from potable water and food grade salt and should be saturated.

19.6

Succeeding extraction

Potential hazards: unlikely
Potential defects: undesirable odour and taste
Technical guidance:

- Succeeding brine extraction of the fish residues may be carried on as long as requirements in the *Standard for Fish Sauce* (CXS 302-2011) are fulfilled.

19.7

Separation

Refer to Section 18.4.

19.8

Blending

Potential hazards: microbiological contamination, scombrototoxin (histamine), unsafe unauthorized additives, allergens
Potential defects: ingredient measurement errors, unauthorized food additives, incorrect pH, incorrect labelling.
Technical guidance:

- Total nitrogen (TN) of fermentation and extract batches should be analysed before blending. TN, amino acid nitrogen content and pH in the final product must be in compliance with the *Standard for Fish Sauce* (CXS 302-2011).
- To obtain good quality fish sauce, ingredients should meet the required characteristics and appropriate concentrations.
- All utensils should be clean.
- Food additives and levels used need to be in compliance with the *Standard for Fish Sauce* (CXS 302-2011). Food additives used need to be identified with names and identification numbers that comply with *Class Names and the International Numbering System for Food Additives* (CXG 36-1989).
- Before blending, chemical properties, essential quality factors and histamine should be monitored according to the *Standard for Fish Sauce* (CXS 302-2011), and the results should be recorded. Batches exceeding histamine requirements should be discarded.
- Care should be taken to ensure that labelling is in accordance with Section 4.2 of the *General Standard for the Labelling of Prepackaged Foods* (CXS 1-1985), especially for known allergens.

19.9

Filtering

Potential hazards: unlikely
Potential defects: foreign matter and turbidity
Technical guidance:

- An appropriate filtering system should be checked regularly and properly maintained.

19.10 Storage

Potential hazards: physical and chemical contamination

Potential defects: foreign matter

Technical guidance:

- Storage tanks should have lids and be easy to clean and disinfect, resistant to rust and salt, and located in an appropriate area.
- The product should be kept away from any source of contamination.
- The batches or lots in storage should be identified for tracing purposes.

19.11 Filling of containers

Potential hazards: residual chemical cleaning agent,
physical contamination such as glass fragments.

Potential defects: foreign matter, incorrect volume, defective
and unclean bottles and containers

Technical guidance:

- Filling machines should be kept clean to prevent contamination.
- Filling machines should be regularly checked to prevent failure in the filling of container.
- Defective containers should not be used.

19.12 Capping

Potential hazards: unlikely

Potential defects: loose plastic matter, broken caps, foreign matter,
leaking containers

Technical guidance:

- After capping containers should be checked for proper seal and leakage.

19.13 Labelling/ packaging

Potential hazards: allergens

Potential defects: incorrect labelling

Technical guidance:

- Refer to Sections 9.2.3
- Care should be taken to ensure that labelling is in accordance with Section 4.2 of the *General Standard for the Labelling of Prepackaged Foods* (CXS 1-1985), especially for known allergens.

19.14

Transportation/ distribution

Potential hazards: unlikely.

Potential defects: contaminated and damaged containers and cartons

Technical guidance:

- Cartons should be clean, dry, durable and suitable for the intended use; damage to the packaging materials should be avoided.
- Cartons should be used to avoid the damage of containers.
- Also refer to Section 21.4.

19.15

Application of fermentation aids (optional)

Potential hazards: microbiological contamination

Potential defects: improper fermentation, undesirable flavour/odour

Technical guidance:

- Fermentation aids should be stored at appropriate temperature in order to avoid deactivation of fermentation aids. Cartons should be used to avoid the damage of containers.
- When enzymes and bacterial cultures are used as fermentation aids, they should be handled to minimize microbiological contamination.

19.16

Heating (optional)

Potential hazards: unlikely

Potential defects: over-heating

Technical guidance:

- Adequate temperature and time combination should be applied.

19.17

Ingredients and additives reception and storage (optional)

Potential hazards: microbiological contamination

Potential defects: loss of quality characteristics

Technical guidance:

- Refer to Sections 9.5.1 and 9.5.2.

19.18

Packaging materials reception and storage

Potential hazards: chemical and physical contamination

Potential defects: misdescription, loss of packaging integrity

Technical guidance:

- Refer to Sections 9.5.1 and 9.5.2
- Labels should be verified to ensure that all information declared meets, where applicable, the *General Standard for the Labelling of Prepackaged Foods* (CXS 1-1985) and labelling provisions of the *Standard for Fish Sauce* (CXS 302-2011).
- Containers should be made of material that is resistant to high salt content and will not release any substances harmful to human health.
- Packaging materials including caps should be randomly and regularly checked for defects and cleanliness.
- Packaging materials should be stored in a dry and clean place under hygienic conditions.





A close-up photograph showing a person's hand wearing a light-colored nitrile glove. The hand is pointing towards a large pile of dark, round sturgeon caviar. A significant portion of the caviar is covered with a thick layer of white, granular salt. The background is a plain, light-colored surface.

20

Processing of sturgeon caviar

General considerations

In the context of recognizing controls at individual processing steps, this Section provides examples of potential hazards and defects and describes technical guidance that can be used to develop control measures and corrective actions. At any particular step, only the hazards and defects that are likely to be introduced or controlled at that step are listed. It should be recognized that in preparing a Hazard Analysis Critical Control Point (HACCP)³⁷ and/or defect action point (DAP) plan it is essential to consult Section 5, which provides guidance for the application of the principles of HACCP and DAP analysis. However, within the scope of this Section, it is not possible to give details of critical limits, monitoring, record-keeping and verification for each of the steps as these are specific to particular hazards and defects, and to the process used.

This Section applies to products covered by the *Standard for Sturgeon Caviar* (CXS 291-2010) and covers the production of caviar by extraction of non-ovulated eggs and the production of caviar from ovulated eggs by induction of ovulation using natural means as well as by the use of authorized products. Potential hazards and defects that may be introduced at each processing step are identified. A summary of major defects and additional prerequisites programmes are listed below:

Microbial hazards: Ovaries remain sterile as long as they are located in the belly cavity. Contamination may occur through contact with hands, equipment and utensils, air, water, additives, fish skin and guts. Therefore, implementation of good hygienic practices (Section 3), use of potable or clean water and regular monitoring are very important. Time/temperature control (shortest possible processing time under cold chain conditions) followed by rapid transfer to cold area will reduce the risk of microbial growth and related toxin production.

Proteolytic and non-proteolytic *Clostridium botulinum* are spore-forming microbial hazards which should be controlled in packed caviar. These pathogens are controlled by an adequate quantity of salt (product salt content $\geq 3\text{g}/100\text{g}$; ≥ 5 percent salt in the water phase; a water activity of < 0.97) and cold storage, (temperatures of ≤ 4 °C). Other controlling factors shown to prevent *Clostridium botulinum* growth and toxin production in the caviar can be used when shown to be effective by scientific studies. In addition to the control of *C. botulinum*, countries producing caviar should ensure that the process used (e.g. pasteurization step, use of permitted food additives, percentage salt, microbiological testing, temperature controls) will control non-spore forming microorganisms (e.g. *Salmonella*, *Listeria monocytogenes*).

37 Refer to Annex II for a comprehensive list of the acronyms used in this Code..

Chemical hazards: Consideration must be given to contaminants such as heavy metals, pesticides, oil derivatives, residues of veterinary drugs, including hormones. The technical guidelines mentioned in Section 6 should be considered. Potential chemical hazards can also come from the water used for washing fish eggs and from other processing steps; potable or clean water should therefore be used for that purpose. Contaminants from the salt and additives may also introduce chemical hazards.

Physical hazards: Sharp and hard fish body fragments, glass and metal (from utensils and packaging materials) may be introduced. The introduction of such hazards should be controlled and the control measures should be monitored and verified.

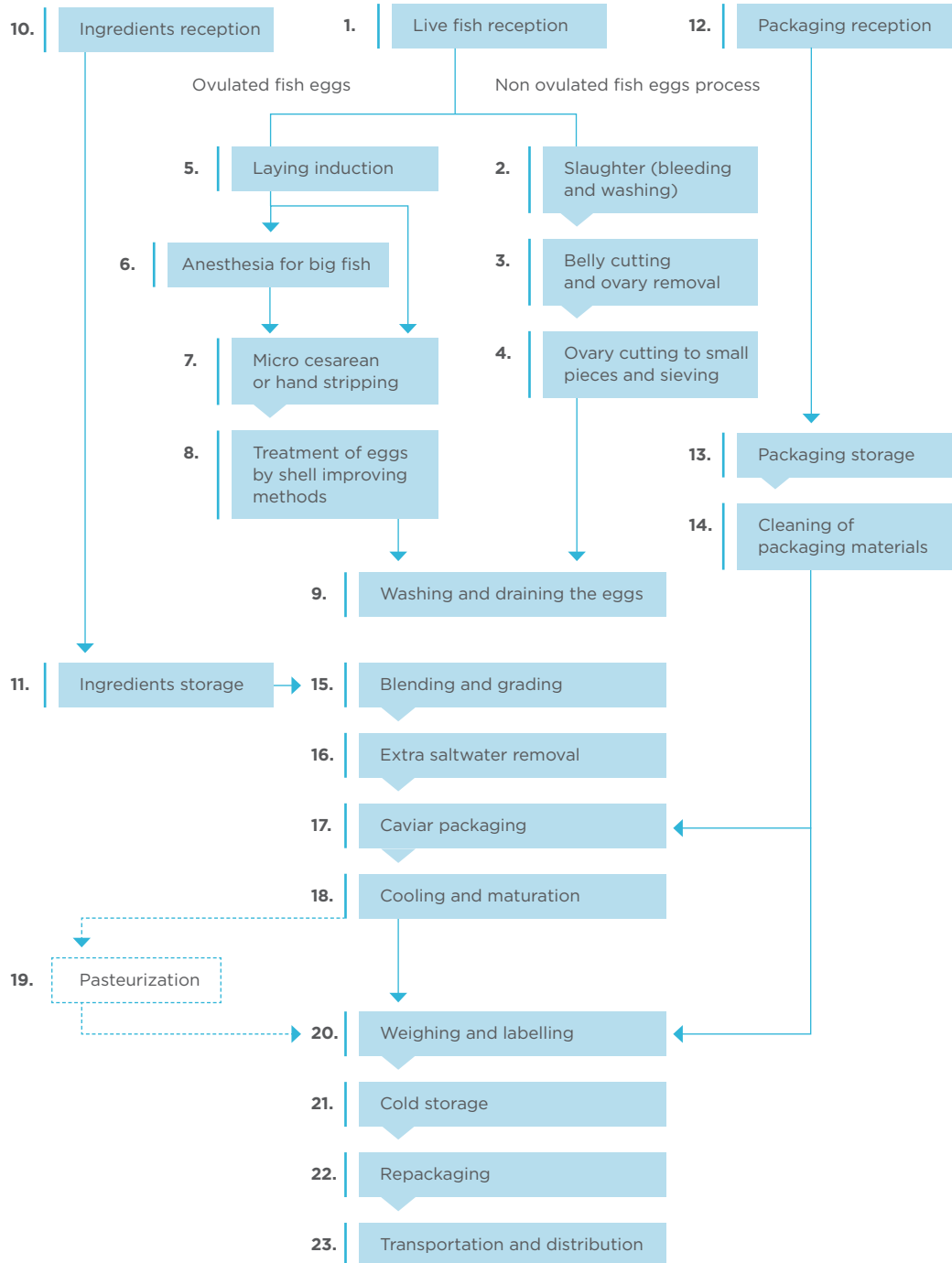
Defects: Potential defects could be classified in three categories:

1. Development of chemical decomposition due to temperature abuse during caviar production process, handling and storage. This can be prevented by controlling time and temperature.
2. Fat tissues, ovarian follicles and blood clots in caviar (from slaughtered sturgeon) can be avoided by proper bleeding, careful sieving and ovarian washing.
3. A number of factors can have an effect on the physico-chemical and sensory properties of caviar, such as egg breakage, shell loosening, egg-softening or -hardening owing to excessive pressure on caviar and temperature abuse. Impure salt or additives, dust, smoke and aromatics in detergents or disinfecting agents can be absorbed by caviar and affect flavour and taste.

This Code provides guidance for the common steps used for processing caviar as shown in the Example flow chart for caviar production (Figure 20.1).

Figure 20.1 Example flow chart for caviar processing

This flow chart is for illustrative purpose only. For in factory HACCP implementation, a complete and comprehensive flow chart has to be drawn up for each process. References correspond to relevant sections of the Code.



----- Dashed lines indicate an optional step

20.1

Live fish reception (Processing Step 1)

Potential hazards: chemical contamination (e.g. oil pollutants, heavy metals, pesticides, drugs residue)

Potential defects: decomposition, physical damage

Technical guidance:

- Refer to Sections 6.1, 6.2 and 6.3.
- Farmed fish should be harvested from growing areas where water quality should comply with Section 6.1.2.
- Fish handling should be undertaken in a manner to avoid stress (e.g. direct sunlight, high temperature, oxygen depletion) and contamination.
- In order to prevent the mortality of live fish, which could result in decomposition of fish eggs, they should be handled with care, stored in clean (filtered), oxygenated water, and rapidly prepared for ovary removal.
- Live fish should be transported to a processing establishment quickly without causing physical damage.
- Training should be provided to persons who harvest, handle or receive fish.
- All documents relating to the health status of farmed fish, such as veterinary drug or medicated feed dosage and period of treatment as well as feed composition, should be reviewed at the reception point. For example, it should be ensured that the fish has been subjected to the proper withdrawal time for the specific products in question (e.g. antibiotics or hormones).
- To facilitate the traceability/product tracing of the fish, a record-keeping system should be in place, including the name and address of the farm sites (in case of farmed fish). If fish is kept out of water, the period of time should be short and the places used for this purpose should be clean.
- In the case of fresh dead fish, the fish should be stored under refrigeration or in cold clean water.

20.2

Slaughter (bleeding and washing) (Processing Step 2)

Potential hazards: microbiological contamination

Potential defects: blood remaining in fish organs

Technical guidance:

- Stunning may be used to reduce stress after fish are harvested. It should be done by a skilled person and in accordance with the technical guidelines established by the World Organization for Animal Health (OIE) in order not to harm or damage the fish or eggs.
- As soon as the live fish have been slaughtered, the fish should be bled to prevent blood dispersion into the eggs.
- Fish should be bled by cutting gills in both sides or by cutting the tail.
- The bleeding process should be completed before ovary removal.
- After bleeding, fish should be washed with potable or clean water to remove all residual blood from surface and reduce the risk of contaminating the eggs.
- Suitable facilities for hygienic waste disposal should be available at the bleeding site.

20.3

Belly cutting and ovary removal (Processing Step 3)

Potential hazards: [microbiological and physical contamination](#)

Potential defects: [physical damage to the eggs, off flavour, off odour, decomposition](#)

Technical guidance:

- Prior to cutting, the belly part (around cutting area) should be thoroughly brushed using potable or clean water to remove all foreign matter (e.g. sand and blood) and to reduce microbial load on the skin.
- All equipment/utensils used for cutting the belly, such as tables, knives and bowls used for ovary transfer and storage, should be cleaned and disinfected.
- Cleaning and disinfection agents used for hand washing and on equipment should not affect the flavour or odour of the eggs.
- Belly cutting should be done by trained and skilled personnel using an appropriate method to preclude any contamination with viscera and damage to the eggs.
- All utensils that come in contact with fish eggs should not be used for other purposes and should be carefully cleaned, disinfected and stored in a proper place to avoid any contamination.
- Knives that are used for belly cutting should be distinct from those used for ovary cutting.
- If appropriate, the personnel performing the abdominal incision should be different from that in charge of cutting the ovaries.

20.4

Cutting ovaries into small pieces and sieving (Processing Step 4)

Potential hazards: [microbiological contamination](#)

Potential defects: [physical damage to the eggs, off flavour and off odour, eggs with bad consistency](#)

Technical guidance:

- Prior to cutting into small pieces, ovaries may be placed in cold potable or clean water or cold potable or clean water with added salt to improve consistency.
- To prevent microbial contamination:
 - all caviar processing steps should be performed in areas set apart from belly cutting and gutting areas;
 - all utensils and work surfaces may be cleaned and disinfected using agents that will not affect the flavour or odour of the eggs;
 - staff should be trained and have appropriate experience in cutting and sieving; and
 - sieves should be washable and made from suitable material; mesh size should match egg size.
- Ovaries should be cut into small pieces to improve the sieving process and reduce friction among eggs.

- Sieving should be performed in a manner that minimizes damage to the eggs to the extent possible while removing ovary follicles and other undesirable matter (fat and blood).
- The ambient temperature and duration of exposure to the ambient temperature should be controlled and monitored to prevent microbial growth.

20.5

Laying induction (Processing Step 5)

Potential hazards: chemical contamination (residues of veterinary drugs), use of unapproved drugs

Potential defects: quality deterioration

Technical guidance:

- If hormones are used to induce ovulation (or to assist in the release of eggs), the hormones should have undergone regulatory assessment and be approved for use for the purpose of food production by the competent authorities having jurisdiction.
- Hormone dosage and treatment time should be applied in accordance with fish size and manufacturer's instructions.
- Eggs should only be harvested after the appropriate withdrawal period following hormone injection has passed.

20.6

Anaesthesia for large fish (Processing Step 6)

Potential hazards: chemical contamination (residues of veterinary drugs), use of unapproved drugs

Potential defects: physical damage to the eggs, off flavour and off odour, quality deterioration

Technical guidance:

- If electric shock is used, skilled personnel should administer correct voltage to minimize stress to fish and physical damage to eggs.
- If anaesthetics are used, they must be approved by the competent authorities having jurisdiction for use in sturgeon intended for human consumption.
- Anaesthetic dosage and treatment time should be applied in accordance with fish size and the manufacturer's instructions.
- Refer to Section 6.3.2.

20.7

Microcaesarean or hand-stripping (Processing Step 7)

Potential hazards: microbiological contamination

Potential defects: physical damage to the eggs, foreign matter, off flavour and off odour

Technical guidance:

- Prior to cutting, the belly area should be appropriately brushed and washed with potable or clean water to remove all foreign matter (e.g. sand, blood) and reduce microbial load.

- Cleaning and disinfection agents used on hands and equipment should not affect the flavour or odour of eggs.
- Belly-cutting and the extraction of the eggs should be done by skilled personnel to minimize contamination with fish guts and faecal matter and reduce physical damage to the eggs.
- Hand-stripping should be performed gently taking into account the anatomical position and direction of the oviduct in order to release the eggs quickly.

20.8

Treatment of eggs by shell improving methods (Processing Step 8)

Potential hazards: chemical contamination (e.g. use of texturizing agents), microbiological contamination, drug residue

Potential defects: damage to the egg texture, off flavour and off odour, quality deterioration

Technical guidance:

- Shell texturizing agents are not permitted in accordance with Section 4 of the *Standard for Sturgeon Caviar* (CXS 291-2010)
- Eggs should be treated with shell improving methods in such a manner as to avoid chemical or microbiological contamination or growth, damage to the eggs, modification of their flavour or odour, or deterioration in their quality.

20.9

Washing and draining the eggs (Processing Step 9)

Potential hazards: microbiological and chemical contamination

Potential defects: quality deterioration (damage to texture, off flavours and off odours), residues of undesirable matter (fat, blood and ovary remnant).

Technical guidance:

- The water used for washing the eggs should be potable or clean, free of any off odour or flavour, and sufficiently cold to prevent any loss in texture quality. Salt may be added to the water in order to prevent water uptake by the eggs.
- The eggs should be washed until they are free of all foreign matter.
- The eggs should be drained using a sieve to remove water that may impact the final weight at packaging.
- Draining should be performed in a chilled cold room or in a temperature-controlled environment away from any source of contamination.

20.10

Ingredients reception (Processing Step 10)

Potential hazards: [microbiological, chemical and physical contamination \(impurities\), non-permitted additives](#)

Potential defects: [quality deterioration, foreign matter](#)

Technical guidance:

- Refer to Section 9.5.1.
- Additives should be used in compliance with requirements mentioned in Section 4 of the *Standard for Sturgeon Caviar* (CXS 291-2010).
- The ingredients should be inspected to ensure that they are clean and show no visible sign of contamination with dirt, oil or other extraneous materials.
- Ingredients should be sourced from reliable suppliers, received with appropriate documentation about their composition and verified against the specifications requested.
- Salt used for caviar should comply with the *Standard for Food Grade Salt* (CXS 150-1985).
- Salt impurities such as magnesium (Mg²⁺) and calcium (Ca²⁺) can affect the taste of the caviar and the penetration of sodium chloride into the eggs.
- Granule size of salt crystals and permitted additives should be tiny to allow for rapid dissolution and absorption into the eggs and to prevent damage to the eggs.

20.11

Ingredient storage (Processing Step 11)

Potential hazards: [microbiological, chemical and physical contamination](#)

Potential defects: [loss of effectiveness, moisture absorption, dust and foreign matter.](#)

Technical guidance:

- Refer to section 9.5.2.
- Salt and additives should be packed and protected from chemical pollutants and foreign matter, such as dust, that may affect safety, odour and other sensory characteristics.
- Suitable procedures and controls should be in place to prevent exposure of ingredients to insects and pests.
- Storage area and packaging materials used for additives and salt should comply with Section 3.
- All stored additives and salt should be kept with labels with the name, expiry date and storage requirements.

20.12

Packaging reception (Processing Step 12)

Potential hazards: microbiological, chemical and physical contamination

Potential defects: improper quality of packaging materials (material, paint coating, construction, sealing, corrosion). Inaccurate or misleading label information, contaminated packaging materials, foreign matter inclusion.

Technical guidance:

- Refer to Section 9.5.1.
- All packaging materials such as metal or plastic cans, glass jars and rubber bands should be resistant to the components of caviar, especially salt and additives, and able to preserve the product throughout its shelf-life without any quality loss.
- All packaging materials should be verified prior to use by trained personnel to ensure that specifications are met and absence of damage or contamination.
- Any non-compliant items should be rejected and all corrective measures recorded.
- Prior to their application, labels should be verified to ensure that all information declared meets, where applicable, the *General Standard for the Labelling of Prepackaged Foods* (CXS 1 - 1985) and labelling provisions of the *Standard for Sturgeon Caviar* (CXS 291-2010).
- Packaging materials and labels should be sourced from reliable suppliers and accompanied by appropriate documentation on the specifications and composition.

20.13

Packaging storage (Processing Step 13)

Potential hazards: microbiological, chemical and physical contamination

Potential defects: quality deterioration, physical damage, foreign matter inclusion

Technical guidance:

- Refer to Section 9.5.2.
- Packaging materials and labels should be stored in dry and clean area to avoid any chemical and microbial contamination.
- Storage area should be clean and free of insects and pests.
- Trained personnel should periodically monitor the storage environment and records should be kept.

20.14

Cleaning of packaging materials (Processing Step 14)

Potential hazards: [microbiological, chemical and physical contamination](#)

Potential defects: [damage of containers](#)

Technical guidance:

- The cleanliness, integrity and safety of packaging materials should be monitored prior to use to prevent cross-contamination of the caviar.
- Cleaning and disinfection should be performed outside of the processing area. Controls should be performed at the reception step and related records should be checked.
- Packaging materials should be cleaned and disinfected by trained personnel using potable or clean water and permitted detergents and disinfectants.
- The effectiveness of the cleaning and disinfection of packaging materials should be validated and revalidated after any changes to procedures (e.g. change of disinfectants, cleaners).

20.15

Blending and grading (Processing Step 15)

Potential hazards: [microbiological and physical contamination \(e.g. glass and metal inclusion\)](#)

Potential defects: [foreign matter, additive misuse](#)

Technical guidance:

- The quantity or weight of eggs, salt and, as applicable, additives should be measured adequately with calibrated equipment to ensure that the appropriate percentage of salt and additives are met.
- Additives should be used in compliance with the *Standard for Sturgeon Caviar* (CXS 291-2010).
- Additives should be used in accordance with good manufacturing practices in compliance with Section 3 of the *General Standard for Food Additives* (CXS 192-1995).
- Ingredients should be verified prior to use to ensure they are free from hazardous glass or other foreign matter.
- To prevent the growth of and toxin production by non-proteolytic *Clostridium botulinum*, the quantity of salt added should result in at least 5 percent water phase salt or a water activity of < 0.97.
- The ingredients and additives should be blended uniformly with the eggs.
- The ambient temperature and humidity and the duration of exposure to the ambient temperature should be controlled and monitored to ensure they do not affect the homogeneous distribution of ingredients and additives and to prevent microbial growth.
- Grading and blending should be done by trained personnel.

20.16

Extra saltwater removal (Processing Step 16)

Potential hazards: microbiological contamination

Potential defects: quality deterioration due to improper saltwater removal

Technical guidance:

- Extra saltwater removal (sieving) should be done in such a manner as not to damage caviar quality.
- Extra saltwater removal should be performed by trained personnel.
- The salt content of final product should be equal to or above 3g/100g and below or equal to 5g/100g (≥ 5 percent in the water phase or a water activity of <0.97).
- The ambient temperature and duration of exposure to the ambient temperature should be controlled and monitored to prevent microbial growth.

20.17

Caviar packaging (Processing Step 17)

Potential hazards: microbiological contamination

Potential defects: oxidation, physical damage, off flavour, egg discoloration due to corrosion of container's epoxy coatings, improper coding, rusting

Technical guidance:

- All packaging materials should be verified prior to use to ensure that they are not contaminated and are free of physical damage. These materials should be dry.
- The cans/jars should be filled to capacity to minimize the air space but should not put pressure on the caviar.
- Vacuum application and sealing of cans or jars should be performed by trained personnel to ensure that air is fully removed from cans/jars to inhibit the growth of aerobic microorganisms as well as fat oxidation.
- During the vacuum sealing process, the cans/jars should be kept clean of the saltwater removed from the cans/jars.
- The ambient temperature and duration of exposure to the ambient temperature should be controlled and monitored to minimize microbial growth by maintaining caviar temperature ≤ 4 °C.
- The primary coding should be verified by trained personnel to ensure that it is legible, accurate and permanent.

20.18

Cooling and maturation (Processing Step 18)

Potential hazards: [microbiological contamination](#)

Potential defects: [decomposition, quality deterioration](#)

Technical guidance:

- Packaged caviar should be stored in an appropriate manner prior to final cold storage (e.g. in a refrigerator at a temperature between 2 °C and 4 °C for 24 hours) upon packaging to facilitate salt absorption, equilibrium and maturation (equal salt distribution in caviar, giving enough time for saltwater removal) and to minimize microbial growth.
- Laboratory checks should be performed for proper caviar salt content (e.g. by water phase salt determination or by water activity measurement and weight as appropriate) after maturation is complete.
- The cooling system should be cleaned and equipped with a thermometer and thermograph to frequently monitor and record caviar temperature.
- The cooling system should be frequently calibrated to ensure accuracy and efficiency.

20.19

Pasteurization (optional step) (Processing Step 19)

Potential hazards: [microbiological contamination](#)

Potential defects: [taste and flavour change, hardening of caviar grains](#)

Technical guidance:

- The pasteurization process should be performed and monitored by trained personnel to ensure process specifications are followed and the equipment is functioning appropriately.
- The containers should be sealed hermetically prior to pasteurizing in order to prevent post-processing contamination.
- Caviar cans/jars should be cooled to lower temperature (0 °C to 4 °C) immediately after pasteurization to prevent germination, growth and toxin production of spore-forming microorganisms and prolonged heating of proteins that may affect taste or texture.
- Pasteurization time and temperature should be determined in relation to can/jar volume, shape and material, as well as weight of caviar in cans and the type of pasteurization equipment used so as to ensure the required temperature is applied on the caviar for a suitable period of time.
- All thermal equipment and monitoring devices should be regularly checked and calibrated based on a schedule to ensure accuracy.

20.20

Weighing and labelling (Processing Step 20)

Potential hazards: unlikely

Potential defects: incorrect labelling and weighing

Technical guidance:

- Information printed on the labels should be in compliance with the *General Standard for the Labelling of Prepackaged Foods* (CXS 1-1985) and the *Standard for Sturgeon Caviar* (CXS 291-2010).
- The cans/jars should be weighed to ensure the quantity of caviar meets the weight declared on the label.
- Net weight, refrigeration instructions and a maximum shelf-life for caviar should be clearly labelled.
- Caviar cans/jars should not be described or presented on any label in a manner that is false or misleading to consumers.
- Labels should be monitored for accuracy by trained personnel.

20.21

Cold storage (Processing Step 21)

Potential hazards: microbiological contamination

Potential defects: freezing, decomposition and quality deterioration

Technical guidance:

- The product should be held at cold storage temperatures between -4°C and 0°C . Care should be taken to avoid temperatures below -5°C , which will cause freezing and quality deterioration. Normally freezing or frozen storage are not permitted, unless it can be demonstrated that quality deterioration is avoided.
- The caviar cold storage room should be cleaned and disinfected based on a continuous cleaning and disinfection schedule.
- The chilled storage facility should have a temperature-monitoring device and preferably a continuous recording unit to monitor and record ambient temperatures properly.
- The temperature-monitoring system should be equipped with an alarm to alert of any fluctuations outside of the permitted range.
- All time/temperature monitoring and record systems should be calibrated regularly through a permanent schedule to ensure accurate and precise performance.
- Containers of caviar should be periodically checked for loss of vacuum or can corrosion; any affected containers should be rejected.

20.22

Repackaging (Processing Step 22)

Refer to Sections 20.17 and 20.20.

20.23

Transportation and distribution (Processing Step 23)

Potential hazards: [microbiological contamination](#)

Potential defects: [decomposition, physical damage to the caviar cans/jars](#)

Technical guidance:

- Refer to Section 21.
- Proper handling and vehicle specifications should be ensured to prevent physical damage to caviar cans/jars.
- Caviar temperature should be monitored during loading to ensure it remains between -4 °C and 0 °C.
- The temperature of vehicle storage cabin should be maintained between -4 °C and 0 °C.
- The duration of caviar exposure to surrounding temperatures above 2 °C should be monitored to prevent temperature abuse and pathogen growth.
- Products should be transported in a way that allows cool air to circulate easily around cans/jars and that protects them from physical damage.
- The product cabin should be completely insulated and subject to regular cleaning and disinfection.
- The storage cabin should be equipped with a thermometer and a thermo-graph to frequently monitor and record the storage temperature.
- Handling should be done by trained personnel.







21

Transportation

Refer to the *General Principles of Food Hygiene* (CXC 1-1969) Section VIII – Transportation, and the *Code of Hygienic Practice for the Transport of Food in Bulk and Semi-Packed Food* (CXC 47-2001).

Transportation applies to all sections and is a step of the flow diagram that needs specific skills. It should be considered with the same care as the other processing steps. This Section provides examples of potential hazards and defects and describes technological guidelines that can be used to develop control measures and corrective action. At any particular step, only the hazards and defects that are likely to be introduced or controlled at that step are listed. It should be recognized that in preparing a Hazard Analysis Critical Control Point (HACCP)³⁸ and/or defect action point (DAP) plan it is essential to consult Section 5, which provides guidance on the application of the principles of HACCP and DAP analysis. However, it is not possible within the scope of this Code to give details of critical limits, monitoring, record-keeping and verification for each step as such information is specific to any particular hazard or defect.

It is particularly important throughout the transportation of fresh, frozen or refrigerated fish, shellfish or products thereof that care be taken to minimize any rise in temperature of the product and that the chilled or frozen temperature, as appropriate, be maintained under controlled conditions. Moreover, appropriate measures should be applied to minimize damage to products and their packaging.

21.1

For fresh, refrigerated and frozen products

Refer to Section 3.6 and Section 10.3 for fish at risk of scombrototoxin formation.

Potential hazards: [scombrototoxin](#), [microbiological contamination](#)

Potential defects: [decomposition](#), [physical damage](#),
[chemical contamination \(fuel\)](#)

Technical guidance:

- Check product temperature before loading.
- Avoid unnecessary exposure to elevated temperatures during loading and unloading of fish, shellfish and their products.
- Load in such a way as to ensure a good air-flow between product and wall, floor and roof panels; load stabilizer devices are recommended.
- Monitor air temperatures inside the cargo hold during transportation; the use of a recording thermometer is recommended.

³⁸ Refer to Annex II for a comprehensive list of the acronyms used in this Code.

- During transportation:
 - Frozen products should be maintained at $-18\text{ }^{\circ}\text{C}$ or below (maximum fluctuation $+3\text{ }^{\circ}\text{C}$).
 - Fresh fish, shellfish and their products should be kept at a temperature as close as possible to $0\text{ }^{\circ}\text{C}$. Fresh whole fish should be kept in shallow layers and surrounded by finely divided melting ice; adequate drainage should be provided in order to ensure that water from melted ice does not remain in contact with the products or meltwater from one container does not cross-contaminate products in other containers.
 - Transportation of fresh fish in containers with dry freezer bags instead of ice should be considered where appropriate.
 - Transportation of fish in an ice slurry, chilled seawater or refrigerated seawater (e.g. for pelagic fish) should be considered where appropriate. Chilled seawater or refrigerated seawater should be used under approved conditions.
 - Refrigerated processed products should be maintained at the temperature specified by the processor but generally should not exceed $4\text{ }^{\circ}\text{C}$.
 - Provide fish, shellfish and their products with adequate protection against contamination from dust, exposure to higher temperatures and the drying effects of the sun or wind.

21.2

For live fish and shellfish

Refer to the provisions in the relevant sections of the Code.

21.3

For canned fish and shellfish

Refer to the relevant specific provisions in Section 18.

21.4

For all products

-
- Before loading, the cleanliness, suitability and sanitation of the cargo hold of the vehicles should be verified.
 - Loading and transportation should be conducted in such a way as to avoid damage to or contamination of the products and to ensure the integrity of packaging.
 - After unloading, the accumulation of waste should be avoided and any waste should be disposed of in a proper manner.





22

Retail



In the context of recognizing controls at individual processing steps, this Section provides examples of potential hazards and defects and describes technological guidelines that can be used to develop control measures and corrective action. At any particular step, only the hazards and defects that are likely to be introduced or controlled at that step are listed. It should be recognized that in preparing a Hazard Analysis Critical Control Point (HACCP)³⁹ and/or defect action point (DAP) plan it is essential to consult Section 5, which provides guidance on applying the principles of HACCP and DAP analysis. However, within the scope of this Code, it is not possible to give details of critical limits, monitoring, record-keeping and verification for each of the steps as these are specific to particular hazards and defects.

Fish, shellfish and their products at retail should be received, handled, stored and displayed to consumers in a manner that minimizes potential food safety hazards and defects and maintains essential quality. Consistent with the HACCP and DAP approaches to food safety and quality, products should be purchased from known or approved sources under the control of competent health authorities that can verify HACCP controls. Retail operators should develop and use written purchase specifications designed to ensure food safety and desired quality levels. Retail operators should be responsible for maintaining quality and safety of products.

Proper storage temperature after receipt is critical to maintain product safety and essential quality. Chilled products should be stored in a hygienic manner at temperatures less than or equal to 4 °C (40 °F), modified atmosphere packaging (MAP) products at 3 °C (38 °F) or below, and frozen products at temperatures less than or equal to -18 °C (0 °F).

Preparation and packaging should be carried out in a manner consistent with the principles and recommendations found in Section 3. Products in an open full display should be protected from the environment, for example, by the use of display covers (sneeze guards). At all times, displayed seafood items should be held at temperatures and in conditions that minimize the development of potential bacterial growth, toxins and other hazards in addition to loss of essential quality.

Consumer information at the point of purchase, for example, placards or brochures that inform consumers about storage, preparation procedures and potential risks of seafood products if mishandled or improperly prepared, is important to ensure that product safety and quality are maintained.

A system of tracking the origin and codes of fish, shellfish and their products should be established to facilitate product recall or public health investigations in the event of the failure of preventative health protection processes and measures. These systems exist for molluscan shellfish in some countries in the form of molluscan shellfish tagging requirements.

39 Refer to Annex II for a comprehensive list of acronyms used in this Code..

22.1

Reception of fish, shellfish and their products at retail – general considerations

Potential hazards: see Sections 7.1 and 9.1

Potential defects: see Sections 7.1 and 9.1

Technical guidance:

- The transport vehicle should be examined for overall hygienic condition. Products subject to filth, taint or contamination should be rejected.
- The transport vehicle should be examined for possible cross-contamination of ready-to-eat fish and fishery products by raw fish and fishery products: it should be determined that cooked-ready-to-eat product has not been exposed to raw product, juices or live molluscan shellfish and that raw molluscan shellfish have not been exposed to other raw fish or shellfish.
- Seafood should be regularly examined for adherence to purchasing specifications.
- All products should be examined for decomposition and spoilage at receipt. Products exhibiting signs of decomposition should be rejected.
- When a log of the cargo-hold temperature for the transport vehicle is kept, records should be examined to verify adherence to temperature requirements.

22.1.1

Reception of chilled products at retail

Potential hazards: microbiological contamination, chemical and physical contamination, scombrototoxin formation, *C. botulinum* toxin formation

Potential defects: spoilage (decomposition), contaminants, filth

Technical guidance:

- Product temperature should be taken from several locations in the shipment and recorded. Chilled fish, shellfish and their products should be maintained at or below 4 °C (40 °F). MAP product, if not frozen, should be maintained at or below 3 °C (38 °F).
- For fish susceptible to scombrototoxin formation, retailers should ensure that fish are purchased from suppliers that use HACCP or similar control systems to prevent histamine formation. In case the fish being received are likely to be susceptible to scombrototoxin formation, retailers should evaluate if fish are surrounded by ice or other cooling media, measure fish internal temperatures when appropriate, and perform sensory evaluation of representative fish samples before accepting delivery.

22.1.2

Reception of frozen products at retail

Potential hazards: unlikely

Potential defects: thawing, contaminants, filth

Technical guidance:

- Incoming frozen seafood should be examined for signs of thawing and evidence of filth or contamination, and suspect shipments rejected.

- Incoming frozen seafood should be checked for internal temperatures, taken and recorded from several locations in the shipment. Frozen fish, shellfish and their products should be maintained at or below -18 °C (0 °F).

22.1.3

Chilled storage of products at retail

Potential hazards: scombrototoxin formation, microbiological contamination, chemical contamination, *C. botulinum* toxin formation

Potential defects: decomposition, contaminants, filth

Technical guidance:

- Products in chilled storage should be held at 4 °C (40 °F). MAP product should be held at 3 °C (38 °F) or below.
- Seafood should be properly protected from filth and other contaminants through proper packaging and stored off the floor.
- A continuous temperature-recording chart for seafood storage coolers is recommended.
- The cooler room should have proper drainage to prevent product contamination.
- Ready-to-eat items and molluscan shellfish should be kept separate from each other and other raw food products in chilled storage. Raw product should be stored on shelves below cooked product to avoid cross-contamination from drips.
- A proper product rotation system should be established. Such a system could be based on first-in, first-out usage, production date or “best before” date on labels, or sensory quality of the lot, as appropriate.

22.1.4

Frozen storage of products at retail

Potential hazards: unlikely

Potential defects: chemical decomposition (rancidity), dehydration

Technical guidance:

- Product should be maintained at -18 °C (0 °F) or below. Regular temperature monitoring should be carried out. A recording thermometer is recommended.
- Seafood products should not be stored directly on the floor. Product should be stacked to allow proper air circulation.

22.1.5

Preparation and packaging chilled products at retail

Refer to Section 9.2.3.

Potential hazards: microbiological contamination, scombrototoxin formation, physical and chemical contamination, allergens

Potential defects: decomposition, incorrect labelling

Technical guidance:

- Care should be taken to ensure that handling and packaging of products is conducted in accordance with the guidelines in Section 3.
- Care should be taken to ensure that labelling is in accordance with the guidelines in Section 3 and Codex labelling standards, especially for known allergens.
- Care should be taken to ensure that product is not subjected to temperature abuse during packaging and handling.
- Care should be taken to avoid cross-contamination between ready-to-eat and raw shellfish or between shellfish and their products in the work areas or via utensils or personnel.

22.1.6

Preparation and packaging of frozen seafood at retail

Refer to Section 9.2.3.

Potential hazards: [microbiological contamination](#), [chemical or physical contamination](#), [allergens](#)

Potential defects: [thawing](#), [incorrect labelling](#)

Technical guidance:

- Care should be taken to ensure that allergens are identified in accordance with Section 3 and Codex labelling standards.
- Care should be taken to avoid cross-contamination of ready-to-eat and raw products.
- Frozen seafood products should not be subjected to ambient room temperatures for a prolonged period of time.

22.1.7

Retail display of chilled seafood

Potential hazards: [scombrototoxin formation](#), [microbiological contamination](#), [C. botulinum toxin formation](#)

Potential defects: [decomposition](#), [dehydration](#)

Technical guidance:

- Products in chilled display should be kept at 4 °C (40 °F) or below. Temperatures of products should be taken at regular intervals.
- Ready-to-eat items and molluscan shellfish should be separated from each other and from raw food products in a chilled full-service display. A display diagram is recommended to ensure that cross-contamination does not occur.
- If ice is used, proper drainage of meltwater should be in place. Retail displays should be self-draining. Replace ice daily and ensure ready-to-eat products are not placed on ice upon which raw product has previously been displayed.
- Each commodity in a full-service display should have its own container and serving utensils to avoid cross-contamination.

- Care should be taken to avoid arranging product in such a large mass/depth that proper chilling cannot be maintained and product quality is compromised.
- Care should be taken to avoid drying of unprotected products in full-service displays. Use of an aerosol spray, under hygienic conditions, is recommended.
- Product should not be added above the “load line” where a chilled state cannot be maintained in self-service display cases of packaged products.
- Product should not be exposed to ambient room temperature for a prolonged period of time when filling/stocking display cases.
- Seafood in full-service display cases should be properly labelled by signs or placards to indicate the commonly accepted name of the fish so the consumer is informed about the product.

22.1.8

Retail display of frozen seafood


Potential hazards: unlikely

Potential defects: thawing, dehydration (freezer burn)

Technical guidance:

- Product should be maintained at $-18\text{ }^{\circ}\text{C}$ ($0\text{ }^{\circ}\text{F}$) or below. Regular temperature monitoring should be carried out. A recording thermometer is recommended.
- Product should not be added above the “load line” of cabinet self-service display cases. Upright freezer self-service display cases should have self-closing doors or air curtains to maintain a frozen state.
- Product should not be exposed to ambient room temperature for a prolonged period of time when filling/stocking display cases.
- A product rotation system to ensure first-in, first-out usage of frozen seafood should be established.
- Frozen seafood in retail displays should be examined periodically to assess packaging integrity and the level of dehydration or freezer burn.



A scientist with long brown hair, wearing a white lab coat over a light blue shirt, is working in a laboratory. The background is filled with shelves containing various laboratory equipment and containers. In the foreground, a piece of salmon is visible on a white surface. The text is overlaid on the right side of the image.

Annex I
Potential hazards
associated with
fresh fish, shellfish
and other aquatic
invertebrates

1.

Examples of possible biological hazards

1.1

Parasites

The parasites known to cause disease in humans and transmitted by fish or crustaceans are broadly classified as helminths or parasitic worms. These are commonly referred to as nematodes, cestodes and trematodes. Fish can be parasitized by protozoans, but there are no records of fish protozoan disease being transmitted to human beings. Parasites have complex life cycles involving one or more intermediate hosts and are generally passed to human beings through the consumption of raw, minimally processed or inadequately cooked products that contain the parasite infectious stage, causing food-borne disease. Freezing at $-20\text{ }^{\circ}\text{C}$ or below for seven days or $-35\text{ }^{\circ}\text{C}$ for about 20 hours for fish intended for raw consumption will kill parasites. Processes such as brining or pickling may reduce the parasite hazard if the products are kept in the brine for a sufficient time but may not eliminate it. Candling, trimming belly flaps and physically removing the parasite cysts will also reduce the hazards but may not eliminate them.

Nematodes

Many species of nematode are known to occur worldwide and some species of marine fish act as secondary hosts. Among the nematodes of greatest concern are *Anisakis* spp., *Capillaria* spp., *Gnathostoma* spp., and *Pseudoterranova* spp., which can be found in the liver, belly cavity and flesh of marine fish. An example of a nematode causing disease in human beings is *Anisakis simplex*; the infective stage of the parasite is killed by heating ($60\text{ }^{\circ}\text{C}$ for one minute) and by freezing ($-20\text{ }^{\circ}\text{C}$ for 24 hours) of the fish core.

Cestodes

Cestodes are tapeworms and the species of greatest concern associated with the consumption of fish is *Dibothriocephalus latus*. This parasite occurs worldwide and both fresh and marine fish are intermediate hosts. Similar to other parasitic infections, the foodborne disease occurs through the consumption of raw or under-processed fish. Similar freezing and cooking temperatures as applied to nematodes will kill the infective stages of this parasite.

Trematodes

Fish-borne trematode (flatworm) infections are a major public health problem endemic to approximately 20 countries around the world. The most significant species in terms of the number of people infected belong to the genera *Clonorchis* and *Ophisthorchis* (liver flukes), *Paragonimus* (lung flukes), and, to a lesser extent, *Heterophyes* and *Echinochasmus* (intestinal flukes). The most important definitive hosts of these trematodes are human beings or other mammals. Freshwater fish are the second intermediate host in the life cycles of *Clonorchis* and *Ophisthorchis*, and freshwater crustaceans in the case of *Paragonimus*. Foodborne infections occur through the consumption of raw, undercooked or otherwise under-processed products containing the infective stages of these parasites. Freezing fish at $-20\text{ }^{\circ}\text{C}$ for seven days or at $-35\text{ }^{\circ}\text{C}$ for 24 hours will kill the infective stages of these parasites.

1.2

Bacteria

The level of contamination in fish at the time of capture will depend on the environment and the bacteriological quality of the water in which fish are harvested. Many factors influence the microflora of finfish, the most important being water temperature, salt content, proximity of harvesting areas to human habitations, quantity and origin of food consumed by fish, and method of harvesting. The edible muscle tissue of finfish is normally sterile at the time of capture and bacteria are usually present on the skin, gills and in the intestinal tract.

There are two broad groups of bacteria of public health importance that may contaminate products at the time of capture: (i) those normally or incidentally present in the aquatic environment, referred to as indigenous microflora; and (ii) those introduced through environmental contamination by domestic and/or industrial wastes. Examples of indigenous bacteria that may pose a health hazard are *Aeromonas hydrophila*, *Clostridium botulinum*, *Vibrio parahaemolyticus*, *Vibrio cholerae*, *Vibrio vulnificus* and *Listeria monocytogenes*. Non-indigenous bacteria of public health significance include members of the Enterobacteriaceae, such as *Salmonella* spp., *Shigella* spp. and *Escherichia coli*. Other species that cause foodborne illness and that have occasionally been isolated from fish are *Edwardsiella tarda*, *Plesiomonas shigelloides* and *Yersinia enterocolitica*. *Staphylococcus aureus* may also appear and may produce heat-resistant toxins.

Indigenous pathogenic bacteria, when present on fresh fish, are usually found in fairly low numbers, and food safety hazards are insignificant where products are adequately cooked prior to consumption. During storage, indigenous spoilage bacteria will outgrow indigenous pathogenic bacteria, thus fish will spoil before becoming toxic and will be rejected by consumers. Hazards from these pathogens can be controlled by heating seafood sufficiently to kill the bacteria, holding fish at chilled temperatures and avoiding post-process cross-contamination.

Vibrio species are common in coastal and estuarine environments and populations can depend on water depth and tidal levels. They are particularly prevalent in warm tropical waters and can be found in temperate zones during summer months. *Vibrio* species are also natural contaminants of brackish-water tropical environments and will be present on farmed fish from these zones. Hazards from *Vibrio* spp. associated with finfish can be controlled by thorough cooking and preventing cross-contamination of cooked products. Health risks can also be reduced by rapidly chilling products after harvest, thus reducing the possibility of proliferation of these organisms. Certain strains of *Vibrio parahaemolyticus* can be pathogenic.

1.3

Viral contamination

Molluscan shellfish harvested from inshore waters that are contaminated by human or animal faeces may harbour viruses that are pathogenic to human beings. Enteric viruses that have been implicated in seafood-associated illness are the hepatitis A virus, caliciviruses, astroviruses and the norovirus. The latter three are often referred to as small round structured viruses. All of the seafood-borne viruses causing illness are transmitted by the faecal-oral cycle and most viral gastro-enteritis outbreaks have been associated with eating contaminated shellfish, particularly raw oysters.

Generally, viruses are species-specific and will not grow or multiply in foods or anywhere outside the host cell. There is no reliable marker for indicating the presence of viruses in shellfish harvesting waters. Seafood-borne viruses are difficult to detect, requiring relatively sophisticated molecular methods to identify the virus.

Occurrence of viral gastro-enteritis can be minimized by controlling sewage contamination of shellfish-farming areas and pre-harvest monitoring of shellfish and growing waters as well as controlling other sources of contamination during processing. Depuration and relaying are alternative strategies, but longer periods are required for shellfish to purge themselves clean of viral contamination than of bacteria. Thermal processing (85–90 °C for 1.5 minutes) will destroy viruses in shellfish.

1.4

Biotoxins

There are a number of important biotoxins to consider. About 400 poisonous fish species exist and, by definition, the substances responsible for the toxicity of these species are biotoxins. The poison is usually limited to some organs or is restricted to some periods during the year.

For some fish, the toxins are present in the blood; these are ichthyohaemotoxin. The species concerned are eels from the Adriatic Sea, moray eels and lampreys. In other species, the toxins are spread all over the tissues (flesh, viscera, skin); these are ichthyosarcotoxins. The tetrodotoxic species responsible for several poisonings, often lethal, are in this category.

In general, these toxins are known to be heat stable and the only possible control measure is to check the identity of the species used.

Phycotoxins

Ciguatoxin

Another important toxin to consider is ciguatoxin, which can be found in a wide variety of mainly carnivorous fish inhabiting shallow waters in or near tropical and subtropical coral reefs. The source of this toxin is dinoflagellates and more than 400 species of tropical fish have been implicated in intoxication. The toxin is known to be heat stable. There is still much to be learned about this toxin, and the only control measure that can reasonably be taken is to avoid marketing fish that have a known consistent record of toxicity.

PSP/DSP/NSP/ASP

Paralytic shellfish poison (PSP), diarrhetic shellfish poison (DSP), neurotoxic shellfish poison (NSP) and amnesic shellfish poison (ASP) complexes are produced by phytoplankton. They concentrate in bivalve molluscan shellfish, which filter the phytoplankton from the water, and may also concentrate in some fish and crustaceans.

Generally, the toxins remain toxic through thermal processing, hence, knowledge of the species identity and/or origin of fish or shellfish intended for processing is important.

Tetrodotoxin

Some fish species, mainly belonging to the family *Tetraodontidae* (“puffer fishes”), may accumulate this toxin, which is responsible for several poisonings,

often lethal. The toxin is generally found in the fish liver, roe and guts, and less frequently in the flesh. Unlike most other fish biotoxins that accumulate in live fish or shellfish, algae do not produce this toxin. The mechanism of toxin production is still not clear. However, there are often indications of the involvement of symbiotic bacteria.

1.5

Scombrototoxin

Scombroid intoxication, sometimes referred to as histamine poisoning or scombrototoxin fish poisoning, results from eating fish that have been incorrectly chilled during and/or after harvesting. Scombrototoxin is attributed mainly to bacteria in the Enterobacteriaceae family, which can produce high levels of histamine and other biogenic amines in the fish muscle when products are not immediately chilled after catching and retained in a chilled state. The main susceptible fish are the scombroids such as tuna, mackerel and bonito, although it can be found in other fish families such as Clupeidae, Engraulidae, Coryphaenidae, Pomatomidae, Scomberesocidae. The intoxication is rarely fatal and symptoms, while typically mild, can be severe. Rapid refrigeration after catching and a high standard of handling during processing should prevent the development of the toxin. The toxin is not inactivated by heat processing. In addition, fish may contain toxic levels of histamine without exhibiting any of the usual sensory parameters, characteristic of spoilage.

2. Chemical hazards

Fish may be harvested from coastal zones and inland habitats that are exposed to varying quantities of environmental contaminants. Of greatest concern are fish harvested from coastal and estuarine areas rather than fish harvested from the open seas. Chemicals, organochloric compounds and heavy metals may accumulate in products that can cause public health problems. Veterinary drug residues can occur in aquaculture products when correct withdrawal times are not followed or when the sale and use of these compounds are not controlled. Fish can also be contaminated with chemicals such as diesel oil (when incorrectly handled) and detergents or disinfectants (when not properly rinsed off).

3. Physical hazards

These can include materials such as metal or glass fragments, shell and bones.

Annex II

List of acronyms

ASP	amnesic shellfish poisoning
AZP	poisoning caused by azaspiracid
CCP	critical control point
DAP	defect action point
DSP	diarrhetic shellfish poisoning
GMP	good manufacturing practice
HACCP	Hazard Analysis Critical Control Point
IQF	individually quick frozen
MAP	modified atmosphere packaging
MRL	maximum residue limit
NSP	neurotoxic shellfish poisoning
OIE	World Organization for Animal Health
PAH	polycyclic aromatic hydrocarbons
PSP	paralytic shellfish poisoning
RTE	ready-to-eat
TN	total nitrogen
TVBN	total volatile basic nitrogen





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