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# Code of practice for fish and fishery products

First edition

World Health Organization

Food and Agriculture Organization of the United Nations

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WORLD HEALTH ORGANIZATION

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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## THE CODEX ALIMENTARIUS COMMISSION

The Codex Alimentarius Commission is an intergovernmental body with more than 180 members, within the framework of the Joint Food Standards Programme established by the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO), with the purpose of protecting the health of consumers and ensuring fair practices in the food trade. The Commission also promotes coordination of all food standards work undertaken by international governmental and non-governmental organizations.

The *Codex Alimentarius* (Latin, meaning Food Law or Code) is the result of the Commission's work: a collection of internationally adopted food standards, guidelines, codes of practice and other recommendations. The texts in this publication are part of the Codex Alimentarius.

## CODE OF PRACTICE FOR FISH AND FISHERY PRODUCTS
## First edition

The *Code of practice for fish and fishery products* is intended for all those engaged in the handling, production, storage, distribution, export, import and sale of fish and fishery products. The Code will help in attaining safe and wholesome products that can be sold on national or international markets and meet the requirements of the Codex Standards. The Code is a work in progress and a number of appendixes remain under development. This first printed edition contains revisions to the texts adopted by the Codex Alimentarius Commission up to 2008.

Further information on these texts, or any other aspect of the Codex Alimentarius Commission, may be obtained from:

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# CODE OF PRACTICE FOR FISH AND FISHERY PRODUCTS

**CAC/RCP 52-2003**





Adopted 2003. Revisions 2004, 2005, 2007, 2008.

# CODE OF PRACTICE FOR FISH AND FISHERY PRODUCTS

**CAC/RCP 52-2003**

## INTRODUCTION

This *Code of practice for fish and fishery products* has been developed by the Codex Committee on Fish and Fishery Products from the merging of the individual codes listed in Appendix 12[1] plus a section on aquaculture and a section on frozen surimi. These 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. This Code also deals with the distribution and retail display of fish and fishery products.

This combined Code of Practice has been further modified to incorporate the Hazard Analysis Critical Control Point (HACCP) approach described in the *Recommended international code of practice – general principles of food hygiene* (CAC/RCP 1-1969), Annex: "Hazard Analysis and Critical Control Point (HACCP) system and guidelines for its application". A prerequisite programme is described in the Code 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 this Code, a similar systematic approach 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, i.e. 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. The Committee further recommended that this detail should be described in a section on Final Product Specifications, which now appear as Appendixes 2–11[1] of this document. A similar approach to HACCP has been incorporated into the Code as guidelines for the control of defects (DAP analysis).

This Code will assist all those who are engaged in the handling and production of fish and fishery products, or are 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 the Codex Standards (see Appendix 12[1]).

[1] Under development.

## How to use this Code

The aim of this Code is to provide a user-friendly document as background information and guidance for the elaboration of fish and shellfish process management systems that would incorporate good manufacturing practice (GMP) as well as the application of HACCP in countries where these, as yet, have not 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 with regard to *national* fisheries would, therefore, require some modifications and amendments, taking into account local conditions and specific consumer requirements. Therefore, this Code is not intended to replace the advice or guidance of trained and experienced technologists regarding the complex technological and hygienic problems that might be unique to a specific geographical area or specific fishery and, in fact, is intended to be used as a supplement in such instances.

This Code is divided into separate though interrelated sections. It is intended that in order to set up an HACCP or DAP programme, these should be consulted as appropriate:

(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 exists. This section covers the groundwork that should be regarded as 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 invertebrates* – This section provides an overall view 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 the fresh fish, shellfish and other aquatic invertebrates, and then it is up to the team to determine the significance of the 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 an example of the processing of a canned tuna product to help illustrate how the principles of HACCP should be applied to a process.

(e) *Sections 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.[2]

Although potential hazards and potential defects are listed for most steps in Sections 6–18, it should be noted that this is only for guidance and the consideration of other hazards

[2] Under development.

and/or defects may be appropriate. Also, the format in these sections has been designed for maximum "ease of use" and, therefore, the "potential hazards" or "potential defects" are listed only where they may be introduced into a product or where they are controlled, rather than repeating them at all the 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 8 – 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 the various steps. This section should be used as the basis for all the other processing operations (Sections 9–16), which give additional guidance specific to the appropriate product sector.[3]

(g) *Sections 9–16 – 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.[3]

(h) *Sections 17–18 – Transportation* and *Retail* cover general transportation and retail issues. Transportation and retail apply to most if not all sections for processing of specific products. They should be considered with the same care as the other processing steps.[3]

(i) Additional information will be found in the *Appendixes*.[3]

## SECTION 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.

## SECTION 2 – DEFINITIONS

For the purposes of this Code:

### 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 as may affect the health quality of fish, shellfish and their products.

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

[3] Under development.

***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 and their products

***Control measure*** Any action and 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 a DAP.

***Critical control point (CCP)*** 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 a DAP.

***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 a DAP.

***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 micro-organisms 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 and 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, or 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.

***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 a DAP.

***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 the HACCP plan. For the purposes of this Code, this also applies to a DAP.

***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 all 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 the live fish, its pathogens, the water, equipment used for production or the land within the aquaculture establishment.

***Colouring*** Obtaining 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 agency having 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 is dependent upon 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 that are 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, reaction products, and impurities considered to be of toxicological significance.

***Residues*** Any foreign substances, 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 of them 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 micro-organisms 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, 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 that is 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 °C (0 °F) or lower at the thermal centre after thermal stabilization.

***Frozen storage facility*** A facility that is 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* (CODEX STAN 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.

## 2.5 Frozen surimi

***Dewatering*** Removal of excessive 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 level of myofibrillar proteins thereof.

***Washed meat*** Fish meat that is washed and then drained of water.

## 2.6 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 a way so that the core remains frozen.

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

## 2.7 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 for 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*** A discoloration and a 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 2 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 2 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*** A 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 of these.

***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.

## 2.8 Crabs and lobsters

## 2.9 Smoked fish

## 2.10 Shrimps and prawns

***Dehead*** To remove the head from the whole shrimp or prawn.

***Deveined shrimps*** All the shrimps that have been peeled, the back of the peeled segments of the shrimps have been opened out and the gut ("vein") removed.

***Fresh shrimps*** Freshly caught shrimps that have received no preserving treatment or that 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.

## 2.11 Cephalopods

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

## 2.12 Canned fish and shellfish

For the purposes of this Code, only the definitions of the main terms related to canning industry and used in Section 13 are given. For an overall set of definitions, please refer to the *Recommended International Code of Hygienic Practice for low and acidified low acid canned foods* (CAC/RCP 23-1979).

***Canned food*** Commercially sterile food in hermetically sealed containers.

***Commercial sterility of thermally processed food*** The condition achieved by application of heat, sufficient, alone or in combination with other appropriate treatments, to render the food free from micro-organisms capable of growing in the food under normal non-refrigerated conditions at which the food is likely to be held during distribution and storage.

***Hermetically sealed containers*** Containers that are sealed to protect the content against the entry of micro-organisms 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 and is quantified in terms of time and temperature.

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

### 2.13 Transportation

### 2.14 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.

## SECTION 3 – PREREQUISITE PROGRAMME

Prior to the application of HACCP 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 within an individual establishment or for an individual vessel and will require monitoring and evaluation to ensure their continued effectiveness.

Reference should be made to the *Recommended International Code of Practice – general principles of food hygiene* (CAC/RCP 1-1969), Annex: Hazard Analysis and Critical Control Point (HACCP) system and guidelines for its Application for further information to assist with the design of the prerequisite programmes for a processing facility or vessel.

It should be noted that some of the issues listed below, e.g. those related to damage, are designed to maintain quality rather than food safety and are 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

There are many different types of fishing vessel used throughout the world. They have evolved in particular regions to take account of the prevailing economics, environment and types of fish and shellfish caught or harvested. This section attempts to highlight the basic requirements for cleanability, 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 in order to avoid dirt traps.
- Construction should facilitate ample drainage.
- A good supply of clean water or potable water[4] at adequate pressure.

### 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 buildup 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 located 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.;
  - offal and waste materials.
- Adequate hand washing and toilet facilities, isolated from the fish and shellfish handling areas, should be available where appropriate.

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

- 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.
- The fishing gear and its usage should minimize damage and deterioration to the 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 are 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 easily cleanable 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 is 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.$CO_2$, $O_2$, temperature and nitrogenous wastes).

## 3.2 Facility design and construction

The facility should include a product flow-through pattern that is 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. Therefore, the facility should 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 of corrosion-resistant, impervious material that is light-coloured, smooth and easily cleanable.

- 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 buildup of dirt and condensation, and the shedding of particles.
- Windows should be constructed to minimize the buildup of dirt and, where necessary, be 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 buildup 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 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 capable of coping with peak demands.
- 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.;
  - offal and waste materials.

- Adequate hand washing and toilet facilities, isolated from handling area, should be available.
- Prevent the entry of birds, insects or other pests and animals.
- Water supply lines should be fitted with back-flow devices, where appropriate.

3.2.3 **To provide adequate lighting**

- Adequate lighting should be provided to 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 buildup of residues and prevents them becoming a source of contamination.

The design and construction 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 designed and constructed to minimize sharp inside corners and projections and tiny crevices or gaps in order to avoid dirt traps.
- A suitable and adequate supply of cleaning utensils and cleaning agents, approved by the official agency having 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 buildup 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**

- Surfaces should have a minimum of sharp corners and projections.
- Chutes and conveyors should be designed to prevent physical damage caused by long drops or crushing.
- Storage equipment should be fit for the 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 needed will depend on the size of the operation and the nature of its activities.

Schedules should be implemented to:

- prevent the buildup of waste and debris;
- protect the 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;
- 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:

**Precleaning** 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 micro-organisms on surface.

**Post-rinse** As appropriate, a final rinse with potable water or clean water to remove all disinfectant residues.

**Storage** Cleaned and disinfected equipment, container and utensils should be stored in a fashion that would 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, and in 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 to be 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**

- An ample supply of cold and hot potable water[5] and/or clean water under adequate pressure should be provided where appropriate.
- Potable water[4] should be used wherever necessary to avoid contamination.

3.4.5.2 **Ice**

- Ice should be produced using potable water[4] 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.

[5] WHO *Guidelines for Drinking-water Quality,* Geneva, Switzerland.

- 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

Personal hygiene and facilities should be such to ensure that an appropriate degree of personal hygiene can be maintained in order to avoid contamination.

3.5.1 **Facilities and equipment**

Facilities and equipment should include:

- Adequate means of hygienically washing and drying 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, headcoverings 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;
  - immediately after using the toilet.
- The following should not be permitted in handling and processing areas:
  - smoking;
  - spitting;
  - chewing or eating;
  - sneezing or coughing over unprotected food;
  - 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 colder (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;
- 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 recall of 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 effect 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.
- Each container of fish, shellfish and their products intended for the final consumer or for further processing should be clearly marked to ensure 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.

Each fish and shellfish facility should ensure that individuals have received adequate and appropriate training in the design and proper application of an HACCP system and process control. Training of 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 of relevant employees in the facility so that they understand the principles involved in HACCP.

## SECTION 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 and other aquatic invertebrates should be accepted if they are known to contain parasites, undesirable micro-organisms, 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 being paid 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 micro-organisms. For species prone to scombrotoxin production, time and temperature control may be the most effective method for ensuring food safety. Therefore, it is essential that fresh fish, fillets, shellfish and their products that are to be chilled should be held at a temperature as close as possible to 0 °C.

#### 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.
- monitoring and controlling the time and temperature and homogeneity of chilling should be performed 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 in order 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. $CO_2$, $O_2$, 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 in order to prevent unnecessary dehydration.
- Finely divided ice should be used where possible; 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.

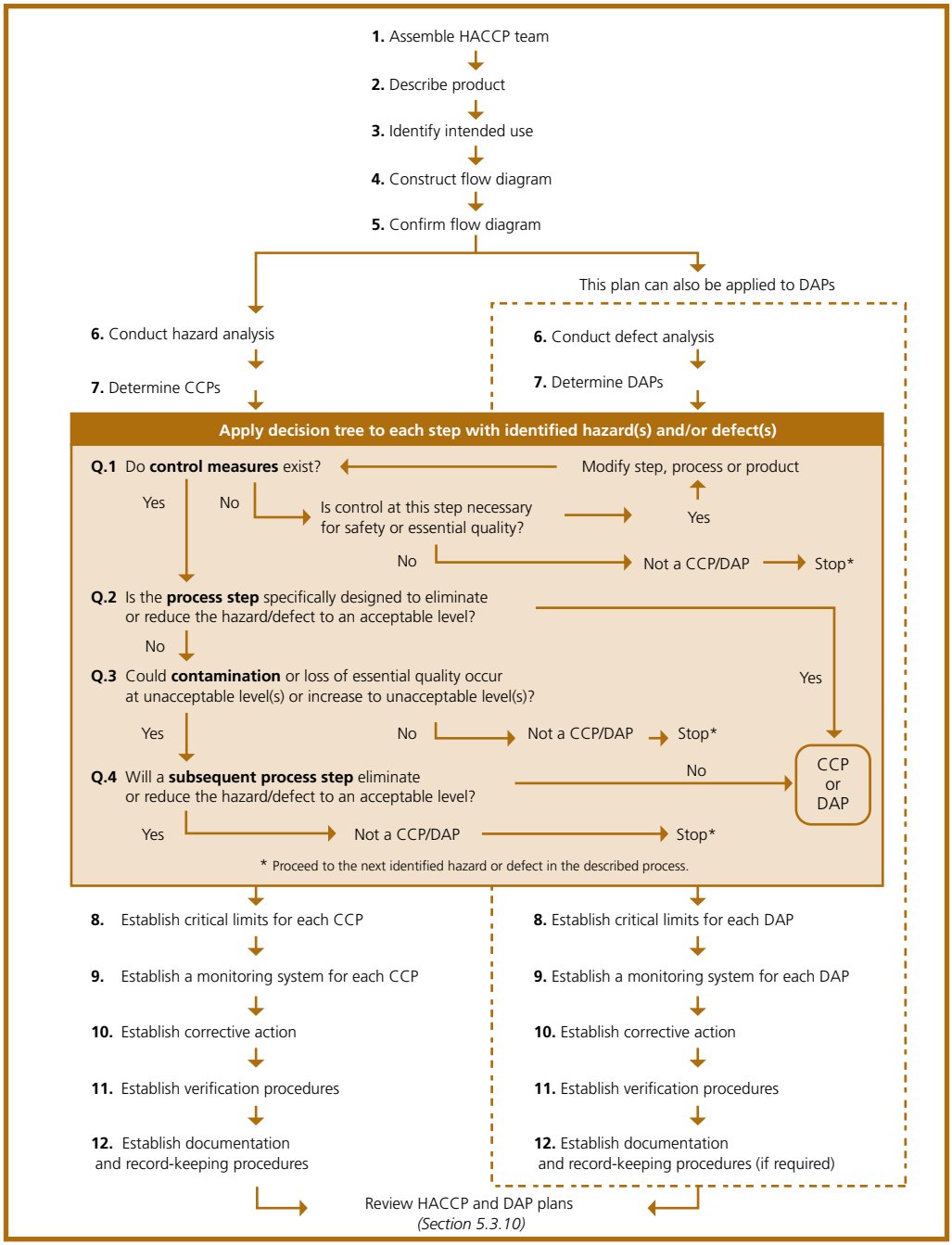
## SECTION 5 – HAZARD ANALYSIS AND CRITICAL CONTROL POINT (HACCP) AND DEFECT ACTION POINT (DAP) ANALYSIS

Hazard Analysis and Critical Control Point (HACCP) 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 the identification of specific hazards and the implementation of 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 aquaculture and molluscan shellfish production and to handling and processing, but the Code can only provide guidance on how to use these principles and offer suggestions as to the type of hazards that may occur in the various fishery products. The HACCP plan, which should be incorporated into the food management plan, should be well documented and be 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 for defect analysis is optional and other techniques that achieve the same objective may be considered.

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

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



## 5.1 HACCP principles

The HACCP system[6] 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.

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

As the Code is intended to cover not only those 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, not only are critical control points (CCPs) described but also defect action points (DAPs) are included in the Code. The HACCP principles may be applied to the determination of 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 to defects, both of which are described in this 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.

[6] *Recommended International Code of Practice – general principles of food hygiene* (CAC/RCP 1-1969), Annex: Hazard Analysis and Critical Control Point (HACCP) system and guidelines for its application.

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 consist of people 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 and, therefore, 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;
- whether the HACCP or DAP plan or its method of application need 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.

### 5.3.2 Flow diagram

For hazard and defect analysis, it is necessary to examine carefully both the product and the process and produce a flow diagram (or diagrams). Any flow diagram should be as simple as possible. Each step in the process, including process delays, from the selection

TABLE 5.1
**A product description for canned tuna in salted water**

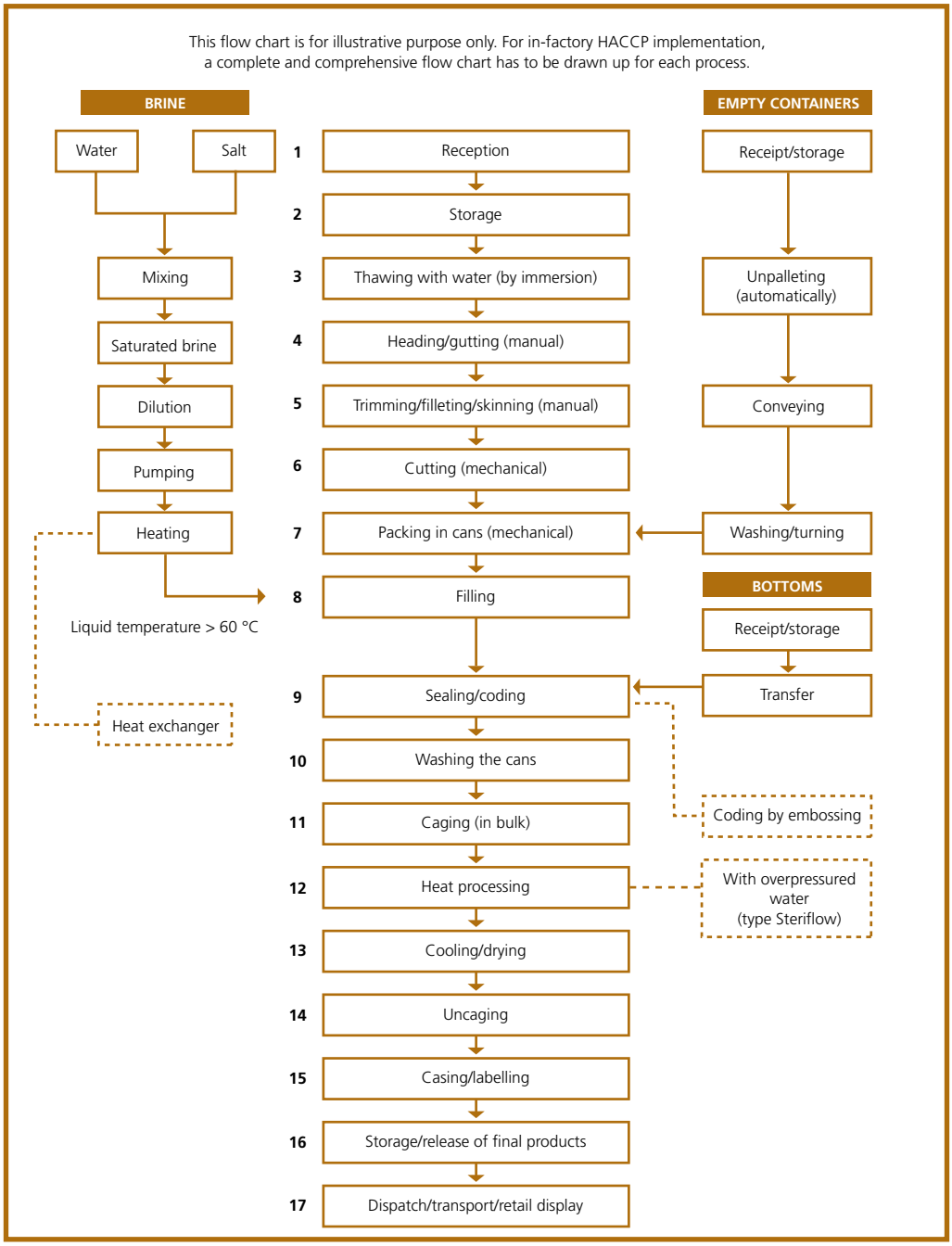
| | Objective | Example |
|---|---|---|
| **Product name(s)** | Identify the species and method of processing. | Canned tuna in salted water |
| **Source of raw material** | Describe the origin of the fish. | Yellowfin tuna caught by purse seine in the Gulf of Guinea<br>Whole brine frozen |
| **Important 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<br>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 |

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 for 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 8.1–10.1 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.

Figure 5.2
**Example of a flow diagram for a processing line of canned tuna fish in brine**



5.3.3.1 **Identification of hazards and defects**

It cannot be stressed enough 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 an 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.

For the example on canned tuna developed in this section, Table 5.5 lists the potential defects.

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

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** | *Salmonella*, *Shigella*, *E. coli*, *Vibrio cholerae*, *Vibrio parahaemolyticus*, *Vibrio vulnificus* | **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, scombrotoxin | **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** | *Listeria monocytogenes*, *Clostridium botulinum*, *Staphylococcus aureus* | **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** | Scombrotoxin, 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 its 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 or storage or transportation |
|---|---|---|
| **Biological** | Presence of *C. botulinum*, presence of scombrotoxin | Contamination by *C. botulinum*, growth of *C. botulinum*, survival of spores of *C. botulinum*, contamination and growth of *Staphylococcus aureus*<br>Microbial recontamination after heat processing<br>Production of scombrotoxin during processing<br>Production of staphylotoxin |
| **Chemical** | Presence of heavy metals | Recontamination by metals coming from the cans<br>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 micro-organisms 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 |

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 after harvest. 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 contamination 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 listed in Appendix 12.[7] Where no Codex Standard exists, reference should be made to national regulations and/or commercial specifications.

End product specifications outlined in Appendixes 2–11,[6] describe optional requirements that are intended to assist buyers and sellers in describing those provisions that are often used in commercial transactions or in designing specifications for final products. These requirements are intended for voluntary application by commercial partners and not necessarily for application by governments.

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.

[7] Under development.

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 consumers who will likely consume it (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".

### 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 labelling provisions of the appropriate Codex Standard. The Codex

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 | *C. botulinum* viable spores | Yes | An insufficient heat processing may result in survival of *C. botulinum* spores and, therefore, 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<br>Stock management procedure<br>Maintenance procedure of the refrigeration system<br>Personnel training and qualification |

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

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

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. Where CCPs and DAPs have been identified at a step, 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.

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 in a concise fashion providing 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 responsible person for verification.

Because 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.

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 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 as a part of 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 enable problems to be detected and dealt with in a timely manner. For illustration 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 are capable of meeting their objectives.

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: *Clostridium botulinum* viable spores**

| Critical limit | Monitoring procedure | Corrective action | Records | Verification |
|---|---|---|---|---|
| Those specific parameters associated with heat processing | **Who:** qualified person assigned to heat processing<br><br>**What:** all parameters<br><br>**How:** checks of sterilization schedule and other factors<br><br>**Frequency:** every batch | **Who:** qualified personnel<br><br>**What:**<br>personnel retraining<br><br>new heat processing or batch destruction<br><br>corrective maintenance of equipment<br><br>hold product until safety can be evaluated<br><br>**Who:** appropriate trained personnel | 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<br><br>Storage temperature and time | **Who:** appropriately trained personnel<br><br>**What:** fish quality and acceptability based on Codex product standard<br><br>**How:**<br>organoleptic examination<br>chemical tests<br><br>checking of the storage premise temperature<br><br>checking of stock forms<br><br>**Frequency:** as required | **Who:** appropriately trained personnel<br><br>**What:**<br>application of an intensified monitoring<br><br>according to the results of this intensified inspection, immediate processing, sorting or rejection of frozen tuna exceeding the critical limits<br><br>adjust storage temperature<br><br>personnel retraining | Analysis results<br><br>Stock forms<br><br>Temperature records | On-site audit<br><br>Review of monitoring and corrective action reports |

## 5.4 Conclusion

Section 5 has demonstrated the principles of HACCP and how they should be applied to a process to ensure safe product. The same principles can be used to determine the points in a process where it is necessary to control defects. As every facility and each 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 8 refers to the processing of fresh, frozen and minced fish and will provide useful guidance for most of the other processing operations.

## SECTION 6 – AQUACULTURE PRODUCTION

### Preamble

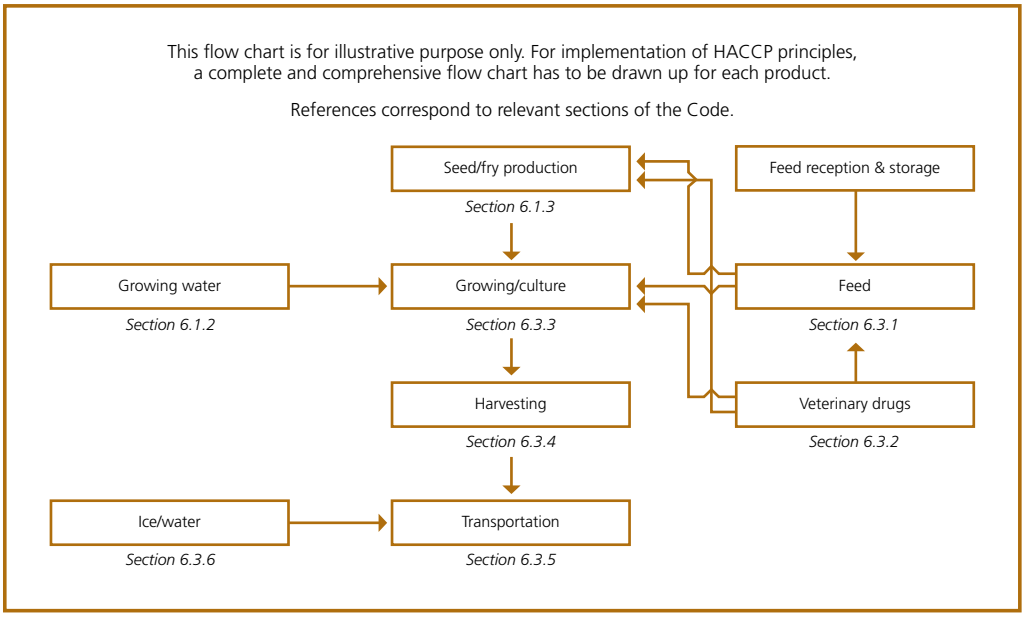
Aquaculture establishments should operate in a responsible way such that they comply with the recommendations of the *Code of Conduct for Responsible Fisheries* (FAO, Rome, 1995) in order to minimize any adverse impact on human health and the environment, including any potential ecological changes.

Fish farms should operate effective fish health and welfare management. Fry and fingerlings should be disease free and should comply with the OIE (World Organisation for Animal Health) Codes of Practice (*International Aquatic Animal Health Code*, 6th Edition, 2003). Growing fish should be monitored for disease. 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.

Figure 6.1
**Example of a flow chart for aquaculture production**




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 an HACCP and/or 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 diagram in Figure 6.1 will provide guidance to some of the common steps in aquaculture production.

## 6.1 General

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

### 6.1.1 Site selection

- The siting, 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 environment 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 that 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 such 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 4.1). 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 pose 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 as this can 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* (CAC/RCP 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 that 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 *Recommended International Code of Practice for control of the use of veterinary drugs* (CAC/RCP 38-1993) and the *Guidelines for the establishment of a regulatory programme for control of veterinary drug residues in foods* (CAC/GL 16-1993).
- 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 those fish which tested with drug residue concentrations above the maximum residue limit (MRL) (or, in some countries, by an industry imposed lower level), harvest of the batch should be postponed until the batch complies with the MRL.

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 should be 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 fallowing 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 to 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 to 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 to 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.
- In order to reduce fish stress, clean water utilized to fill holding tanks, or to pump fish between holding tanks, or for conditioning 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 them.

- 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 and, in general, fish should not be fed 24 hours before transporting.
- 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 transportation (holding tanks) of live fish should be capable of:
  - maintaining 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;
  - maintaining the temperature of storage and transportation for species sensitive to temperature fluctuations. It may be necessary to insulate the holding tanks and install a temperature control system;
  - keeping water in reserve that might be needed 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.
- For species known to exhibit strong territoriality, cannibalism or hyperactivity when under stress, these fish should be separated in 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 should aim at reducing the metabolic rate of fish in order to minimize the stress to them. Conditioning of the fish at low temperatures should be done according to the characteristics of the species (minimum temperature, cooling rate, water/humidity requirements, packaging conditions). Conditioning is a biological operation to reduce the metabolic rate of the fish in order to minimize the stress to them.
- The level of temperature to be reached should be in accordance with the species, transportation and packaging conditions. There is a range of temperature in which fish do not exhibit or have reduced physical activity. The limit is attained at the temperature at which the metabolic rate of the fish is minimized without causing adverse effects to them (basal metabolic rate).
- When performing conditioning, only approved anaesthetics and procedures accepted by the 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 the fish was taken from, but at the temperature of storage.
- Water-absorbent pads, shredded wood, wood shavings or sawdust and tying material that may be utilized for packaging conditioned fish should be clean, first use, free of possible hazards and be wet at the time of packaging.
- Conditioned and packaged fish should be stored or transported under conditions that ensure proper temperature control.

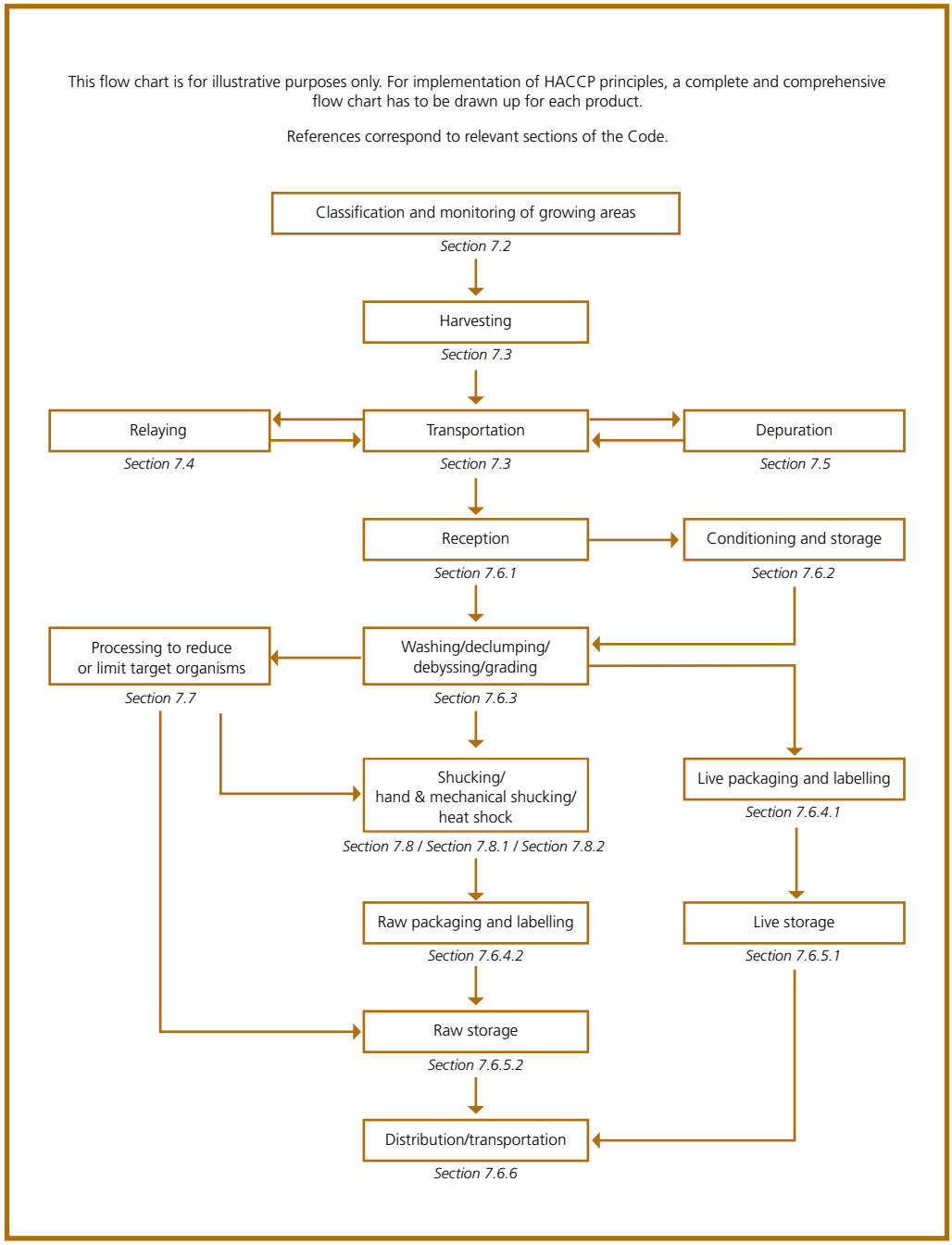
## SECTION 7 – LIVE AND RAW BIVALVE MOLLUSCS

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 an HACCP and/or 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.

### 7.1 General remarks, addition to the prerequisite programme

Bivalve molluscs species, such as oysters, mussels, manilla 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

Figure 7.1
**Example of a simplified flow diagram for production of live and raw bivalve molluscs**



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 becomes 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 waters in which they grow, especially when the bivalve molluscs are intended to be eaten live or raw. Because molluscs are filter feeders, they concentrate contaminants to a much higher concentration than 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 like enteric bacterial and/or viral pathogens (norovirus, viruses causing hepatitis) or from natural occurring bacterial pathogens (*Vibrio* spp.). Another hazard is posed by 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 pose a hazard in certain areas.

To control the 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 for 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. If biotoxins are found in the bivalve molluscs 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 or a depuration process to reduce the level of bacteria if the process is continued long enough, or by 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:*

There are five different types of important hazards coming from the bivalve molluscs growing environment:

- 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]);
- chemical contaminants (e.g. heavy metals such 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 to 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. FAO, 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
- non-suitable 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 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 upon the use of indicator organisms for the presence of contamination rather than upon 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 this area.

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 close immediately and effectively patrol affected areas when acceptable levels are exceeded in edible portions of bivalve mollusc meats. These areas should not be 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 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 this 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, 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 *Draft Standard for live and raw bivalve molluscs*. Any methods may be deemed suitable for screening purposes provided they are approved by the competent authority in a country.

7.2.2.5 **Chemical contaminants**
Growing areas should be monitored for chemical contaminants on a sufficiently frequent basis 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 a defined event occurs – for example, 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 or 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 or 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 full sun or surfaces heated by the sun or come into direct contact with ice and 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 already 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 molluscs 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 a 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 micro-organisms 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 that they represent a health hazard for the consumer.
- Use only shellstock designated as acceptable by the official agency having jurisdiction.
- 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 before 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 the reducing of the number of indicator bacteria does not always reflect the real situation as regards contamination by viruses and *Vibrio*.

- Water used in depuration tanks should be changed continuously or at suitable intervals or, if recirculated, be treated properly. The flow of water per hour should be sufficient to the amount of bivalve molluscs treated and should depend on the degree of contamination of the bivalve molluscs.
- 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 rays of the sun 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 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 otherwise unwholesome should be removed.
- Before removing the bivalve molluscs form 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 an adequate salinity and adequate physical water quality parameters 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 the direct rays of the sun. 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 time as they remain sound and active.
- Tanks should be drained, cleaned and disinfected at suitable intervals.
- Recirculating 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 micro-organisms.
- Damage to shells and stress will shorten the shelf-life of bivalve molluscs and increase the risk of contamination and deterioration. Therefore, bivalve molluscs have to be handled carefully:
  - the number of handlings of bivalve molluscs should be minimized.
  - 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 micro-organisms.

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 may be used to bear an indication as to how the bivalve molluscs should be kept from the time they were bought at the retailer. 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 take place quickly (see Section 8.3). 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 micro-organisms. The packaging material of the end product should not have direct contact with the floor but should be placed on a clean, raised surface.
- Storage periods should be kept as short as possible.
- Re-immersion in or spraying with water of live bivalve molluscs must not take place after they have been packaged and have 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 17.

*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 of the bivalve molluscs against damage to the shells 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 micro-organisms 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 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* [CAC/GL 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 after 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 whether the bivalve molluscs are alive and not badly damaged.
- Heat shocked bivalve molluscs should be cooled to 7 °C or less 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;
- 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 easy 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.

## SECTION 8 – 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 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 an HACCP and/or 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 12, canned fish as described in Section 16, frozen breaded or battered fish as described in Section 15). Traditional methods often prevail in the design of a process. However, modern scientific food technology is having an increasingly important role in enhancing the preservation and shelf-stability of a product. 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 8.1) will provide guidance to 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 an 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 9–16[8]), where appropriate.

## 8.1 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.

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

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

*Potential defects:* *decomposition, parasites, physical contamination*

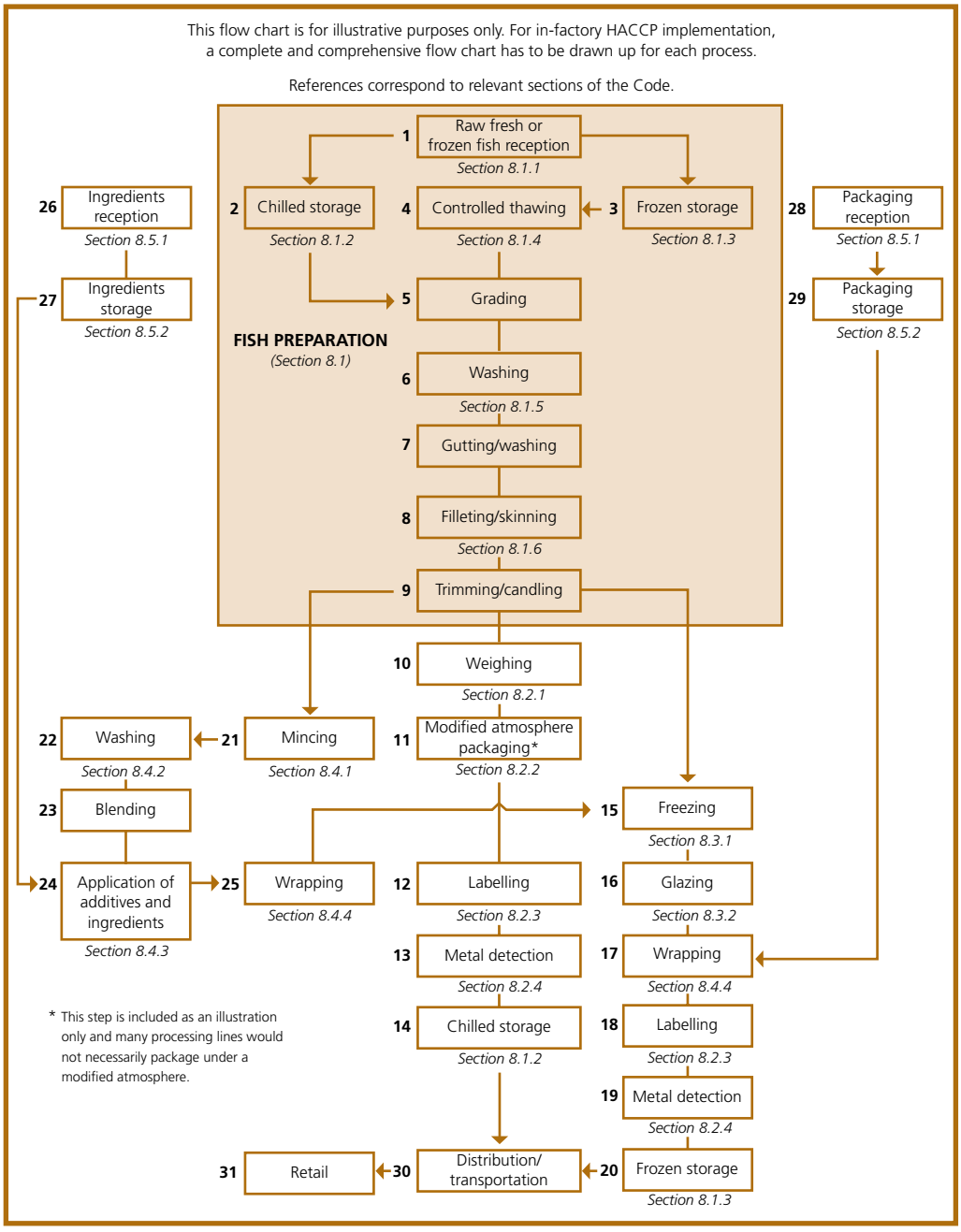
*Technical guidance:*

- 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;
  - species homogeneity.

[8] Sections 12–13 under development.

Figure 8.1

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



- 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 ciguatoxin in large carnivorous tropical and subtropical reef fish or scombrotoxin 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 8.1.5).
- 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.

8.1.1.1 **Sensory evaluation of fish**

The best method of assessing the freshness or spoilage of fish is by sensory evaluation techniques.[9] 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. |

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

*Potential hazards:* *microbiological pathogens, 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 the 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.
- The 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 such that damage from overstacking or overfilling of boxes will be prevented.

[9] *Guidelines for the sensory evaluation of fish and shellfish in laboratories* (CAC/GL 31-1999).

- Where appropriate, replenish ice supply on the fish or alter temperature of the room.

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

*Potential hazards:* *microbiological pathogens, 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.
- 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.

8.1.4 **Controlled thawing (Processing Step 4)**

*Potential hazards:* *microbiological pathogens, biotoxins, scombrotoxin*
*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 micro-organisms 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 buildup of micro-organisms.
- 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.

8.1.5 **Washing and gutting (Processing Steps 6 and 7)**

*Potential hazards:* *microbiological pathogens, biotoxins and scombrotoxin*
*Potential defects:* *presence of viscera, bruising, off-flavours, cutting faults*
*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 buildup 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.

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

*Potential hazards:* *viable parasites, microbiological pathogens, biotoxins, scombrotoxin, 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 buildup 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 Standards[10] 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.

## 8.2 Processing of vacuum or modified atmosphere packaged fish

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 (see also Appendix 1).

### 8.2.1 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.

### 8.2.2 Vacuum or modified atmosphere packaging (Processing Step 11)

*Potential hazards:* *subsequent microbiological pathogens and biotoxins, 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. Refer to Appendix 1 for process control issues in MAP.
- 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;
  - existence of adequate vacuum and packaging.

[10] *Standard for quick frozen blocks of fish fillets, minced fish flesh and mixtures of fillets and minced fish flesh* (CODEX STAN 165-1989) and *General Standard for quick frozen fish fillets* (CODEX STAN 190-1995).

- 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.

8.2.3 **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* (CODEX STAN 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.

8.2.4 **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.

## 8.3 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.

8.3.1 **Freezing process (Processing Step 15)**

*Potential hazards:* *viable parasites*
*Potential defects:* *texture deterioration, development of rancid odours, freezer burn*
*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 micro-organisms 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.

8.3.2 **Glazing (Processing Step 16)**

*Potential hazards:* *microbiological pathogens*
*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 buildup of fish protein, which can hamper freezing performance.

## 8.4 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.

8.4.1 **Mincing fish using mechanical separation process (Processing Step 21)**

*Potential hazards:* *microbiological pathogens, biotoxins and scombrotoxin, 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.

8.4.2 **Washing of minced fish (Processing Step 22)**

*Potential hazards:* *microbiological pathogens and scombrotoxin*

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

*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.

8.4.3 **Blending and application of additives and ingredients to minced fish (Processing Steps 23 and 24)**

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

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

*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* (CODEX STAN 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.

8.4.4 **Wrapping and packaging (Processing Steps 17 and 25)**

*Potential hazards:* *microbiological pathogens*
*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.

## 8.5 Packaging, labels and ingredients

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

*Potential hazards:* *microbiological pathogens, 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.

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

*Potential hazards:* *microbiological pathogens, chemical and physical contamination*
*Potential defects:* *loss of quality characteristics of packaging materials or ingredients*
*Technical guidance:*

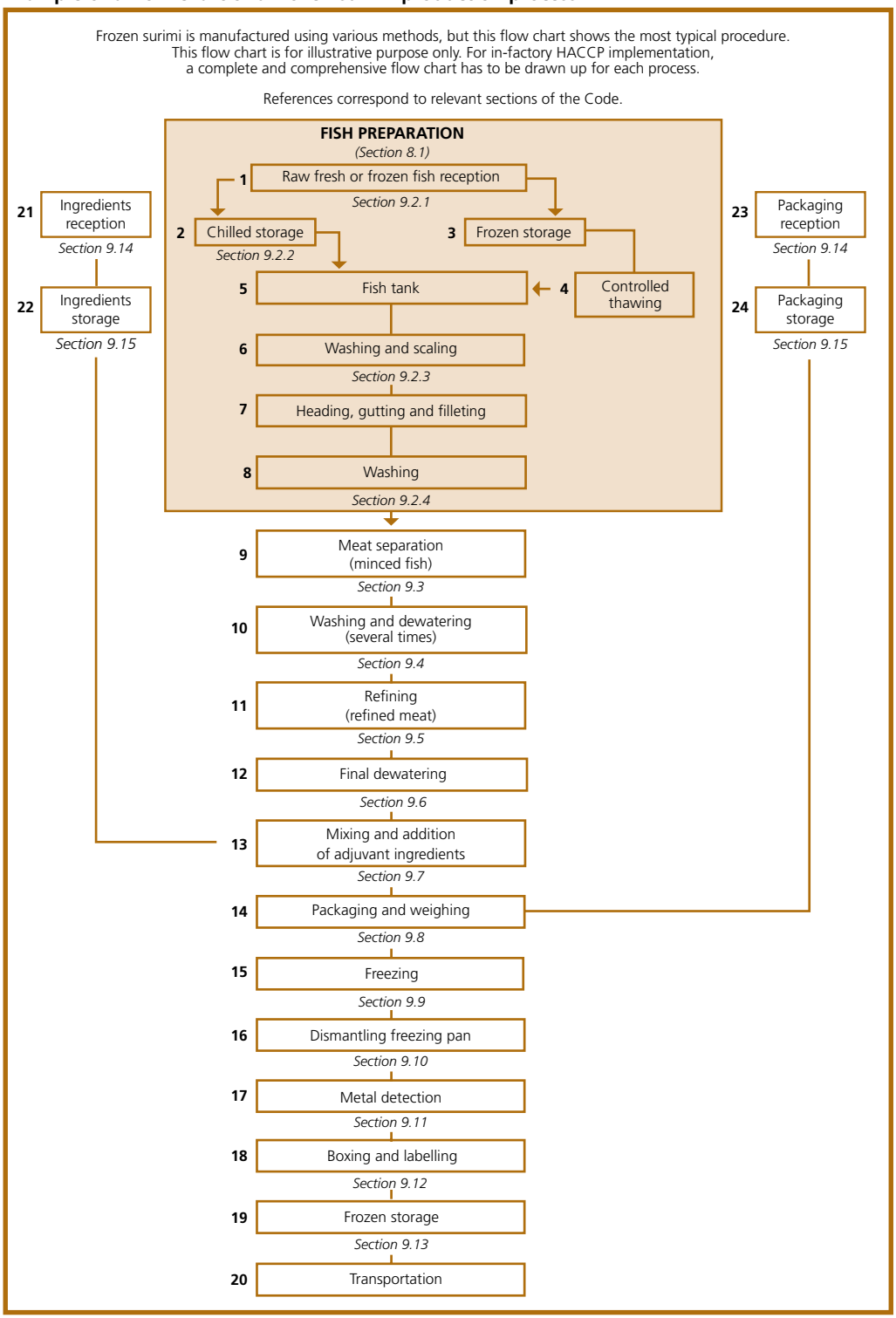
- Ingredients and packaging should be stored appropriately in terms of temperature and humidity.
- A systematic stock rotation plan should be developed and maintained to avoid out-of-date materials.
- Ingredients and packaging should be properly protected and segregated to prevent cross-contamination.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

# SECTION 9 – 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

Figure 9.1

**Example of a flow chart of a frozen surimi production process**



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 an HACCP and/or 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.

## 9.1 General considerations of hazards and defects for frozen surimi production

### 9.1.1 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 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. 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.

9.1.2 **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. These and others are described in more detail in Appendix 4.[11]

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 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 in to 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.

[11] Under development.

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.

## 9.2 Fish preparation (Processing Steps 1–8)

Refer to Section 8.1 Steps 1–8 for information regarding preparation of fish for processing. For frozen surimi processing, consideration should be given to the following for each step:

### 9.2.1 Raw fresh and frozen fish reception (Processing Step 1)

*Potential hazards:* *unlikely when using marine groundfish as the raw material*
*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.

### 9.2.2 Chilled storage (Processing Step 2)

*Potential hazards:* *unlikely*
*Potential defects:* *protein denaturation*
*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.

9.2.3 **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.

9.2.4 **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.

## 9.3 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.

## 9.4 Washing and dewatering process (Processing Step 10)

*Potential hazards:* *pathogenic microbial growth*
*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 $CaCO_3$.
- 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.

## 9.5 Refining process (Processing Step 11)

*Potential hazards:* *pathogenic microbial growth, metal fragments*
*Potential defects:* *objectionable matter, protein denaturation*
*Technical guidance:*

- Temperature of the minced fish flesh in the refining process should be adequately controlled to prevent the growth of pathogenic bacteria.
- 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.
- 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.

## 9.6 Final dewatering process (Processing Step 12)

*Potential hazards:* *pathogenic microbial growth*
*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.

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

*Potential hazards:* *pathogenic microbial growth, metal fragments*
*Potential defects:* *improper use of food additives, protein denaturation*
*Technical guidance:*

- Temperature of the product in the mixing process should be adequately controlled to avoid the growth of pathogenic bacteria.
- 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.
- 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.
- Food additives should be the same and comply with the *General Standard for food additives* (CODEX STAN 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.

## 9.8 Packaging and weighing (Processing Step 14)

*Potential hazards:* *pathogenic microbial growth*
*Potential defects:* *foreign matter (packaging), incorrect net weight, incomplete packaging, denaturation of protein*
*Technical guidance:*

- Temperature of the product should be adequately controlled during packaging to avoid the growth of pathogenic bacteria.
- 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 or decomposition.
- Packaged products should not contain voids.
- The product should meet appropriate standards for net weight.

See also Sections 8.2.1 and 8.4.4.

### 9.9 Freezing operation (Processing Step 15)

Refer to Section 8.3.1 for general considerations on freezing fish and fishery products.

*Potential hazards:* *unlikely*
*Potential defects:* *protein denaturation, decomposition*
*Technical guidance:*

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

### 9.10 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.

### 9.11 Metal detection (Processing Step 17)

Refer to Section 8.2.4 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.

### 9.12 Boxing and labelling (Processing Step 18)

Refer to Sections 8.2.3 and 8.4.4.

*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 conducted to avoid the damage of packaging materials.
- Product in damaged boxing should be re-boxed so that it is properly protected.

### 9.13 Frozen storage (Processing Step 19)

Refer to Section 8.1.3 for general information concerning fish and fishery products.

*Potential hazards:* *unlikely*
*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.

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

Refer to Section 8.5.1.

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

Refer to Section 8.5.2.

## SECTION 10 – 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 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 an HACCP and/or 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.

### 10.1 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.
- Prefrying baths, freezing cabinets used for re-freezing should be equipped with permanent temperature and belt speed control device.
- 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.

## 10.2 Identification of hazards and defects

Refer also to Section 5.3.3 and Appendix 5.

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

### 10.2.1 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.

### 10.2.2 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* (CODEX STAN 166-1989).

End-product specifications outlined in Appendix 11 describe optional requirements specific to quick-frozen coated fishery products.

## 10.3 Processing operations

Refer to Figure 10.1 for an example of a flow chart for coated fish product processing.

### 10.3.1 Reception

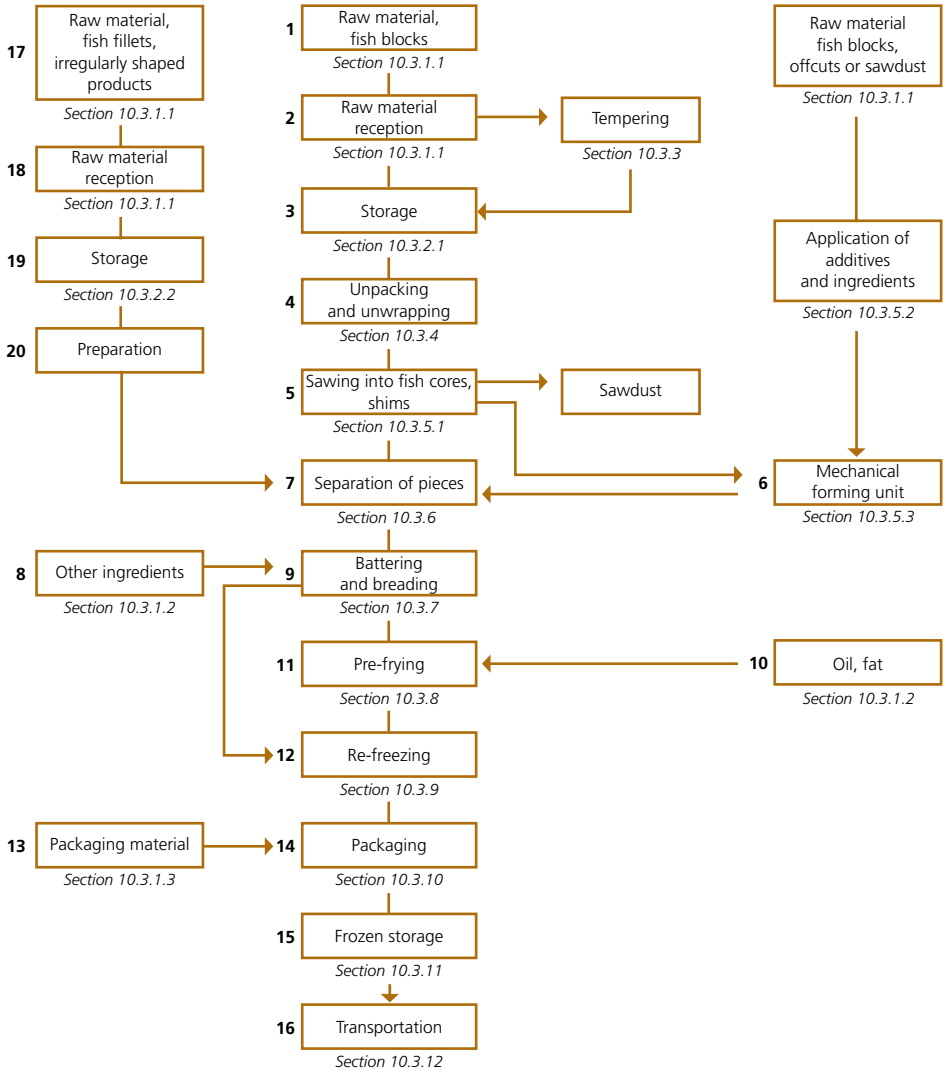
#### 10.3.1.1 Fish

*Potential hazards:* *chemical and biochemical contamination, histamine*
*Potential defects:* *tainting, block irregularities, water and air pockets, packaging material, foreign matter, parasites, dehydration, decomposition*

Figure 10.1
**Example of a flow chart for the processing of coated fish products**

This flow chart is for illustrative purposes 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.



*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.

10.3.1.2 **Other ingredients**

*Potential hazards:* *chemical, biochemical and microbiological contamination*
*Potential defects:* *mould, colour deviations, filth, sand*
*Technical guidance:*

- Breading 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.

10.3.1.3 **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.
- Preprinted labelling and packaging material should be examined for accuracy.

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

10.3.2.1 **Fish (frozen storage)**

Refer to Section 8.1.3.

10.3.2.2 **Fish (chilled storage)**

For storage of non-frozen fish, refer to Section 8.1.2.

10.3.2.3 **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.

10.3.3 **Frozen fish block/fillet tempering**

*Potential hazards:* *unlikely*
*Potential defects:* *incorrect dimension owing to sawing of oversoftened 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.
- Oversoftening 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.

10.3.4 **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.

### 10.3.5 Production of fish core

#### 10.3.5.1 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.

#### 10.3.5.2. Application of additives and ingredients

Refer also to Section 8.4.3.

*Potential hazards:* *foreign material, microbiological contamination*
*Potential defects:* *incorrect addition of additives*
*Technical guidance:*

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

#### 10.3.5.3 Forming

*Potential hazards:* *foreign material (metal or plastic from machine) and/or microbiological contamination (fish mixture only)*
*Potential defects:* *poorly formed fish cores, cores subjected to too much pressure (mushy, rancid)*
*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.

### 10.3.6 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 (QF) 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.

10.3.7 **Coating**

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

10.3.7.1 **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.

10.3.7.2 **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* (CODEX STAN 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* (CODEX STAN 166-1989).

10.3.8 **Pre-frying**

There are some variations in industrial production for the frying process in so far that QF 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:* *overoxidized 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.

10.3.9 **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:*

- Re-freezing to –18 °C or lower of the whole product should take place 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.

10.3.10 **Packaging and labelling**

Refer to Sections 8.2.1, 8.2.3 and 8.4.4.

*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 if 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.

10.3.11 **Storage of end products**

Refer also to Section 8.1.3.

*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.

10.3.12 **Transportation of end product**

Refer also to Sections 3.6 and 17.

*Potential hazards:* *unlikely*
*Potential defects:* *thawing of frozen product*
*Technical guidance:*

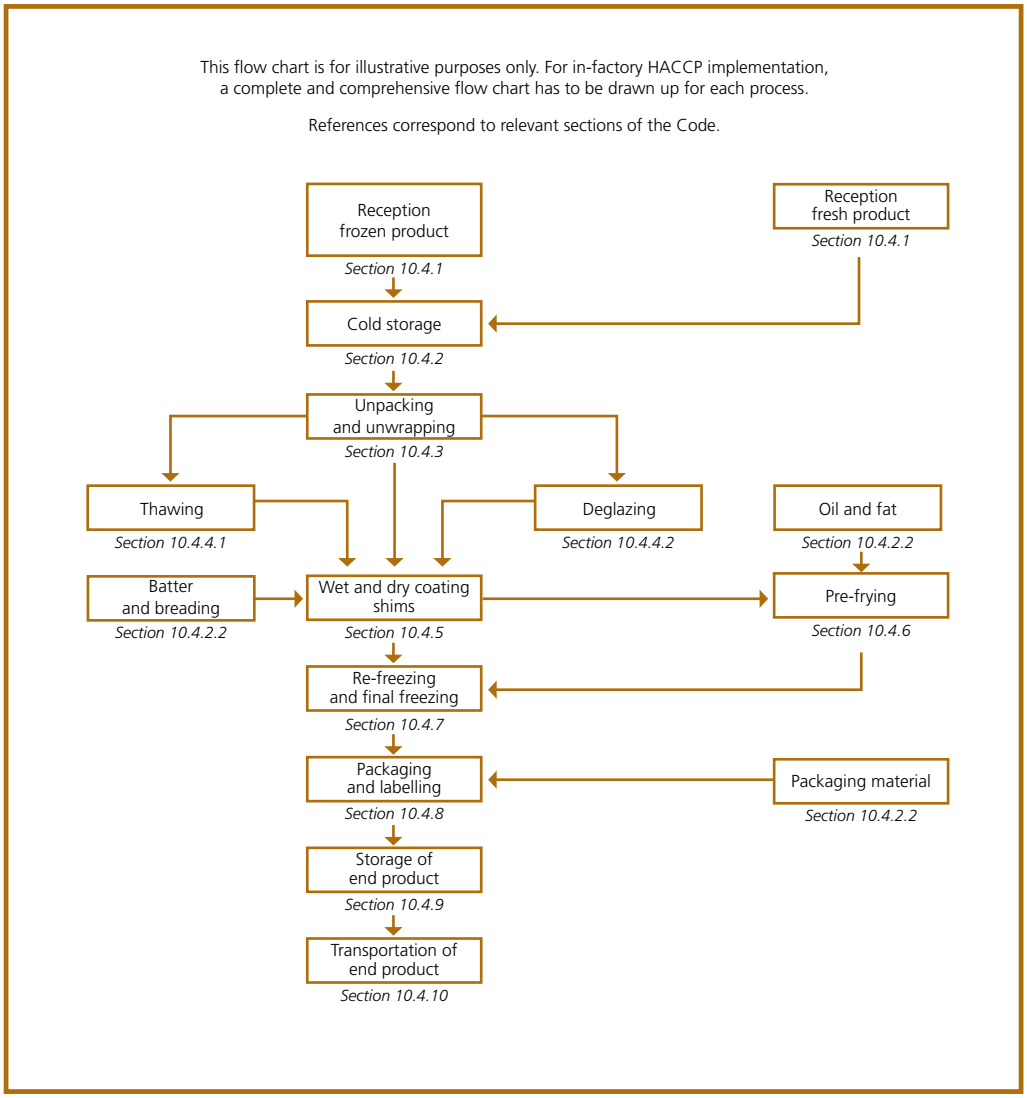
- During all transportation steps, deep-frozen conditions should be maintained at –18 °C (maximum fluctuation ±3 °C) until final destination of product is reached.
- Cleanliness and suitability of the transport vehicle to carry frozen food products should be examined.
- Use of temperature-recording devices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

## 10.4 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 10.2 for an example of a flow chart for coated molluscan shellfish processing.

Figure 10.2
**Example of a flow chart of a coated molluscan shellfish processing line**




10.4.1 **Reception**

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

10.4.1.1 **Molluscan shellfish**

*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.

Refer also to Section 7.

10.4.1.2 **Other ingredients**
See Section 10.3.1.2.

10.4.1.3 **Packaging materials**
See Section 10.3.1.3.

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

10.4.2.1 **Molluscan shellfish (frozen storage)**
See Section 10.3.2.1.

10.4.2.2 **Other ingredients and packaging materials**
See Section 10.3.2.3.

10.4.2.3 **Molluscan shellfish (refrigerated storage)**

*Potential hazards:* *microbiological growth, 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.

See Section 7.6.5.

10.4.3 **Unpacking and unwrapping**
See Section 10.3.4.

10.4.4 **Production of coated molluscan shellfish**

10.4.4.1 **Thawing frozen product**

*Potential hazards:* *microbiological growth*
*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.

10.4.4.2 **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.

10.4.4.3 **Separation of individual molluscan shellfish**

See Section 10.3.6.

10.4.5 **Coating**

See Section 10.3.7.

10.4.5.1 **Wet coating**

See Section 10.3.7.1.

10.4.5.2 **Dry coating**

See Section 10.3.7.2.

10.4.6 **Pre-frying**

See Section 10.3.8.

10.4.7 **Re-freezing – final freezing**

See Section 10.3.9.

10.4.8 **Packaging and labelling**

See Section 10.3.10.

10.4.9 **Storage of end product**

See Section 10.3.11.

10.4.10 **Transportation of end product**

See Section 10.3.12.

## 10.5 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 breading. It is assumed that the end product will be cooked thoroughly before consumption.

Refer to Figure 10.3 for an example of a flow chart for coated shrimp processing.

### 10.5.1 Reception

See Section 14.

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

#### 10.5.1.1 Shrimps

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

*Technical guidance:*

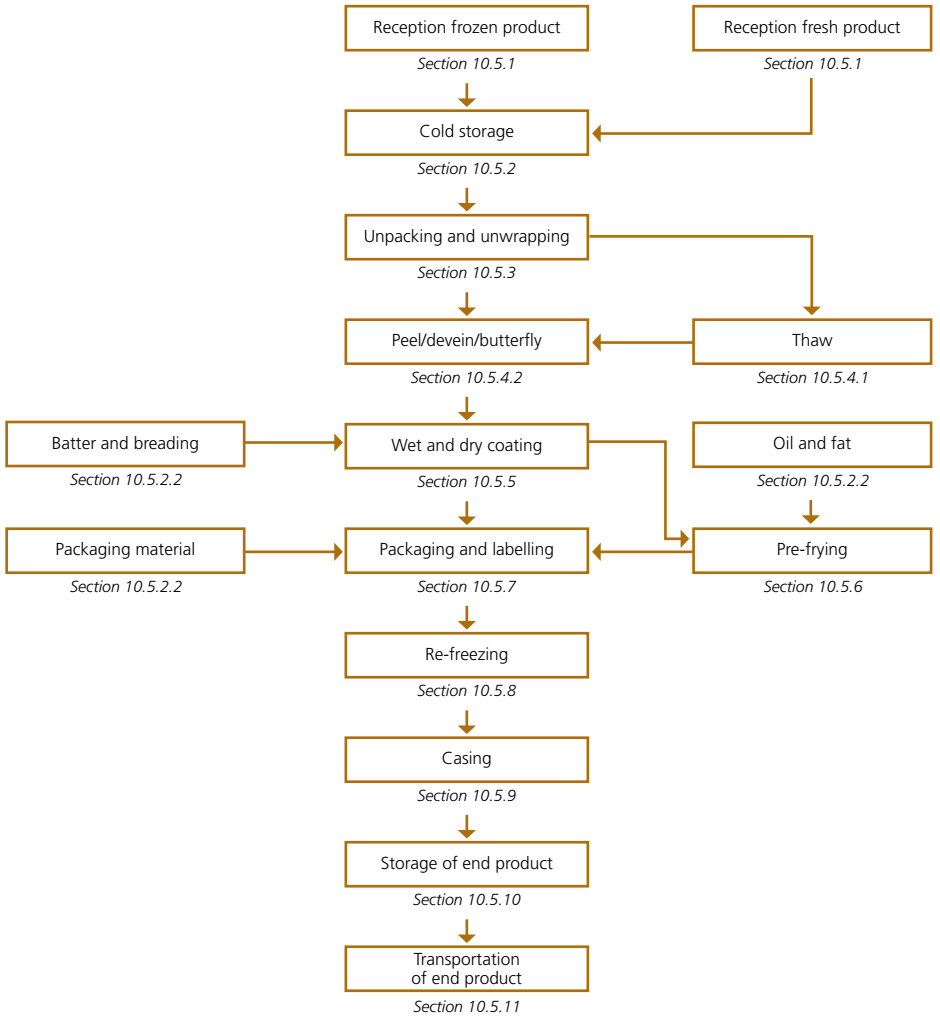
- The presence of sulphites applied to the shrimps for the purpose of preventing blackspot enzyme autolysis should be controlled to ensure that the product can be labelled as containing sulphites.
- Sulphites should be used in accordance with manufacturer instructions and GMP.
- Raw shrimps with extensive 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 °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 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.

See Section 14.2.1.

Figure 10.3
**Example of a flow chart of a coated shrimp processing line**

This flow chart is for illustrative purposes 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.



10.5.1.2 **Other ingredients**
See Section 10.3.01.2.

10.5.1.3 **Packaging material**
See Section 10.3.1.3.

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

10.5.2.1 **Shrimps (frozen storage)**
See Sections 10.3.2.1 and 14.2.2.

10.5.2.2 **Other ingredients and packaging material**
See Section 10.3.2.3.

10.5.2.3 **Shrimps (refrigerated storage)**
*Potential hazards:* *microbiological growth, 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.

See Section 10.3.2.2.

10.5.3 **Unpacking and unwrapping**
See Section 10.3.4.

10.5.4 **Production of coated shrimps**

10.5.4.1 **Thawing frozen product**
*Potential hazards:* *microbiological growth*
*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.

10.5.4.2 **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.

10.5.5 **Coating**

See Section 10.3.7.

10.5.5.1 **Wet coating**

*Potential hazards:* *microbiological growth 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.

See Section 10.3.7.1.

10.5.5.2 **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.

See Section 10.3.7.2.

10.5.6 **Pre-frying**

See Section 10.3.8.

10.5.6.1 **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.

10.5.7 **Packaging and labelling**

See Section 10.3.10.

10.5.8 **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.

10.5.9 **Casing**

*Potential hazards:* *microbiological growth*
*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.

10.5.10 **Frozen storage of end product**
See Section 10.3.11.

10.5.11 **Transportation of end product**
See Section 10.3.12.

## SECTION 11 – 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 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 an HACCP and/or 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.

Salted fish and fish products and dried salted fish and fish products (i.e. klippfish) 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.

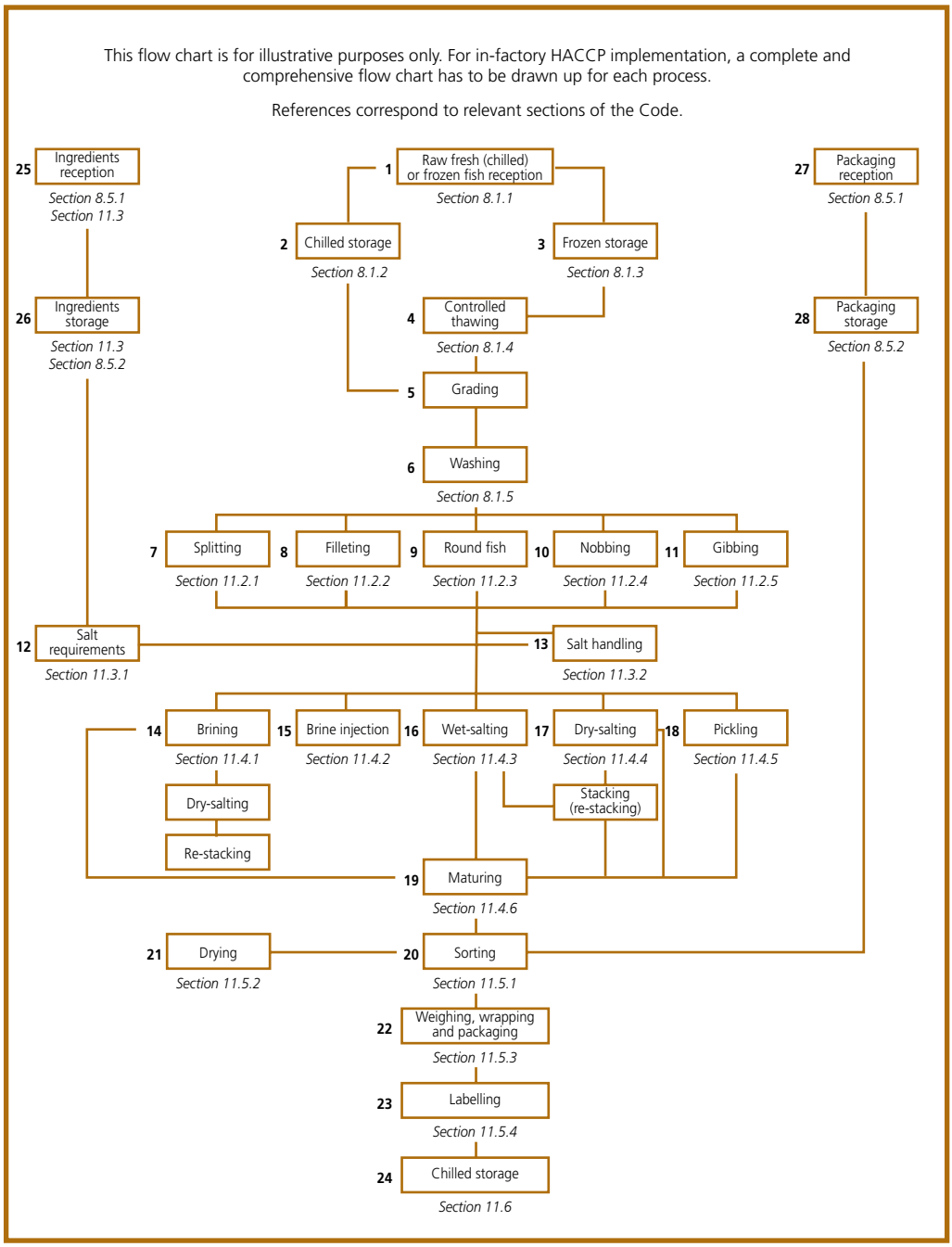
### 11.1 General

Refer also to Section 8.1 for general handling prior to processing and Figure 11.1 for an example flow chart of a salted and dried salted fish processing line.

- 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.
- 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.

Figure 11.1

**Example of flow chart of a salted and dried salted fish processing line**



- 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.

## 11.2 Preparing for salting

11.2.1 **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.

11.2.2 **Filleting, skinning and trimming (Processing Step 8)**

Refer to Section 8.1.6.

11.2.3 **Round fish (Processing Step 9)**

Refer to Sections 8.1.1–8.1.5.

11.2.4 **Nobbing (Processing Step 10)**

*Potential hazards:* *unlikely*
*Potential defects:* *remaining gut content and intestines other than roe or milt, decomposition*
*Technical guidance:*

Refer to Section 11.2.1, 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.

11.2.5 **Gibbing (Processing Step 11)**

*Potential hazards:* *unlikely*
*Potential defects:* *remaining gut content, decomposition*

*Technical guidance:*
Refer to Section 11.2.1, 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.

## 11.3 Salt handling and salt requirements

### 11.3.1 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.

### 11.3.2 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.

## 11.4 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.

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. 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.

### 11.4.1 Brining (Processing Step 14)

*Potential hazards:* *viable parasites, scombrotoxins, 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, incorrect concentration should be adjusted prior to use.
- To ensure proper salt penetration, fish should be of similar size.

### 11.4.2 Brine injection (Processing Step 15)

*Potential hazards:* *viable parasites, scombrotoxins, 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.

11.4.3 **Wet-salting (Processing Step 16)**

*Potential hazards:* *viable parasites, scombrotoxins, 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.

11.4.4 **Dry-salting (Processing Step 17)**

*Potential hazards:* *viable parasites, scombrotoxins, 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.

11.4.5 **Pickling (Processing Step 18)**

*Potential hazards:* *viable parasites, scombrotoxins, 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.

11.4.6 **Maturing (Processing Step 19)**

*Potential hazards:* *viable parasites, scombrotoxins, 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 development of histamine.
- Fatty fish such as herring may be kept in a temperature range of 5–10 °C during the maturing period. 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.

## 11.5 Sorting, drying, weighing, packaging, wrapping and labelling

Refer also to Sections 8.2.3 and 8.4.4.

11.5.1 **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.

11.5.2 **Drying (Processing Step 21)**

*Potential hazards:* *unlikely*
*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.

11.5.3 **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.

11.5.4 **Labelling (Processing Step 23)**

Refer to Sections 8.2.3 and 8.5.

### 11.6 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 overstacked.

### 11.7 Packaging, labels and ingredients (Processing Steps 25, 26, 27 and 28)

Refer to Section 8.5.

## SECTION 12 – SMOKED FISH

*Under development*

## SECTION 13A – LOBSTERS

*Under development*

## SECTION 13B – CRABS

*Under development*

## SECTION 14 – PROCESSING OF SHRIMPS AND PRAWNS

*Scope:* Shrimps frozen for further processing may be whole, head-off or deheaded 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 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 an HACCP and/or 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.

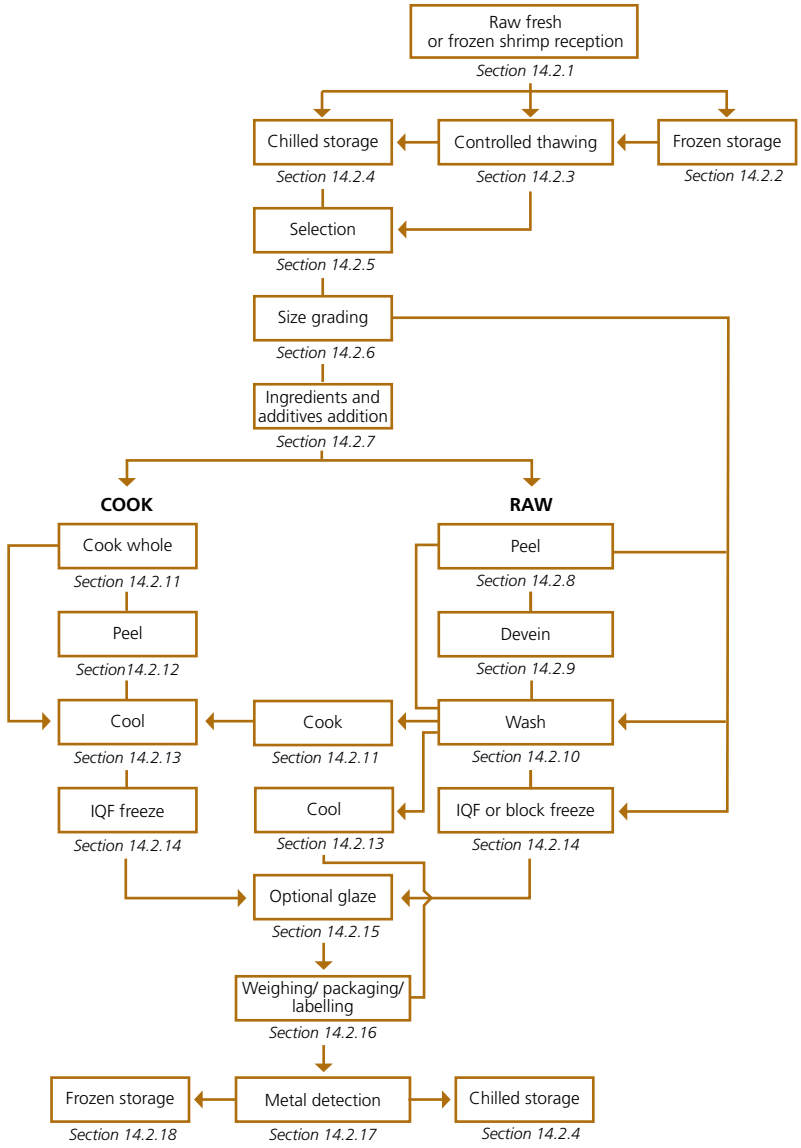
### 14.1 Frozen shrimps and prawns – general

- 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 14.1, but it must be appreciated that, because of the diverse nature of production methods, individual HACCP/DAP plans must be devised for each product.
- 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 de-heading, will have taken place prior to receipt at processing plants.

Figure 14.1
**Example of a flow chart of a shrimp and prawn processing line**

This flow chart is for illustrative purposes 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.



## 14.2 Shrimp preparation (Processing Steps 14.2.1 to 14.2.18)

### 14.2.1 Raw fresh and frozen shrimp reception (process steps)

*Potential hazards:* *phytotoxins (e.g. PSP), 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 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.

### 14.2.2 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.

### 14.2.3 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.

14.2.4 **Chilled storage**

Refer to Section 8.1.2 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.

14.2.5 **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

14.2.6 **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 "carry over" 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.

14.2.7 **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 GMP.

14.2.8 **Full and partial peeling**

*Potential hazards:* *microbiological cross-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 with water jets and the shrimps are rinsed to ensure no carry over of shell fragments.

14.2.9 **Deveining**

*Potential hazards:* *microbiological cross-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;
  - in addition, it is essential to ensure that damaged and contaminated shrimps are removed from the line and that no debris buildup is allowed.

14.2.10 **Washing**

*Potential hazards:* *microbiological contamination*
*Potential defects:* *decomposition, foreign matter*
*Technical guidance:*

- Washing of peeled and deveined shrimps is essential in order to ensure that shell and vein fragments are removed.
- Shrimps should be drained and chilled without delay prior to further processing.

14.2.11 **Cooking processes**

*Potential hazards:* *survival of pathogenic micro-organisms 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 different equipment is essential in order to ensure no cross-contamination.

14.2.12 **Peeling of cooked shrimps**

*Potential hazards:* *microbiological cross-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.

14.2.13 **Cooling**

*Potential hazards:* *microbiological cross-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.

14.2.14 **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.

14.2.15 **Glazing**

*Potential hazards:* *microbiological cross-contamination*
*Potential defects:* *inadequate glaze, too much 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 coldwater sprays on vibratory belts such that the shrimps pass at a steady rate to receive an even and calculable glaze cover.
- Ideally, glazed shrimps should receive a secondary re-freezing prior to packing, but if not, 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.

14.2.16 **Weighing, packaging and labelling of all products**

Refer to Sections 8.4.4 and 8.5.

*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 a manner 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.

14.2.17 **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.
- Larger packs will be detected at a lower sensitivity than smaller packs, so consideration should be given to testing product prior to packaging. However, unless potential re-contamination prior to packaging can be eliminated, it is probably still better to check in-pack.

14.2.18 **Frozen storage of end product**

Refer to Section 8.1.3 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 (±3 °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.

## SECTION 15 – 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 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 an HACCP and/or 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*, *Lolliguncula*, *Loligo*, *Loliolus*, *Nototodarus*, *Ommastrephes*, *Onychoteuthis*, *Rossia*, *Sepiola*, *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 micro-organisms. 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 15.1 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 is being used for illustrative purposes only.

## 15.1 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. TVBN, heavy metals (cadmium);
  - microbiological criteria;
  - parasites, e.g. *Anisakis*, foreign matter;
  - 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 on Section 8 and *Guidelines for sensory evaluation of fish and shellfish in laboratories* (CAC/GL 31-1999).

## 15.2 Storage of cephalopods

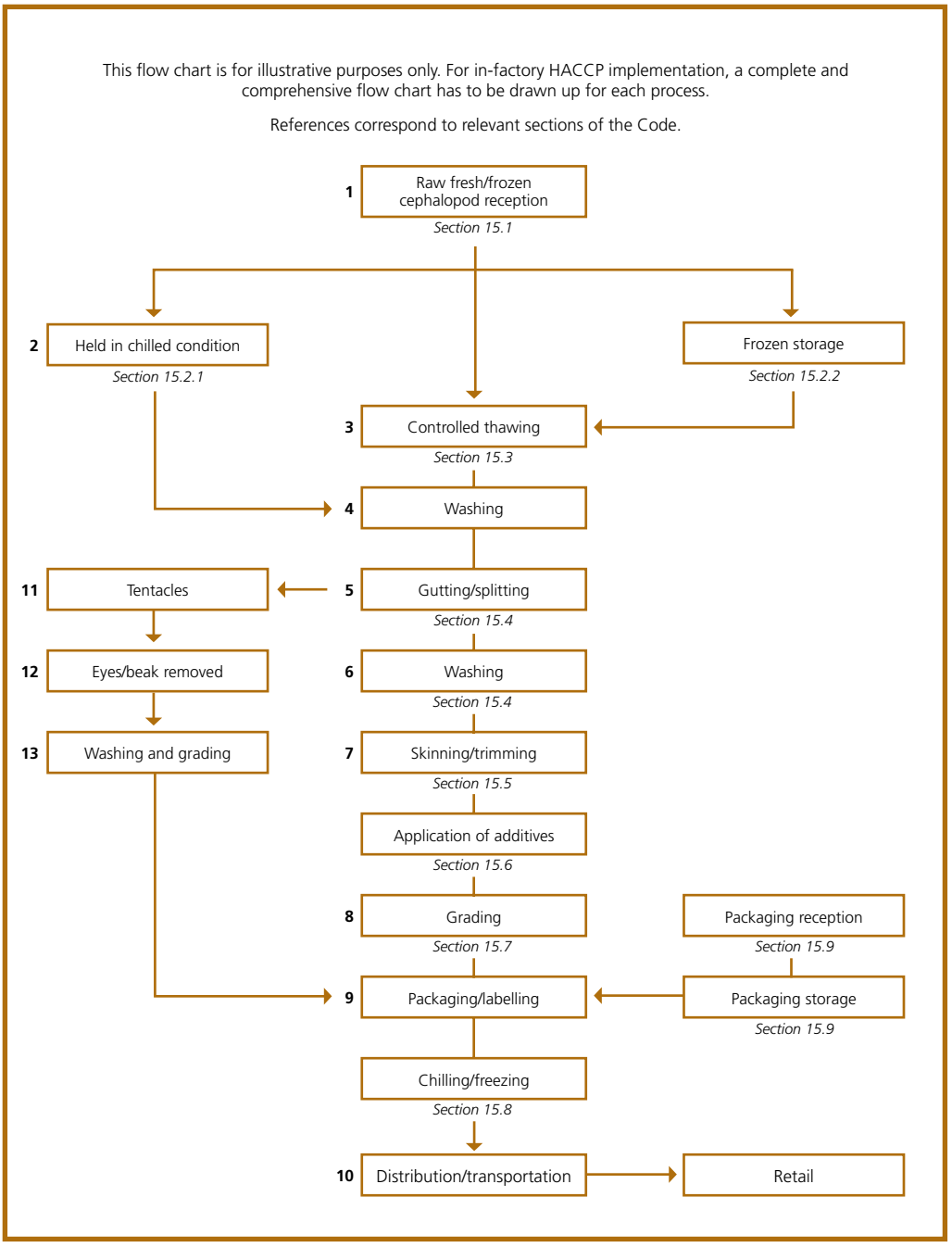
### 15.2.1 Chilled storage (Processing Steps 2 and 10)

*Potential hazards:* *microbiological contamination*
*Potential defects:* *decomposition, physical damage*
*Technical guidance:*
Refer to Section 8.1.2.

### 15.2.2 Frozen storage (Processing Steps 2 and 10)

*Potential hazards:* *heavy metals, e.g. cadmium migration from the gut*
*Potential defects:* *freezer burn*

Figure 15.1
**Example of a possible squid processing line**



*Technical guidance:*
Refer to Section 8.1.3.

- 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.

## 15.3 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 preventing the development of pale-pink discoloration.
- Critical limits for the thawing time and temperature of the product 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 buildup of micro-organisms.

For further guidance, refer to Section 8.1.4.

## 15.4 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, e.g. tentacles, 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 micro-organisms 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.

## 15.5 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 micro-organisms, e.g. enzymatic skinning or hot water techniques

should have defined time/temperature parameters to prevent the growth of micro-organisms.

- 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.

## 15.6 Application of additives

*Potential hazards:* *physical contamination, non-approved additives, non-fish allergens*

*Potential defects:* *physical contamination, additives exceeding their regulatory limits*

*Technical guidance:*

- 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 are met.
- Additives should comply with requirements of the *General Standard for food additives* (CODEX STAN 192-1995).

## 15.7 Grading/packaging/labelling (Processing Steps 8 and 9)

Refer to Section 8.2.3.

*Potential hazards:* *chemical or physical contamination from packaging*

*Potential defects:* *incorrect labelling, incorrect weight, dehydration*

*Technical guidance:*

- Packaging material should be clean, be 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.

## 15.8 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 should 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 8.3.1 and Annex 1 on parasites.

### 15.9 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 8.5.

## SECTION 16 – 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 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 an HACCP and/or 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 containers[12] 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 of the flow diagram (Figure 16.1) will provide guidance on some of the common steps involved in a canned fish or shellfish preparation line.

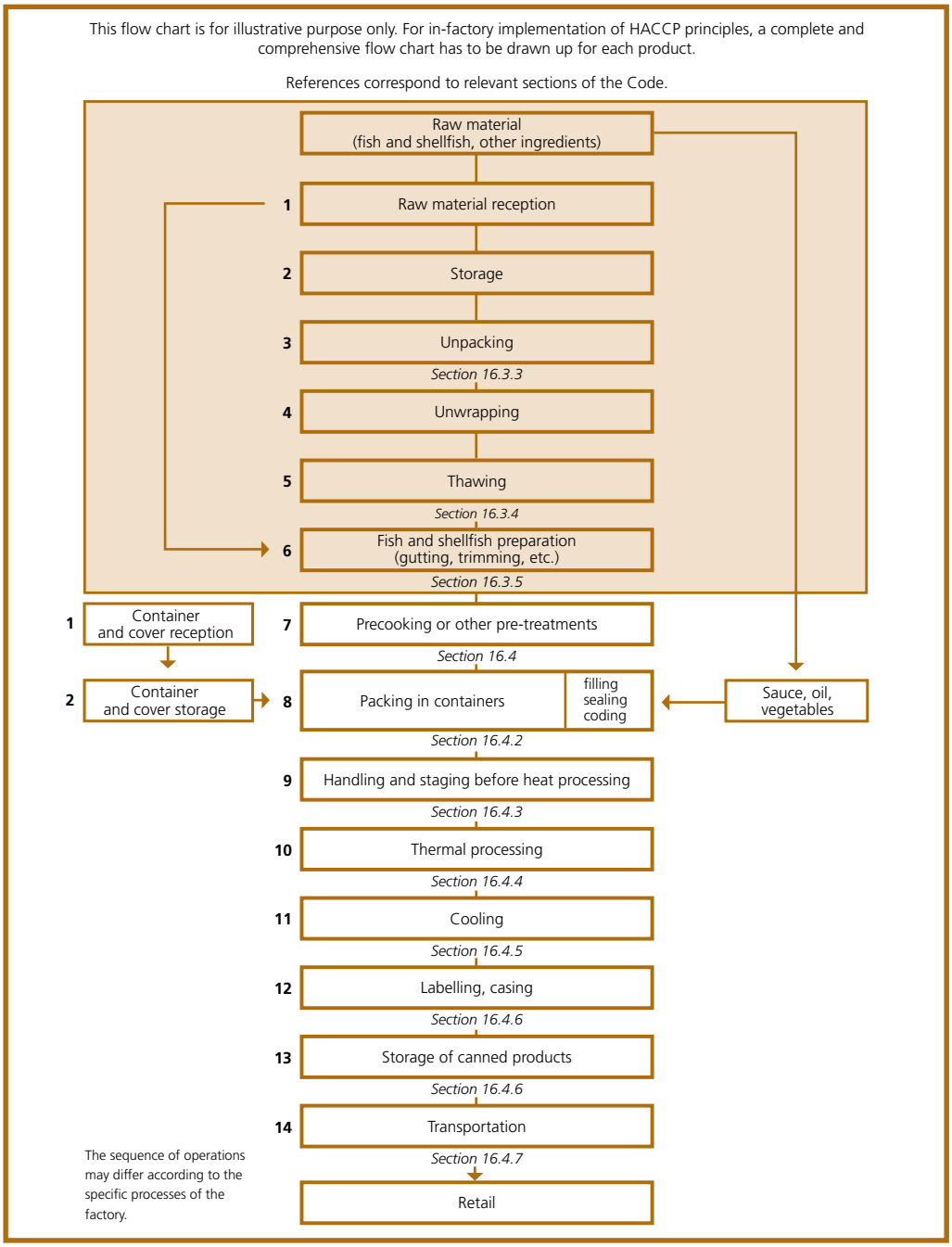
### 16.1 General – addition to prerequisite programme

Section 3 gives the minimum requirements for good hygienic practices for a processing facility prior to the application of hazard and defect analyses.

[12] Aseptic filling is not covered by this Code. Reference to the relevant code is made in Appendix 12.

Figure 16.1

**Example of a flow chart for the processing of canned fish and shellfish**



For fish and shellfish canneries, additional requirements 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 *Recommended International Code of Hygienic Practice for low and acidified low acid canned foods* (CAC/RCP 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 to 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. This thermometer should be regularly calibrated. Records concerning the calibration of instruments should be established and kept.

## 16.2 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.

### 16.2.1 Hazards

#### A Biological hazards

A1 ***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 DSP, PSP or 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 ***Scombrotoxins***

*Histamine*

Histamine is heat stable, and so its toxicity remains practically intact in containers. Good practices for the conservation and handling from capture to heat processing are essential to preventing histamine production. In its Standards for some fish species, the Codex Commission adopted maximum levels tolerated for histamine.

A3 ***Microbiological toxins***

*Clostridium botulinum*

The botulism risk usually appears after 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. Therefore, it is advisable to limit proliferation and the 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 (lubricants, sanitizers, detergents).

C **Physical hazards**

Containers prior to filling may contain materials such as metal or glass fragments.

16.2.2 **Defects**

Potential defects are outlined in the essential quality, labelling and composition requirements described in the relevant Codex Standards listed in Appendix 12. Where no Codex Standard exists, reference should be made to national regulations and/or commercial specifications.

End-product specifications outlined in Appendix 11 describe optional requirements specific to canned products.

## 16.3 Processing operations

Processors can also refer to the *Recommended International Code of Hygienic Practice for low and acidified low acid canned foods* (CAC/RCP 23-1979) in order to obtain detailed advice on canning operations.

16.3.1 **Reception of raw material, containers, covers and packaging material and other ingredients**

16.3.1.1 **Fish and shellfish (Processing Step 1)**

*Potential hazards:* *chemical and biochemical contamination (DSP, PSP, scombrotoxin, heavy metals, etc.)*
*Potential defects:* *species substitution, decomposition, parasites*
*Technical guidance:*
Refer to Section 8.1.1 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.

16.3.1.2 **Containers, covers and packaging materials (Processing Step 1)**

*Potential hazards:* *subsequent microbiological contamination*
*Potential defects:* *tainting of the product*
*Technical guidance:*
Refer to Section 8.5.1; 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 micro-organisms 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;
  - they should be sufficiently durable to withstand the mechanical and thermal stresses encountered during the canning process and to resist physical damage during distribution.

16.3.1.3 **Other ingredients (Processing Step 1)**

Refer to Section 8.5.1.

16.3.2 **Storage of raw material, containers, covers and packaging materials**

16.3.2.1 **Fish and shellfish (Processing Step 2)**

Refer to Sections 8.1.2, 8.1.3 and 7.6.2.

16.3.2.2 **Containers and packaging (Processing Step 2)**

*Potential hazards:* *unlikely*
*Potential defects:* *foreign matter*

*Technical guidance:*
Refer to Section 8.5.2; 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 imperative when containers are put in bags or on pallets. Shocks can deform the containers (can body or flange) – this may compromise tightness (shocks on the seam, deformed flange) or be prejudicial to appearance.

16.3.2.3 **Other ingredients (Processing Step 2)**
Refer to Section 8.5.2.

16.3.3 **Unwrapping, unpacking (Processing Steps 3 and 4)**
*Potential hazards:* *unlikely*
*Potential defects:* *foreign matter*
*Technical guidance:*

- During unwrapping and unpacking operations, precautions should be taken in order to limit product contamination and foreign matter introduction into the product. To avoid microbial proliferation, waiting periods before further processing should be minimized.

16.3.4 **Thawing (Processing Step 5)**
Refer to Section 8.1.4.

16.3.5 **Fish and shellfish preparatory processes (Processing Step 6)**

16.3.5.1 **Fish preparation (gutting, trimming, etc.)**
*Potential hazards:* *microbiological contamination, biochemical development (histamine)*
*Potential defects:* *objectionable matter (viscera, skin, scales, etc. in certain products), off-flavours, presence of bones, parasites, etc.*
*Technical guidance:*
Refer to sections 8.1.5 and 8.1.6; and also:

- When skinning of fish is operated by soaking in soda solution, particular care should be taken to carry out an appropriate neutralization.

16.3.5.2 **Preparation of molluscs and crustaceans**
*Potential hazards:* *microbiological contamination, hard shell fragments*
*Potential defects:* *objectionable matters*

*Technical guidance:*
Refer to Section 7.7; and also:

- 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.

## 16.4 Precooking and other treatments

### 16.4.1 Precooking

*Potential hazards:* *chemical contamination (polar components of oxidized oils), microbiological or biochemical (scombrotoxin) growth*
*Potential defects:* *water release in the final product (for products canned in oil), abnormal flavours*
*Technical guidance:*

#### 16.4.1.1 General considerations

- Methods used to precook fish or shellfish for canning should be designed to bring about the desired effect with a minimum delay and a minimum amount of 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), 13 (Processing of lobsters and crabs), 14 (Processing of shrimps and prawns) and 15 (Processing of cephalopods).
- Care should be taken to prevent temperature abuse of scombrotoxic species before precooking.

#### 16.4.1.1.2 *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.

#### 16.4.1.1.3 *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* (CODEX STAN 210-1999), *Standard for olive oils and olive pomace oils* (CODEX STAN 33-1981) and

*Standard for edible fats and oils not covered by individual standards* (CODEX STAN 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 that the oil or the other fluids used, such as vapour or water, do not impart an undesirable flavour to the product.

16.4.1.1.4 ***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 in 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.

16.4.1.2 **Smoking**

- Refer to Section 12.

16.4.1.3 **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 cleaned at frequent intervals.
- 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.

16.4.2 **Packing in containers (filling, sealing and coding) (Processing Step 8)**

16.4.2.1 **Filling**

*Potential hazards:* *microbiological growth (waiting period), microbiological survival growth and recontamination after heat processing owing to incorrect filling or defective containers*
*Potential defects:* *incorrect weight, foreign matter*
*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 material before they are used.
- Care should also be taken to remove defective containers, because they can jam a filling or sealing machine, or cause trouble during heat processing (inadequate sterilization, leaks).
- Empty containers should not be left on the packing tables or in conveyor systems during cleanup of premises to avoid contamination or splashes.
- Where appropriate, to prevent microbial proliferation, containers should be filled with hot fish and shellfish (for example, > 63 °C for fish soups) or should be filled quickly (the shortest possible waiting period) after the end of the pretreatments.
- If the fish and shellfish must be held for a long 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 in order to comply 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. Buildup of fish and shellfish, as well as 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;
  - 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.

16.4.2.2 **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, at each start of the production line 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.

16.4.2.3 **Coding**

*Potential hazards:* *subsequent contamination owing to damaged containers*
*Potential defects:* *loss of traceability owing to an incorrect coding*
*Technical guidanc:*

- Each container of canned fish and shellfish should bear indelible code markings from which all-important details 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.

16.4.3 **Handling of containers after closure – staging before heat processing (Processing Step 9)**

*Potential hazards:* *microbiological growth (waiting period), subsequent contamination owing to damaged containers*
*Potential defects:* *unlikely*
*Technical guidance:*

- After closure, containers should always be handled carefully in such a way as to prevent any damage capable of causing 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.

16.4.4 **Thermal processing (Processing Step 10)**

Heat processing is one of the most essential operations in canning.

Canners can refer to the *Recommended International Code of Hygienic Practice for low and acidified low acid canned foods* (CAC/RCP 23-1979) in order to obtain 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 micro-organisms responsible for decomposition*
*Technical guidance:*

16.4.4.1 **Sterilization schedule**

- To determine the sterilization schedule, first, the heat process required to obtain the commercial sterility should be established, taking into account some 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 in operations (initial temperature of filling, product composition, size of containers, fullness of the retort, etc.) are made, competent technologists should be consulted as to the need for re-evaluation of the process.

16.4.4.2 **Heat processing operation**
- Only qualified and properly trained personnel should operate retorts. Therefore, it is necessary that retort operators 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 these temperatures.
- In order that the heat processing is effective and process temperature is controlled, 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 retorts (water, steam/air, flame, etc.), refer to the *Recommended International Code of Hygienic Practice for low and acidified low acid canned foods* (CAC/RCP 23-1979).
- If canned fish and shellfish in different size 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.

16.4.4.3 **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; 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.

16.4.5 **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 the 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 beginning, 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 are cooled and thoroughly dry. 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.

16.4.5.1 **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, so that if there are any faults owing to failings on the part of cannery workers or canning equipment, these failings can be corrected without delay. Segregating and properly disposing of all defective units or lots that are unfit for human consumption should be ensured.

16.4.6 **Labelling, casing and storage of finished products (Processing Steps 12 and 13)**
Refer to Section 8.2.3.

*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 have an adequate size in order that the containers fit them and are not damaged by any movement inside. Cases and boxes should be the correct 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 the forklift trucks used for the storage should be used in a proper manner.
- Canned fish and shellfish should be so stored that they will be kept dry and not exposed to extremes of temperature.

16.4.7 **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 17; and also:

- Transportation of canned fish and shellfish should be done in such a way as not to damage the containers. In particular, the forklift trucks used during the loading and unloading should be used in a proper manner.
- Cases and boxes should be completely dry. In fact, moisture has effects on the mechanical characteristics of boxes and 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.

## SECTION 17 – TRANSPORTATION

Refer to the *Recommended International Code of Practice – general principles of food hygiene* (CAC/RCP 1-1969) Section VIII – Transportation, and the *Code of Hygienic Practice for the transport of food in bulk and semi-packed food* (CAC/RCP 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 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 an HACCP and/or 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.

It is particularly important throughout the transportation of fresh, frozen or refrigerated fish, shellfish and their products that care is taken to minimize any rise in temperature of the product and that the chill or frozen temperature, as appropriate, is maintained under controlled conditions. Moreover, appropriate measures should be applied to minimize damage to products and also their packaging.

### 17.1 For fresh, refrigerated and frozen products

Refer to Section 3.6.

*Potential hazards:* *biochemical development (histamine), microbial growth and contamination*

*Potential defects:* *decomposition, physical damage, chemical contamination (fuel)*

*Technical guidance:*

- Check temperature of product before loading.
- Avoid unnecessary exposure to elevated temperatures during loading and unloading of fish, shellfish and their products.
- Load in order 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.
- During transportation:
  - Frozen products should be maintained at –18 °C or below (maximum fluctuation +3 °C).
  - Fresh fish, shellfish and their products should be kept at a temperature as close as possible to 0 °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 stay in

contact with the products or melted water from one container does not cross-contaminate products in other containers.
- Transportation of fresh fish in containers with dry freezer bags and not 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 °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.

### 17.2 For live fish and shellfish

- Refer to the specific provisions laid down in the relevant sections of the Code.

### 17.3 For canned fish and shellfish

- Refer to the specific provisions laid down in Section 16.

### 17.4 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 should be conducted in such a way as to avoid damage and contamination of the products and to ensure the packaging integrity.
- After unloading, accumulation of waste should be avoided and any waste should be disposed of in a proper manner.

## SECTION 18 – 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 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 an HACCP and/or 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.

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 maintaining 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), MAP products at 3 °C (38 °F) or lower, while frozen products should be stored 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 ensuring 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 preventive health protection processes and measures. These systems exist for molluscan shellfish in some countries in the form of molluscan shellfish tagging requirements.

## 18.1 Reception of fish, shellfish and their products at retail – general considerations

*Potential hazards:* *see Sections 7.1 and 8.1*
*Potential defects:* *see Sections 7.1 and 8.1*
*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. Determine that cooked-ready-to-eat product has not been exposed to raw product or 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.

18.1.1 **Reception of chilled products at retail**

*Potential hazards:* *pathogen growth, microbiological contamination, chemical and physical contamination, scombrotoxin 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).

18.1.2 **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. Suspect shipments should be refused.
- 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).

18.1.3 **Chilled storage of products at retail**

*Potential hazards:* *scombrotoxin formation, microbiological contamination, pathogen growth, 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 drip.
- A proper product rotation system should be established. This system could be based on first-in, first-out usage, production date or "best before" date on labels, sensory quality of the lot, etc, as appropriate.

18.1.4 **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 less. 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.

18.1.5 **Preparation and packaging chilled products at retail**

Refer to Section 8.2.3.

*Potential hazards:* *microbiological contamination, scombrotoxin formation, pathogen growth, 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 by utensils or personnel.

18.1.6 **Preparation and packaging of frozen seafood at retail**

Refer to Section 8.2.3.

*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.

18.1.7 **Retail display of chilled seafood**

*Potential hazards:* *scombrotoxin formation, microbiological growth, 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 melt water 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.

18.1.8 **Retail display of frozen seafood**

*Potential hazards:* *unlikely*
*Potential defects:* *thawing, dehydration (freezer burn)*
*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.
- 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.

# ANNEX 1

# 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 foodborne disease. Freezing at –20 °C or below for seven days or –35 °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 nematodes are known to occur worldwide and some species of marine fish act as secondary hosts. Among the nematodes of most concern are *Anisakis* spp., *Capillaria* spp., *Gnathostoma* spp. and *Pseudoteranova* 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 °C for one minute) and by freezing (–20 °C for 24 hours) of the fish core.

**Cestodes**

Cestodes are tapeworms and the species of most 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 major public health problems that occur endemically in about 20 countries around the world. The most important species with respect to the numbers 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 *Ophistorchis*, and

freshwater crustaceans in the case of *Paragonimius*. 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 °C for seven days or at –35 °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 ones 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 that are 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 hydrophyla*, *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*, *Pleisomonas shigeloides* and *Yersinia enterocolitica*. *Staphyloccocus 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 used species.

### 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 Tetradontidea ("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 the 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 Scombrotoxin

Scombroid intoxication, sometimes referred to as histamine poisoning, results from eating fish that have been incorrectly chilled after harvesting. Scombrotoxin is attributed mainly to Enterobacteriaceae, which can produce high levels of histamine and other biogenic amines in the fish muscle when products are not immediately chilled after catching. 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. The intoxication is rarely fatal and symptoms are usually mild. 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 normal 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 amounts 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 out).

## 3. Physical hazards

These can include materials such as metal or glass fragments, shell and bones.

## APPENDIX 1

**MODIFIED ATMOSPHERE PACKAGING**
*Under development*

## APPENDIX 2

**OPTIONAL FINAL PRODUCT REQUIREMENTS – MOLLUSCAN SHELLFISH**
*Under development*

## APPENDIX 3

**OPTIONAL FINAL PRODUCT REQUIREMENTS – FRESH, FROZEN AND MINCED FISH**
*Under development*

## APPENDIX 4

**OPTIONAL FINAL PRODUCT REQUIREMENTS – FROZEN SURIMI**
*Under development*

## APPENDIX 5

**OPTIONAL FINAL PRODUCT REQUIREMENTS – COATED QUICK FROZEN FISHERY PRODUCTS**
*Under development*

## APPENDIX 6

**OPTIONAL FINAL PRODUCT REQUIREMENTS – SALTED FISH**

These products specifications describe the optional defects for salted fish. The descriptions of optional defects will assist buyers and sellers in describing those defect provisions. These descriptions are optional and are in addition to the essential requirements prescribed in the appropriate Codex product standards.

### 1. PRODUCT DESIGNATION OF SALTED FISH OF GADIDAE FAMILY

Reference is given to the *Codex Standard for salted fish and dried salted fish of the Gadidae family of fishes* (CODEX STAN 167-1989).

Products from the following species, all belonging to the Gadidae family, that have been bled, gutted, beheaded and split so that approximately two-thirds of the backbone is removed, washed and fully saturated with salt. Salted fish used for production of dried salted fish shall have reached 95-percent salt saturation prior to drying.

| English name | Latin name |
|---|---|
| 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* |
| Pollock | *Pollachius pollachius* |

*Other sections of Appendix 6 under development*

## APPENDIX 7

### OPTIONAL FINAL PRODUCT REQUIREMENTS – SMOKED FISH

*Under development*

## APPENDIX 8

### OPTIONAL FINAL PRODUCT REQUIREMENTS – LOBSTERS AND CRABS

*Under development*

## APPENDIX 9

### OPTIONAL FINAL PRODUCT REQUIREMENTS – SHRIMPS AND PRAWNS

*Under development*

## APPENDIX 10

### OPTIONAL FINAL PRODUCT REQUIREMENTS – CEPHALOPODS

*Under development*

## APPENDIX 11

### OPTIONAL FINAL PRODUCT REQUIREMENTS – CANNED FISH

*Under development*

## APPENDIX 12

### LIST OF INDIVIDUAL CODEX CODES FROM WHICH THE CODE OF PRACTICE HAS BEEN DEVELOPED

*Under development*

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# Code of practice for fish and fishery products

The *Code of practice for fish and fishery products* is intended for all those engaged in the handling, production, storage, distribution, export, import and sale of fish and fishery products. The Code will help in attaining safe and wholesome products that can be sold on national or international markets and meet the requirements of the Codex Standards. The Code is a work in progress and a number of appendixes remain under development. This first printed edition contains revisions to the texts adopted by the Codex Alimentarius Commission up to 2008.

The Codex Alimentarius Commission is an intergovernmental body with more than 180 members, within the framework of the Joint FAO/WHO Food Standards Programme established by the Food and Agriculture Organization (FAO) of the United Nations and the World Health Organization (WHO). The main result of the Commission's work is the *Codex Alimentarius,* a collection of internationally adopted food standards, guidelines, codes of practice and other recommendations, with the objective of protecting the health of consumers and ensuring fair practices in the food trade.

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