CODE OF PRACTICE FOR FISH AND FISHERY PRODUCTS
(CAC/RCP 52-2003, Rev. 1-2004)

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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 XII* 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 fishery products on board fishing vessels and on shore. It 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, Rev.3 1997), Annex: *HACCP System and Guidelines for its Application*. A pre-requisite programme is described in the Code covering technological guidelines and the essential requirements of hygiene in the production of fish, shellfish and their products, which 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 Appendices II - XI* 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 which can be sold on national or international markets and meet the requirements of the Codex Standards (see Appendix XII*).

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 which would incorporate Good Management 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 for training of fishermen and employees of 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. This Code, therefore, is not intended to replace the advice or guidance of trained and experienced technologists regarding the complex technological and hygienic problems which 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 a 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.

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* Under development

(b) *Section 3 - Pre-requisite 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 which 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 which may have to be considered when building up a HACCP or DAP plan. This is not intended to be an exhaustive list but is designed to help a 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 Critical Control Point (HACCP) and Defect Action Point (DAP) Analysis* - Only when the groundwork in Section 3 has been satisfactorily achieved 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 *Molluscan Shellfish production* deal with pre-harvest and primary production of fish, crustaceans and molluscan shellfish not caught in the wild*.

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

Additionally, 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*.

(g) *Sections 9 to 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*.

(h) *Sections 17 to 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*.

(i) Additional information will be found in the *Appendices**.

SECTION 1 - SCOPE

This Code of practice 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, which are intended for human consumption.

SECTION 2 - DEFINITIONS

For the purpose of this Code:

2.1 GENERAL DEFINITIONS

* Under development.

Biotoxins	means 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	is the process of cooling fish and shellfish to a temperature approaching that of melting ice;
Clean Water	means 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	means the removal of soil, food residues, dirt, grease or other objectionable matter;
Contaminant	means any biological or chemical agent, foreign matter, or other substances not intentionally added to food which may compromise food safety or suitability;
Contamination	the introduction or occurrence of a contaminant in fish, shellfish and their products;
Control Measure	means 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	means 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	is a criterion, which separates acceptability from unacceptability. For the purpose 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 purpose of this Code this also applies to a DAP;
Decomposition	is the deterioration of fish, shellfish and their products including texture breakdown and causing a persistent and distinct objectionable odour or flavour;
Defect	means a condition found in a product which 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 acceptable level, or a fraud risk eliminated;
Disinfection	means the reduction, by means of chemical agents and/or physical methods, the number of micro-organisms in the environment, to a level that does not compromise food safety or suitability;
Dressed	means that portion of fish remaining after heading and gutting;
Facility	means any premises where fish and fishery products are prepared, processed, chilled, frozen, packaged or stored. For the purposes of this Code, premises also includes vessels;
Fish	means 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 to decide which are significant for food safety and therefore should be addressed in the HACCP plan;
Hazard Analysis Critical Control Point (HACCP)	a system which identifies, evaluates, and controls hazards which 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 purpose of this Code this

	also applies to a DAP;
Potable Water	is fresh water 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", World Health Organisation;
Pre-Requisite Programme	is 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 Material	are fresh and frozen fish, shellfish and/or their parts which may be utilised to produce fish and shellfish products intended for human consumption;
Refrigerated Water	is 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	means those species of aquatic molluscs and crustaceans that are commonly used for food;
Step	is a point, procedure, operation or stage in the food chain including raw materials, from primary production to final consumption;
Validation	means 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)	are fish as captured, ungutted.

2.4 FRESH, FROZEN AND MINCED FISH

Candling	is passing fillets of fish over a translucent table illuminated from below to detect parasites and other defects
Dehydration	is 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	is a slice of fish of irregular size and shape removed from the carcase by cuts made parallel to the backbone;
Freezer	is equipment designed for freezing fish and other food products, by quickly lowering the temperature so that after thermal stabilisation the temperature in the thermal centre of the product is the same as the storage temperature;
Freezing Process	is a process which is carried out in appropriate equipment in such a way that the range of temperature of maximum crystallisation 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 stabilisation;
Frozen Storage Facility	a facility that is capable of maintaining the temperature of fish at - 18ºC
Fresh Fish	are fish or fishery products which have received no preserving treatment other than chilling;
Frozen Fish	are fish which 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 which have been maintained at this low temperature, as specified in the Standard for Quick Frozen Finfish, Eviscerated and Uneviscerated during transportation, storage and distribution up to and including the time of final sale. For the purpose 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 sea water, potable water, or potable water with approved additives, as appropriate;

Minced Fish is comminuted flesh produced by separation from skin and bones;

Modified Atmosphere Packaging (MAP) means packaging in which the atmosphere surrounding the fish is different from the normal composition of air;

Separation is a mechanical process for producing minced fish whereby the skin and bone is substantially removed from the flesh;

Separator is a mechanical device used for separation;

Steak is a section of fish, removed by cutting approximately at right angle to the backbone.

2.5 FROZEN SURIMI

De-Watering means removal of excessive wash water from the minced fish flesh;

Frozen Surimi means the fish protein product for further processing, which has been processed by heading, gutting, cleaning fresh fish, and mechanically separating the edible muscle from the skin and bone. The minced fish muscle is then washed, refined, de-watered, mixed with cryoprotective food ingredients and frozen;

Gel Forming Ability means 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 is a generic term of skeletal muscle proteins such as myosin and actin;

Refining means a process of removing from washed meat by used 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 means a variety of products produced from surimi with addition of ingredients and flavour such as “surimi gel” and shellfish analogues;

Water-Soluble Components means any water-soluble proteins, organic substances and inorganic salts contained in fish meat;

Washing means 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 means 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 colorants and other ingredients used for the final coating of fishery products. Typical breading types are: free-flowing breading, coarse breading, 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 mechanised) of regular shapes QF fish blocks into pieces suitable for later coating.

2.12 CANNED FISH AND SHELLFISH

For the purpose 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-Acid and Acidified Low-Acid Canned Food (CAC/PRC 23-1979, Rev. 2 (1993)).

Canned Food	means commercially sterile food in hermetically sealed containers.
Commercial sterility of thermally processed food	means 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 at normal non-refrigerated conditions at which the food is likely to be held during distribution and storage.
Hermetically Sealed Containers	are containers which are sealed to protect the content against the entry of micro-organisms during and after heat processing.
Retort	means a pressure vessel designed for thermal processing of food packed in hermetically sealed containers.
Scheduled Process (or Sterilisation schedule)	means the thermal process chosen by the processor for a given product and container size to achieve at least commercial sterility.
Sterilisation Temperature	means the temperature maintained throughout the thermal process as specified in the scheduled process.
Sterilisation time	means the time between the moment sterilisation temperature is achieved and the moment cooling started.
Thermal Process	means the heat treatment to achieve commercial sterility and is quantified in terms of time and temperature.
Venting	means thorough removal of the air from steam retorts by steam prior to a scheduled process.

SECTION 3 - PRE-REQUISITE PROGRAMME

Prior to the application of HACCP to any segment of the product processing chain, that segment must be supported by pre-requisite programmes based on good hygienic practice or as required by the competent authority.

The establishment of pre-requisite programmes will allow the HACCP team to focus on the HACCP application to food safety hazards which are directly applicable to the product and the process selected, without undue consideration and repetition of hazards from the surrounding environment. The pre-requisite 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 *International Recommended Code of Practice – General Principles of Food Hygiene* (CAC/RCP 1-1969, Rev.3 1997), Annex: *HACCP System and Guidelines for its Application* for further information to assist with the design of the pre-requisite 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 pre-requisite 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 which 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, minimising 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 minimise sharp inside corners and projections to avoid dirt traps;
- construction should facilitate ample drainage;
- a good supply of clean water or potable water[1] at adequate pressure.

3.1.2 To Minimise Contamination

- all surfaces in handling areas should be non-toxic, smooth impervious and in sound condition, to minimise the build-up of fish slime, blood, scales and guts and to reduce the risk of physical and microbial contamination;
- where appropriate, adequate facilities should be provided for the handling and washing of fish and shellfish and should have an adequate supply of cold potable water or clean water for that purpose;
- adequate facilities should be provided for washing and disinfecting equipment, where appropriate;
- the intake for clean water should be 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;
- prevent the entry of birds, insects, or other pests, animals and vermin, where appropriate.

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[1] WHO Guidelines for Drinking Water Quality , 2nd edition, Geneva, 1993

3.1.3 To Minimise 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 minimise damage and deterioration to the fish and shellfish.

3.1.4 To Minimise Damage during Harvesting of Aquacultured and Molluscan Shellfish

When aquacultured products and molluscan shellfish are harvested using seines or 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 easy cleanable and free from contamination;
- conveying equipment for live and slaughtered products should be constructed of suitable corrosion-resistant material which 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 minimise 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, nitrogenous wastes, etc).

3.2 FACILITY DESIGN AND CONSTRUCTION

The facility should include a product flow-through pattern that is designed to prevent potential sources of contamination, minimise 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. The facility, therefore, 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 in contact should be of corrosion resistant, impervious material which 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 minimise the build-up of dirt and condensation, and the shedding of particles;
- windows should be constructed to minimise the build-up 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 Minimise Contamination

- facility layout should be designed to minimise 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, to minimise the build-up of fish slime, blood, scales and guts and to reduce the risk of physical contamination;
- working surfaces that come into direct contact with fish, shellfish and their products should be in sound condition, durable and easy to maintain. They should be made of smooth, non-absorbent and non-toxic materials, and inert to fish, shellfish and their products, detergents and disinfectants under normal operating conditions;
- adequate facilities should be provided for the handling and washing of products and should have an adequate supply of cold potable water for that purpose;
- suitable and adequate facilities should be provided for 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 minimised 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 to prevent the 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

- 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 minimises the build-up 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 minimise sharp inside corners and projections and tiny crevices or gaps 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 Minimise Contamination

- all surfaces of equipment in handling areas should be non-toxic, smooth, impervious and in sound condition, to minimise the build-up of fish slime, blood, scales and guts and to reduce the risk of physical contamination;
- accumulation of solid, semi-solid or liquid wastes should be minimised 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 Minimise 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 build up 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:

Pre-cleaning	Preparation of area and equipment for cleaning. Involves steps such as removal of all fish, shellfish and their products from area, protection of sensitive components and packaging materials from water, removal by hand or squeegee of fish scraps, etc.
Pre-rinse	A rinsing with water to remove remaining large pieces of loose soil.
Cleaning	means the removal of soil, food residues, dirt, grease or other objectionable matter.
Rinse	A rinsing with potable water or clean water, as appropriate, to remove all soil and detergent residues.
Disinfection	Application of chemicals, approved by the official agency having jurisdiction and/or heat to destroy most microorganisms on 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 which would prevent its contamination
Check of the efficiency of the cleaning	The efficiency of the cleaning should be controlled as appropriate

Handlers or cleaning personnel as appropriate should be well trained in the use of special cleaning tools and chemicals, methods of dismantling equipment for cleaning and should be knowledgeable in 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 within.

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. These procedures should specify for each equipment, 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[2] and/or clean water under adequate pressure should be provided where appropriate;
- potable water[2] should be used wherever necessary to avoid contamination.

3.4.5.2 Ice

- ice should be manufactured using potable water[2] or clean water;
- ice should be protected from contamination.

3.4.5.3 Steam

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

3.4.6 Waste Management

- offal and other waste materials should be removed from the premises of a processing facility or vessel on a regular basis;

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[2] WHO Guidelines for Drinking Water Quality, 2nd edition, Geneva, 1993

- facilities for the containment of offal and waste material should be properly maintained;
- vessel waste discharge should not contaminate vessel water intake system 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 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 the preparation, handling or transportation;
- where necessary, adequate and appropriate protective clothing, headcovering 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 the 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, pins or other items that, if dislodged, may 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 transport 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);
- live fish and shellfish are to be transported at temperature tolerant to 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 pre-requisite 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 an 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 fundamentally important. 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 a 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 employee 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 it is known to contain parasites, undesirable microorganisms, pesticides, veterinary drugs or toxic, decomposed or extraneous substances known to be harmful to human health. When fish and shellfish determined as unfit for human consumption are found they should be removed and stored separately from the catch and either reworked and/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 in controlling food safety. It is therefore essential that fresh fish, fillets, shellfish and their products which are to be chilled should be held at a temperature as close as possible to 0ºC.

4.1.1 Minimise the Deterioration - Time

To minimise the 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 Minimise the 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 0ºC;
- 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 temperature tolerant to 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 which impairs its working efficiency;
- monitoring and controlling the time and temperature and homogeneity of chilling should be performed regularly

4.2 MINIMISE THE DETERIORATION - HANDLING

Poor handling practices can lead to damage of fresh fish, shellfish and other aquatic invertebrates which can accelerate the rate of decomposition and increase unnecessary post-harvest losses. Handling damage can be minimised by:

- fish and shellfish should be handled and conveyed with care particularly during transfer and sorting in order to avoid physical damage such as puncture, mutilation, etc.;
- 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, nitrogenous wastes, etc.);
- 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 deeply;
- 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, which can help minimise damage to fish and shellfish and maximise cooling capacity;
- in refrigerated water storage areas, the density of the fish should be controlled to prevent damage.

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

The Hazard Analysis Critical Control Point (HACCP) is a science-based system which is aimed to prevent food safety problems from occurring rather than reacting 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 the 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 which 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 will demonstrate one format, which may be considered in the development of the 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 Analysis**. This approach for defect analysis is optional and other techniques, which achieve the same objective, may be considered.

Figure 5.1 summarises how to develop a HACCP and Defect Analysis system.

5.1 HACCP PRINCIPLES

The HACCP System consists of seven principles[3], which are

PRINCIPLE 1 - Conduct a hazard analysis.

PRINCIPLE 2 - Determine the Critical Control Points (CCPs).

PRINCIPLE 3 - Establish critical limit(s).

PRINCIPLE 4 - Establish a system to monitor control of the CCP.

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.

[3] *International Recommended Code of Practice – General Principles of Food Hygiene* (CAC/RCP 1-1969, Rev.3 - 1997), Annex: *HACCP System and Guidelines for its Application*

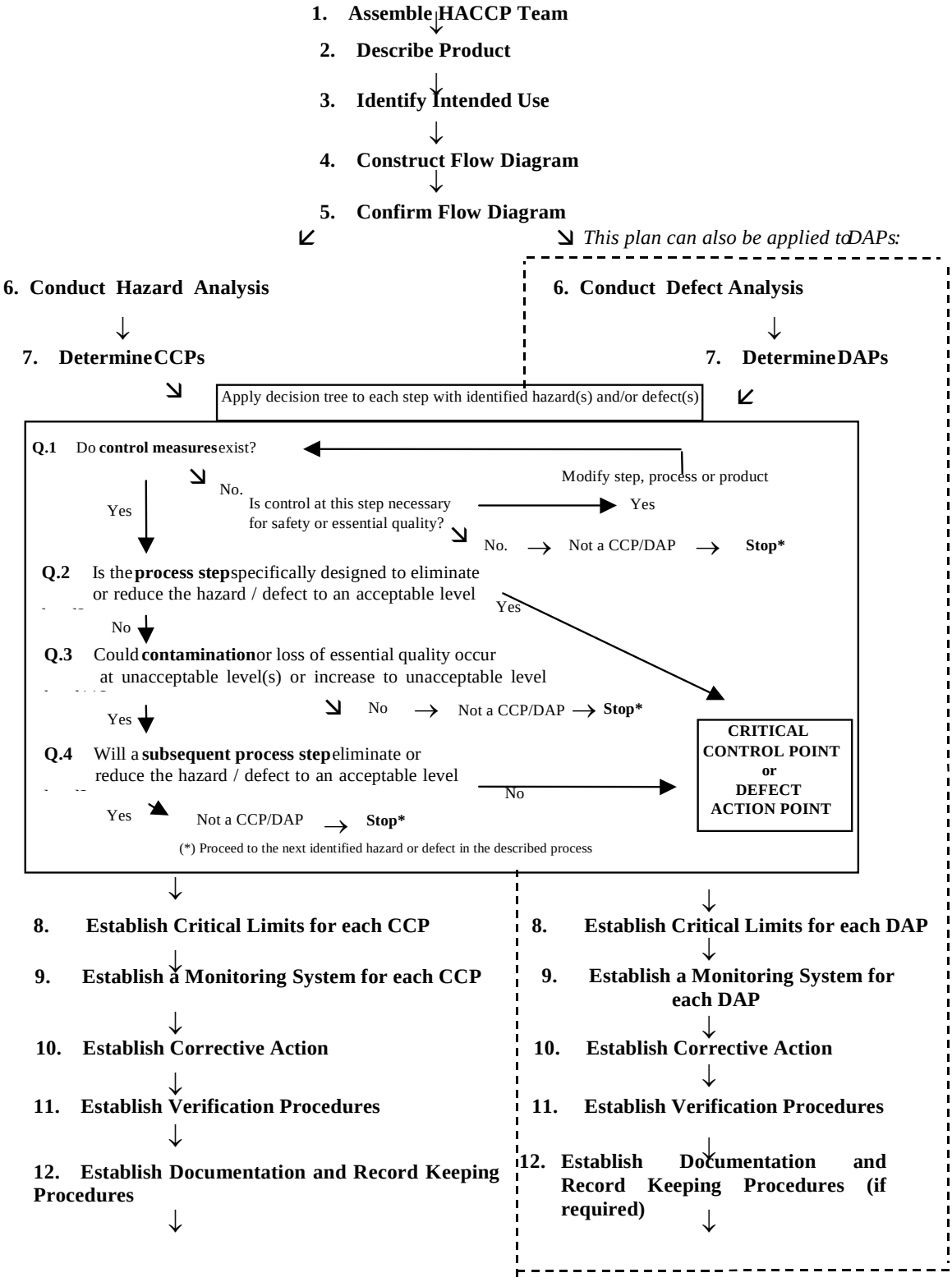

Figure 5.1 Summary of how to implement a HACCP and Defect Analysis

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

HACCP is an important management tool, which can be used by operators for ensuring safe, efficient processing. It must also be recognised that personnel training is essential in order that HACCP will be effective. In following HACCP principles, users are requested to list all of the hazards that may be reasonably expected to occur for each product type at each step or procedure in the process from point of harvest, during unloading, transport, storage or during 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

Since the Code is intended to cover not only those hazards associated with safety but 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 (CCP) described but also defect action points (DAP) 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 pre-requisite programme based on good hygienic practice (see Section 3). It should be noted that parts of the pre-requisite programme may be classified as a CCP or DAP within a particular process.

The food management system developed should indicate responsibility, authority and the 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 should be carried out by a multi-disciplinary 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, operators, etc., 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 is involved and the general classes of hazards to be addressed.

The design of this programme should identify critical control points 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 critical control point, the monitoring system used to record the results of these inspections and any corrective action when required. A record for each critical control point 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 plant's quality assurance programme. 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."

Table 5.1 A product description for Canned Tuna in Salted Water

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

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

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.

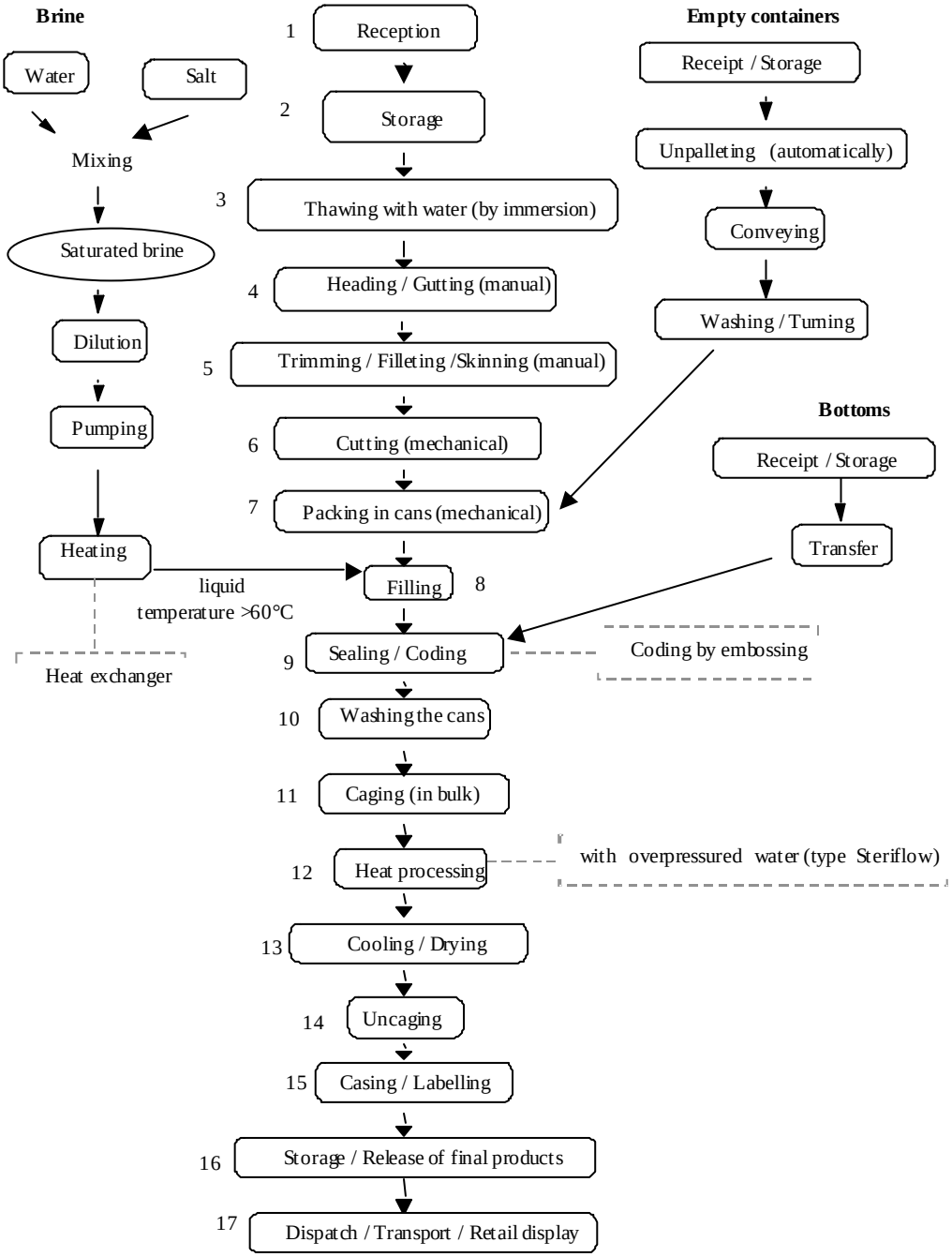

Figure 5.2 Example of a flow diagram for a processing line of canned tuna fish in brine

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 in 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 carefully examine both the product and the process and produce a flow diagram(s). Any flow diagram should be as simple as possible. Each step in the process, including process delays from the selection of raw materials through to the processing, distribution, sale and customer handling, should be clearly outlined in sequence with sufficient technical data to avoid ambiguity. If a process is too complex to be easily represented by a single flow diagram, then it can be sub-divided 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 multi-disciplinary 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 to 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.

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 multi-disciplinary team is able to identify and list, at each step of the process, all of the hazards that may reasonably 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, which have been known to be associated with fresh fish and shellfish, are described in Annex 1. Table 5.2 summarises possible pre-harvest and harvest safety hazards in incoming fish and shellfish and Table 5.3 summarises 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 which may be associated with the use of ice and water. This is covered by the pre-requisite programme and is used to denote hazards that are common to almost any point in the process.

Table 5.2 Examples of Pre-harvest and Harvest Hazards in Incoming Fish & 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:	Norwalk virus	**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 & Shellfish*.

Biological		Chemical		Physical	
Pathogenic bacteria:	Listeria monocytogenes, Clostridium botulinum, Staphylococcus aureus	**Chemicals:**	Disinfectants, Sanitizers or Lubricants (Misapplication)	**Foreign Matter**	Metal fragments; hard or sharp objects
Enteric Viruses:	Hepatitis A, Rotovirus		Disinfectants, Sanitizers or Lubricants (non-approved)		
Biotoxins:	Scombrotoxin, Staph. Enterotoxin, botulinum toxin				
		Ingredients and Additives:	Misapplication and non-approved		

Note: For biological hazards, environmental factors (for example: 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.

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

For the example on canned tuna developed in this section, the following essential potential hazards can be identified:

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 *Cl. botulinum*, Presence of scombrotoxin	Contamination by *Cl. Botulinum*, Growth of *Cl. Botulinum*, Survival of spores of *Cl. Botulinum*, Contamination and growth of *Staphylococcus aureus* Microbial recontamination after heat processing Production of scombrotoxin during processing, Production of staphylotoxin
Chemical	Presence of heavy metals	Recontamination by metals coming from the cans Recontamination by cleaning agents, by the brine, by mechanical grease, …
Physical	Presence of foreign material	Recontamination during processing (pieces of knives, by the cans, …)

For the example on canned tuna developed in this section, the following potential defects can be identified:

Table 5.5 An example of potential defects of canned tuna

	In raw materials (frozen tuna)	During processing or storage or transportation
Biological	Decomposition	Decomposition, survival of micro-organisms responsible of decomposition, …
Chemical		oxidation during storage, …
Physical		Objectionable matters (viscera, scales, skin, …), formation of struvite crystals, container defects (panelled container, …)
Others	species substitution	abnormal flavours, incorrect weight, incorrect coding, incorrect labelling

5.3.3.1.1 Hazards

It is equally important to consider, naturally occurring food safety hazards in the environment from which fish or shellfish are harvested. In general, risks to consumer health from seafood captured in unpolluted marine environments are low, provided these products are handled in line with principles of Good Manufacturing Practice. 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 of environmental contamination is greater when compared to 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 a 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 XII*. Where no Codex Standard exists regard should be made to national regulations and/or commercial specifications.

End product specifications outlined in Appendices II – XI*, describe optional requirements which are intended to assist buyers and sellers in describing those provisions which 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, which 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 purposes of HACCP). Thus, in the processed canned tuna, *Clostridium 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 gastroenteritis, might not warrant the HACCP controls at the same very low probability of occurrence, and thus not be significant for purposes of HACCP.

Information gathered during the product description exercise (refer to Section 5.3.1 – Describe Product) could also help facilitate the determination of significance since the likelihood of occurrence of hazard or defect can be affected by factors such as how the consumer will likely use the product (e.g., to consumed or cooked raw); the types of consumers who will likely consume it (e.g., immuno-compromised, elderly, children, etc.) 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 assess 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 – Flow Diagram) 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 its possible occurrence or to reduce it to an acceptable level. A hazard or defect may be controlled by more that 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”.

* Under elaboration.

Table 5.6 An example of the significant hazard survival of *Cl. 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	*Cl. 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 Stock management procedure Maintenance procedure of the refrigeration system 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 N° 12 Heat processing		**Application of Codex Decision Tree**			
Potential Hazards	Control Measures				
Cl. botulinum viable spores	Ensure adequate heat applied for proper time at retort	**Q1**: Do control measures exist? **If yes** – go to Q2. **If no** – consider whether control measures are available or necessary within the process. Proceed to next identified hazard.	**Q2**: Is the step specifically designed to eliminate or reduce the likely occurrence of *Cl. botulinum* to an acceptable level? **If yes** – this step is a CCP. **If no** – go to Q3.	**Q3**: Could contamination occur in excess of acceptable levels or could these increase to unacceptable levels? **If yes** – go to Q4. **If no** – not a CCP.	**Q4**: Will a subsequent step eliminate or reduce the hazard to an acceptable level? **If yes** – not a CCP. **If no** – CCP. *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 N°12 « Heat processing » is a **Critical Control Point**			

5.3.4 Determine Critical Control Points and Defect Action Points

A thorough and concise determination of Critical Control Points and Defect Action Points 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 decision tree (Figure 5.1, step 7) is a tool , which 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, an example 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 & 5.9, respectively.

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.

<table>
<tr><th colspan="2">Processing Steps N°2
Storage of frozen tuna</th><th colspan="4">Application of Codex Decision Tree</th></tr>
<tr><td>Potential Defects</td><td>Control Measures</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Persistent and distinct objectionable odours or flavours indicative of rancidity</td><td rowspan="2">Controlled temperature in storage premises.
Stock management procedure.</td><td>Q1: Do control measures exist?

If yes – go to Q2.

If no – consider whether control measures are available or necessary within the process.

Proceed to next identified hazard.</td><td>Q2: Is the step specifically designed to eliminate or reduce the likely occurrence of rancidity to an acceptable level?

If yes – this step is a DAP.

If no – go to Q3.</td><td>Q3: Could rancidity occur in excess of acceptable levels or could it increase to unacceptable levels?

If yes – go to Q4.

If no – not a DAP.</td><td>Q4: Will a subsequent step eliminate rancidity or reduce its likely occurrence to acceptable level?

If yes – not a DAP.

If no – DAP. What about consideration of a previous step?</td></tr>
<tr><td>A: Yes, the storage temperature is controlled, procedures exist</td><td>A: No</td><td>A : Yes, if the storage time is too long and/or the storage temperature is too high</td><td>A : No</td></tr>
<tr><td colspan="2"></td><td colspan="4">Decision: Processing Step N°2 « Storage of frozen tuna » is a Defect Action Point</td></tr>
</table>

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 its 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 multi-disciplinary 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 optimising the number of individuals performing the measurement and selection of appropriate methods, which will produce rapid results (for example: time, temperature, 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 recognised 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 which 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 if 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 a HACCP programme and facilitate in the verification process. Examples of the elements of a 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 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 & 5.9), for a CCP & 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 **What**: All parameters **Frequency**: every batch **How**: Checks of sterilisation schedule and other factors	Who: qualified personnel What: Personnel retraining New heat processing or batch destruction Corrective maintenance of equipment Hold product until safety can be evaluated. 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. Storage temperature and time.	**Who**: Appropriate trained personnel **How** : Organoleptic examination Chemical tests Checking of the storage premise temperature Checking of stock forms **What**: fish quality and acceptability based on product Codex standard. **Frequency**: as required	What: Application of an intensified monitoring According to the results of this intensified inspection, immediate processing, sorting or reject of frozen tuna exceeding the critical limits. Adjust storage temperature. Personnel retraining Who: Appropriate trained personnel	Analysis results Stock forms Temperature records	On-site audit 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. Since 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 categorically determine 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 a HACCP and DAP plan will be unique to each operation.

The remaining Sections in the Code concentrate on aquaculture and molluscan shellfish production and to the handling and processing of fish, shellfish and their products and attempt to illustrate the potential hazards and defects at the various stages in a wide range of processes. In developing a HACCP or DAP plan it will be necessary to consult Sections 3 & 5 before turning to the appropriate processing section for specific advice. It should also be noted that Section 8 refers to processing of fresh, frozen and minced fish and will provide useful guidance for most of the other processing operations.

SECTION 8 - PROCESSING OF FRESH, FROZEN AND MINCED FISH

In the context of recognising controls at individual processing steps, this section provides examples of potential hazards and defects and describes technological guidelines, which can be used to develop control measures and corrective action. At a particular step only the hazards and defects, which are likely to be introduced or controlled at that step, are listed. It should be recognised that in preparing a 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 of Practice it is not possible to give details of critical limits, monitoring, record keeping and verification for each of the steps since these are specific to particular hazards and defects.

In general, the processing of fresh, frozen fish 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 fabrication of the desired product relies on the consecutive execution of individual steps. As stressed by this Code, the application of appropriate elements of the pre-requisite 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 and frozen fish. As in the further processing of fresh fish in a MAP product, or minced or frozen fish, the section labelled “Fish Preparation” is used as the basis for all the other fish processing operations (Sections 9-16)[4], where appropriate.

[4] Sections 10-15 under elaboration

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.

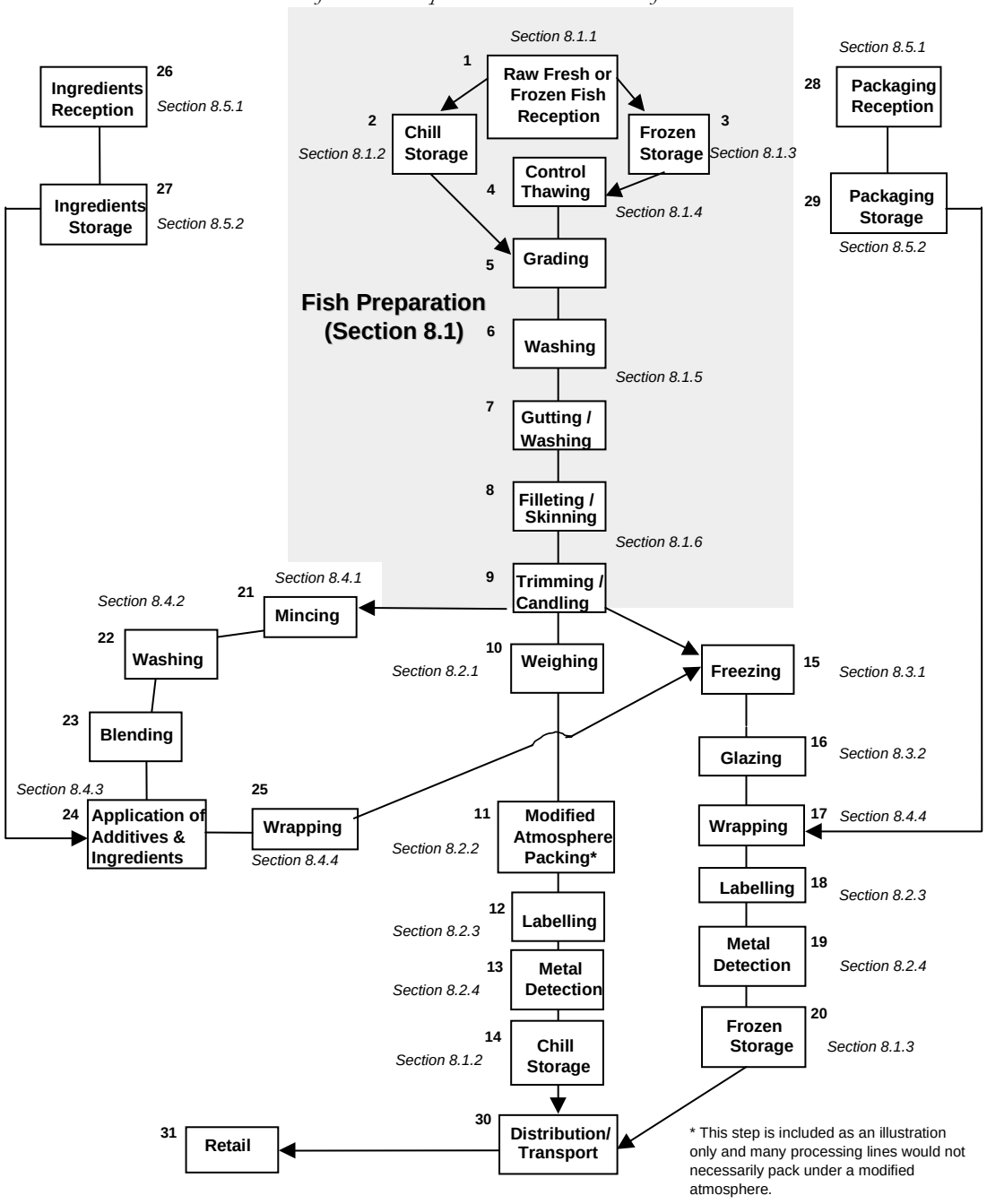

Figure 8.1 Example of a flow chart of a fish fillet preparation line, including MAP, mincing and freezing operations

8.1 FINFISH PREPARATION

The hygienic conditions and technical manner in which fish are prepared is similar and is not influenced greatly by its 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 utilised. The forms may include, but not limited to, dressed, fillets or steaks.

8.1.1 Raw, Fresh or Frozen Fish Reception (Processing Steps 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, etc;
  - chemical indicators of decomposition and/or contamination, for example, TVBN, histamine, heavy metals, pesticide residues, nitrates etc;
  - 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.
- 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. Of special consideration, are the reception and sorting of fish species that poses a risk of biotoxins such as ciguatoxin in large carnivorous tropical and sub-tropical 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 - Washing & Gutting);
- fish should be rejected if it is known to contain harmful, decomposed or extraneous substances, which 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[5]. 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 white fish 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 & 14)

Potential Hazards: *Microbiological pathogens, biotoxin, and scombrotoxin.*

[5] *Guidelines for Sensory Evaluation of Fish and Shellfish in Laboratories* (CAC/GL 31-1999)

Potential Defects: *Decomposition, physical damage.*

Technical Guidance:

- fish should be moved to the chill storage facility without undue delay;
- the facility should be capable of maintaining the temperature of the fish between 0ºC - +4ºC;
- 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 utilisation 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 of water before processing;
- fish should be stored such that damage will be prevented from over-stacking or over-filling of boxes;
- where appropriate replenish ice supply on the fish or alter temperature of the room.

8.1.3 Frozen Storage (Processing Steps 3 & 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 -18ºC, 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, which 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 of 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 Control Thawing (Processing Step 4)

Potential Hazards: *Microbiological pathogens, biotoxins and 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, histamine, where high risk species are concerned or persistent and distinctive objectionable odours or flavours indicative of decomposition or rancidity;
- where water is used as the thawing medium, it should be of potable quality;
- where recycling of water is used, care should be taken to avoid the build up of microorganisms;
- where water is used, circulation should be sufficient to produce even thawing;
- during thawing, according to the method used, products should not be exposed to excessively high temperatures;
- particular attention should be paid to controlling condensation and drip from the fish. An effective drainage should be made;

- 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 & 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 sea water 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 minimise build-up of slime and 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 utilisation.

8.1.6 Filleting, Skinning, Trimming and Candling (Processing Steps 8 & 9)

Potential Hazards: *Viable parasites, microbiological pathogens, biotoxins and scombrotoxin, presence of bones.*

Potential Defects: *Parasites, presence of bones, objectionable matter (e.g. skin, scales, etc.), decomposition.*

Technical Guidance:

- to minimise time delays, the design of the filleting line and candling line, where applicable, should be continuous and sequential to permit the uniform flow without stoppages or slow-downs and removal of waste;
- an adequate supply of clean sea water or potable water should be available for washing of:
  - fish prior to filleting or cutting especially fish that have been scaled;
  - fillets after filleting or skinning or trimming to remove any signs of blood, scales or viscera;
  - filleting equipment and utensils to minimise build-up of slime and blood and offal;
  - for fillets to be marketed and designated as boneless, fish handlers should employ appropriate inspection techniques and use the necessary tools to remove bones not meeting Codex standards[6,7] or commercial specifications;
- The candling of skinless fillets by skilled personnel, in a suitable location which optimises 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 minimise the microbial activity of contact surfaces and the drying of fish residue due to 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.

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6 Codex Standard for Quick Frozen Blocks of Fish Fillet, Minced Fish Flesh and Mixtures of Fillets and Minced Fish Flesh (Codex Stan. 165-1989, Rev.1-1995)

7 Codex Standard for Quick Frozen Fish Fillets (Codex Stan. 190-1995)

8.2 PROCESSING OF VACUUM OR MODIFIED ATMOSPHERE PACKED FISH

This section is designed to augment the processing of fresh fish section with additional operation steps pertaining specifically to the modified atmosphere packing of fish (see also Appendix I).

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 standardised 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 I for process control issues in modified atmosphere packaging.

- modified atmosphere packaging should be strictly controlled by:
  - monitoring the gas to 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;
- occurrence of adequate vacuum and package;
- 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 an appropriately trained personnel to verify the effectiveness of the seal and the proper operation of the packaging machine;
- following sealing, MAP or vacuumed 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 & 18)

Potential Hazards: *Unlikely*

Potential Defects: *Incorrect labelling*

Technical Guidance:

- prior to their application, labels should be verified to ensure that all information declared meet, where applicable, the Codex General Standard for the Labelling of Pre-packaged Foods[8], labelling provisions of the appropriate Codex Standard for products and/or other relevant national legislative requirements;

[8] Codex General Standard for the Labelling of Pre-packaged Foods (CODEX STAN 1-1985, Rev. 2-1991)

- 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 & 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 processing of fresh fish section with additional operation 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 since unnecessary delays before freezing will cause temperature of the fish products to rise, increasing the rate of quality deterioration and reducing shelf-life due 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 crystallisation 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 of 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 minimise the bacterial load and build-up of fish protein, which can hamper freezing performance;

8.4 PROCESSING OF MINCED FISH

This section is designed to augment the processing of fresh fish section (prior to mincing) and 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 due to the formation of fines;
- the washed minced fish flesh may be partially de-watered 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 de-watered mince should be either strained or emulsified;
- special attention should be taken to ensure mince being strained is kept cool;
- the resulting waste water should be disposed of in a suitable manner.

8.4.3 Blending and Application of Additives and Ingredients to Minced Fish (Processing Steps 23 & 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 Codex General Standard for Food Additives;
- 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 Packing (Processing Steps 17 & 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 minimise the risk of contamination and decomposition;
- products should meet appropriate standards for labelling and weights.

8.5 PACKAGING, LABELS & INGREDIENTS

8.5.1 Reception – Packaging, Labels & Ingredients (Processing Steps 26 & 28)

Potential Hazards: *Microbiological pathogens, chemical and physical contamination*

Potential Defects: *Misdescription*

Technical Guidance:

- only ingredients, packaging material and labels complying with the processors' specification should be accepted into the processing facility;
- labels which are to be used in direct contact with the fish should be fabricated 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 refused at reception;

8.5.2 Storage - Packaging, Labels & Ingredients (Processing Steps 27 & 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

(Proposed Draft Section at Steps 5/8 of the Procedure)

In the context of recognising controls at individual processing steps, this section provides examples of potential hazards and defects and describes technological guidelines, which can be used to develop control measures and corrective action. At a particular step only the hazards and defects, which are likely to be introduced or controlled at that step, are listed. It should be recognised that in preparing a 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 of Practice it is not possible to give details of critical limits, monitoring, record keeping and verification for each of the steps since these are specific to particular hazards and defects.

Frozen surimi is an intermediate food ingredient made from myofibrillar fish protein isolated from other constituent fish protein by repeated washing and de-watering 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 analogs (imitation crab) that utilise its gel forming ability.

Frozen surimi is manufactured using various methods, but this flow chart shows the most typical procedure.

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

References correspond to relevant Sections of the Code.

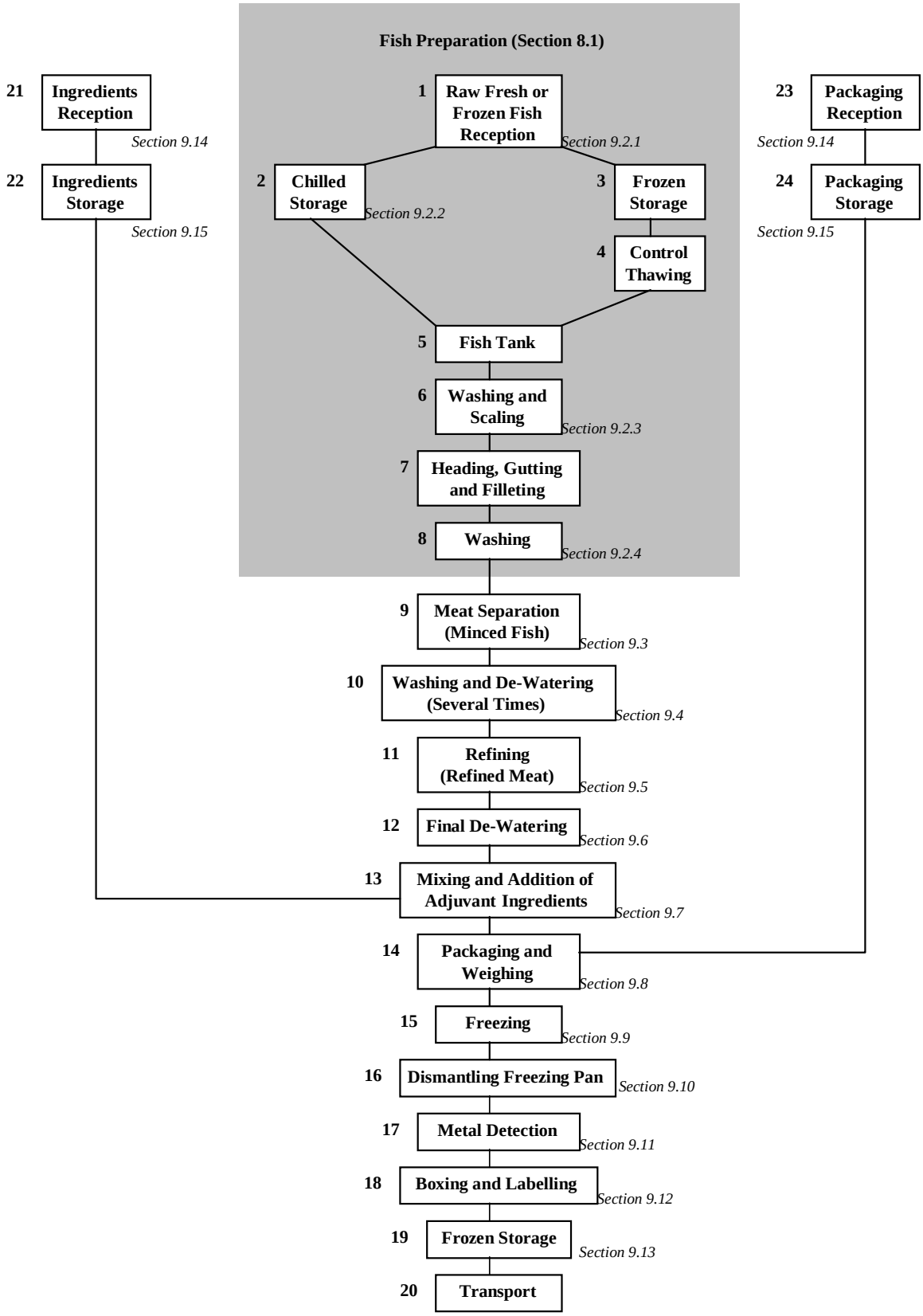

Figure 9.1 Example of a flow chart of a frozen surimi production process.

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 mechanised operations

that are common in Japan, the United States and some other country in which there are processors under mechanised 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 periodic revision of this section of the Code of Practice.

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 analogs. 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 *Clostridium botulinum* (that becomes a hazard due to modified atmosphere packaging of the end product) should be controlled during the cooking or pasteurising steps of final processing. Possible *Staphylococcus aureus* contamination that produces heat-stable enterotoxins should be adequately controlled by the pre-requisite programme. Parasites will not be a hazard since the final product will be cooked or pasteurised.

If scombrotoxin-forming fish such as tuna or mackerel or tropical reef fish that may accumulate ciguatera toxin are utilised for surimi, appropriate controls for these hazards should be developed. Likewise, due to the highly mechanised nature of surimi processing, appropriate controls should be instituted to assure that metal fragments (e.g., bearings, bolts, washers, and nuts) are excluded or eliminated in the end product.

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

9.1.2 Defects

Certain quality attributes of frozen surimi is important for the successful manufacture of surimi-based products such as kamaboko and crab analogs 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 X of the code entitled Optional Final Product Requirements for Frozen Surimi[9].

Myxosporidia is a parasite that is common in marine groundfish such as Pacific Whiting. This organism contains protease enzymes that chemically separates 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, a 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 analogs 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 analog end products. It also necessary to note that decomposed fish should not be used as raw material for production of frozen surimi, because proliferation of spoilage bacteria that cause decomposition of the end product will cause negative effect on the gel forming ability of frozen surimi by denaturing salt soluble protein.

The washing and de-watering cycle should be sufficient to achieve separation of the water-soluble protein from the myofibrillar proteins. If water-soluble proteins remain in the product it 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 minimised as it negatively affects the usability of frozen surimi for processing into end products.

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9 Under elaboration

Due to the comminuted nature of raw surimi, the use of food additive may be necessary to achieve the level of quality that is desired. These additives should be introduced to surimi in accordance to appropriate regulations and manufacturer's recommendation 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 cold water marine fish should not be subjected to temperatures above 10°C during processing. Warm water fishes may denature at a slower rate and may not be as temperature sensitive.

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

9.2 FISH PREPARATION (Processing Steps 1 to 8)

Refer to Section 8.1 steps 1 through 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 ground fish 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. Especially, care should be taken to raw fish received many hours after harvest. For example 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 of 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 pH of 7.0 ± 0.5
- fish that is crushed and suffocated due to abnormally big tow size and duration during harvesting should be deleted from the line in order to avoid negative effect to 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 minimised with prompt processing in order to minimise protein denaturation and loss of gel strength capability;
- raw fish should be preferably 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 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 to eliminate the hazard;
- procedures should be established to assure that chemical contamination of the product is not likely;
- separated minced meat should be immediately spread into water and transferred to the washing and de-watering step to prevent blood from congealing and causing loss of gel strength capability.

9.4 WASHING AND DE-WATERING 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 since this species will usually have a high protease activity. Some warm water species may be processed at temperatures up to 15°C;
- product should be processed promptly to minimise 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 de-watering step in regards 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 100ppm or below in terms of converted CaCO3;
- salt or other de-watering aids can be added (less than 0.3% salt) in the final stage of washing to enhance dehydration efficiency;
- food additives should be added in accordance with national regulations and manufacturer's instructions, if use 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 minimise 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 de-watering;
- 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 DE-WATERING 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 de-watering process should be adequately controlled to prevent the growth of pathogenic bacteria;
- temperature of refined fish flesh should not exceed 10°C for cold water fish species, such as Alaska Pollock. For Pacific Whiting the temperature should not be exceed 5°C, since this species usually will have a high protease activity. Some warm water species may be processed at temperatures up to 15°C;
- product should be processed promptly to minimise possible pathogenic microbial growth;
- the moisture level of refined product should be controlled to specified levels with appropriate de-watering equipment (e.g., centrifuge, hydraulic press, screw press);
- consideration should be given to variations in moisture levels due to 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 cold water fish species such as Alaska Pollock. For Pacific Whiting the temperature should not exceed 5°C since this species usually will have a high protease activity. Some warm water species may be processed at temperatures up to 15°C;
- product should be processed promptly to minimise 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 Codex General Standard for Food additives;
- 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 analogs 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 minimise possible pathogenic microbial growth;
- the packaging operation should have procedures established that make possible cross contamination unlikely;
- product should be stuffed 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 minimise the risk of contamination or decomposition;
- packaged products should not contain voids;
- the product should meet appropriate standards for net weight.

See also Section 8.2.1 "Weighing" and Section 8.4.4 "Wrapping and Packing".

9.9 FREEZING OPERATION (Processing Step 15)

Refer to Section 8.3.1 for general considerations for 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 specifies 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 refrain from deep dehydration during long-term cold storage.

9.11 METAL DETECTION (Processing Step 17)

Refer to Section 8.2.4 "Metal Detection" 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 Section 8.2.3 "Labelling" and Section 8.4.4 "Wrapping and Packing".

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 "Frozen Storage" 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 assure 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 22)

Refer to Section 8.5.1 ”Raw Material Reception - Packaging, Labels and Ingredients".

9.15 RAW MATERIAL STORAGE - PACKAGING AND INGREDIENTS (Processing Steps 23 and 24)

Refer to Section 8.5.2 "Raw Material Storage - Packaging, Labels and Ingredients".

SECTION 10 - PROCESSING OF QUICK-FROZEN COATED FISH PRODUCTS

In the context of recognising controls at individual processing steps, this section provides examples of potential hazards and defects and describes technological guidelines, which can be used to develop control measures and corrective action. At a particular step only the hazards and defects, which are likely to be introduced or controlled at that step, are listed. It should be recognised that in preparing a 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 of Practice it is not possible to give details of critical limits, monitoring, record keeping and verification for each of the steps since these are specific to particular hazards and defects.

This 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.

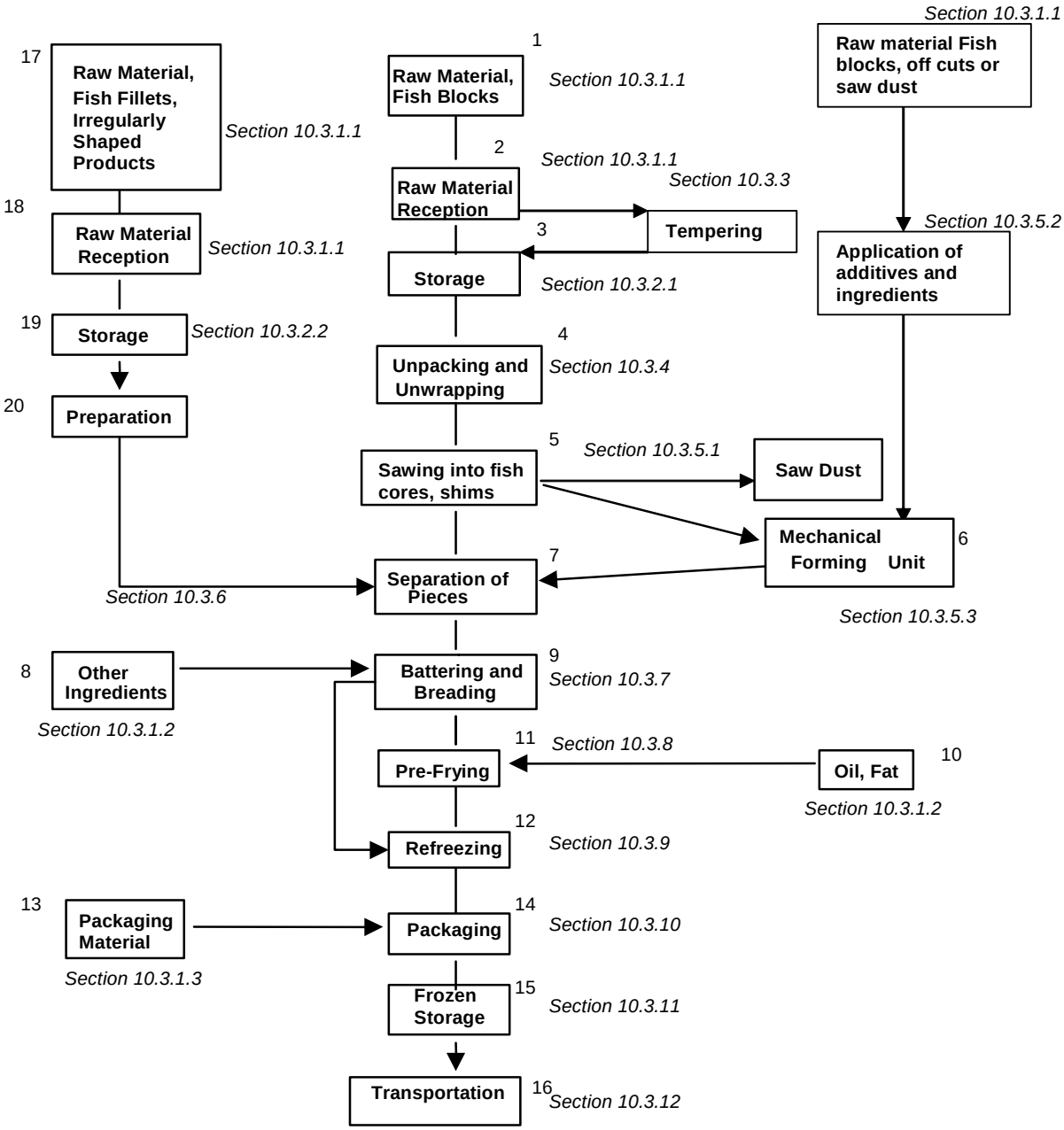

Figure 10.1 Example of a flow chart for the processing of coated fish products

10.1 GENERAL ADDITION TO PRE-REQUISITE PROGRAMME

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

This Section describes the main hazards and defects specific to QF 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 rehydratation 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 toxins 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 Codex 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 XI describe optional requirements specific to QF 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;*

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.
- pre-printed 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 nonfrozen 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 due to sawing of over softened fish flesh (applies to fish sticks)*

Technical Guidance:

- Depending on the use of the fish, the tempering of frozen fish blocks/fillets should be carried out in a manner which will allow the temperature of the fish to rise without thawing.
- Tempering block/fillets of frozen fish in chilled storage is a slow process that usually requires at least 12 hours or more
- Over softening of the outer layers is undesirable (poor performance during sawing) and should be avoided. It could 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 alternate 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 given 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, to avoid tearing of the product and breakage;
- saw dust 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

Also refer 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 subject to too much pressure (mushy, rancid)*

Technical Guidance:

Forming of fish cores is a highly mechanised method of producing fish cores for battering and breading. It utilises 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 QF fish material must be well separated from each other and should not adhere to each other;
- fish cores that are touching each other going through the wet coating step should be removed and placed back on the conveyor in order to get 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 broke, misshape or out of specification peaces.

10.3.7 Coating

In industrial practice the order and the number of coating steps may differ and may therefore 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 products 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 to Codex Standard for Frozen Fish Fingers, Fish Portions and Fish Fillets – Breaded or in Batter (Codex Standard 166-1989);
- the proportion of breading and fish core should be in accordance to Codex Standard for Frozen Fish Fingers, Fish Portions and Fish Fillets – Breaded or in Batter (Codex Standard 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: *over-oxidised oil, insufficient frying, loosely adhering coating, burnt pieces and portions*

Technical Guidance:

- frying oil should have a temperature between approx. 160°C and 195°C;
- coated fish pieces should remain in frying oil for sufficient time depending on the frying temperature to get 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 exchanged when colour becomes too dark or when concentration of fat degradation products exceeds certain limits;
- remains from coating which 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 together 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 assure 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 utilise blast freezers may package the product in the consumer containers before freezing.

10.3.10 Packing and Labelling

Refer to Section 8.2.3 "Labelling", Section 8.4.4 "Wrapping and Packing" and Section 8.2.1. “Weighing”.

Potential Hazards: *Microbiological contamination*

Potential Defects: *Under- or over-packing, improper sealed containers, wrong or misleading labelling*

Technical Guidance:

- packaging should be made without delay after refreezing under clean and hygienic conditions. If packaging is made later (e.g. batch processing) re-frozen products should be kept under deep frozen conditions until being packed;
- 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

Also refer to Section 8.1.3.

Potential Hazards: *Unlikely*

Potential Defects: *texture and Flavour deviations due 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 of storage temperature (greater than 3°C) has 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 Transport of End Product

Also refer to Section 3.6.” Transportation” and Section 17 “ Transport” under elaboration

Potential Hazards: *Unlikely*

Potential Defects: *thawing of frozen product*

Technical Guidance:

- during all transportation steps deep-frozen conditions should be maintained -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.

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

This section concerns the processing of heat processed sterilised canned fish and shellfish products which have been packed in hermetically sealed containers[10] and intended for human consumption.

As stressed by this Code, the application of appropriate elements of the pre-requisite 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 to some of the common steps involved in a canned fish or shellfish preparation line.

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[10] Aseptic filling is not covered by this Code. Reference of the relevant code is made in Appendix XII.

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

References correspond to relevant Sections of the Code.

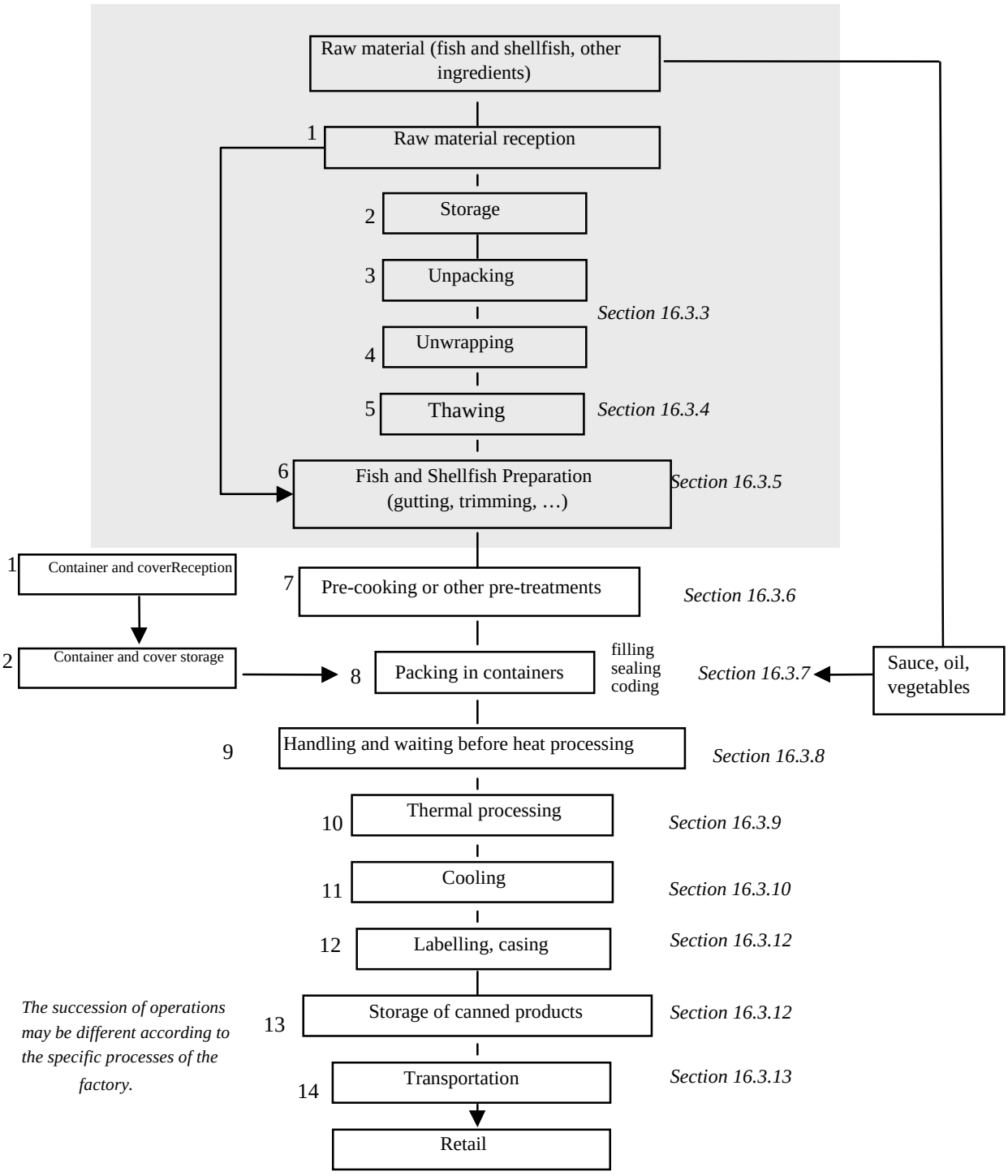

Figure 16.1 Example of a flow chart for the processing of canned fish and shellfish

16.1 GENERAL - ADDITION TO PRE-REQUISITE PROGRAMME

Section 3 (Pre-requisite programme) gives the minimum requirements for good hygienic practices for a processing facility prior to the application of hazard and defect analyses.

For fish and shellfish canneries, additional requirements to the guidelines described in Section 3 are necessary due to 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-Acid and Acidified Low-Acid Canned Food (CAC/PRC 23-1979, Rev. 2 (1993)) for further information.

- design, working and maintenance of baskets and handling and loading devices aimed at retorting should be appropriate for the kind of containers and materials used. These devices should prevent any excessive abuse to 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 it sufficient pressure during the heat treatment of sterilisation ; 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 (Potential Hazards Associated with Fresh Fish and Shellfish)

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 tetrodotoxines or ciguatoxines are known to be generally heat-stable, so the 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, so it 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 prevent the histamine production. The Codex Commission adopted in its standards for some fish species maximum levels tolerated for histamine.

A3 Microbiological toxins

Clostridium botulinum

The botulism risk usually appears after an inadequate heat processing and inadequate container integrity. The toxin is heat-sensitive, on the other hand, the destruction of *Clostridium botulinum* spores, in particular from proteolytic strains, requires high sterilisation values. The heat processing effectiveness 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 and 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 XII. Where no Codex Standard exists regard should be made to national regulations and/or commercial specifications.

End product specifications outlined in Appendix IX 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-Acid and Acidified Low-Acid Canned Foods (CAC/RCP 23-1979, Rev. 2 (1993)) in order to obtain detailed advice on canning operations.

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

16.3.1.1Fish and shellfish (Processing step 1)

Potential Hazards:	*Chemical and biochemical contamination (DSP, PSP, scombrotoxine, heavy metals...)*
Potential Defects:	*Species substitution, decomposition, parasites*
Technical Guidance:	

Refer to section 8.1.1 (Raw Fresh or Frozen Fish Reception) and to other relevant sections; and also:

- When live shellfish (crustaceans) are received for canning processing, inspection should be carried out in order to discard dead or badly damaged animals.

16.3.1.2Container, cover 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 (Raw Material Reception – Packaging, Labels & Ingredients); and also:

- Containers, cover 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 cover 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;

16.3.1.3Other ingredients (Processing step 1)

Refer to section 8.5.1 (Raw Material Reception – Packaging, Labels & Ingredients).

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

16.3.2.1Fish and shellfish (Processing step 2)

Refer to sections 8.1.2 (Chilled storage), 8.1.3 (Frozen storage and 7.6.2 Conditioning and storage of molluscan shellfish in sea water tanks, basins, etc.)

16.3.2.2Containers and packaging (Processing step 2)

Potential Hazards: *Unlikely*

Potential Defects: *Foreign matters*

Technical Guidance:

Refer to section 8.5.2 (Raw Material Storage - Packaging, Labels & Ingredients); and also:

- all materials for containers or packages should be stored in satisfactory clean and hygienic conditions;
- during storage, empty containers and covers should be protected from dirt, moisture and temperature fluctuations, in order to avoid condensations 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 shouldn't 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), that can compromise tightness (shocks on the seam, deformed flange) or be prejudicial to appearance.

16.3.2.3Other ingredients (Processing step 2)

Refer to section 8.5.2 (Raw Material Storage - Packaging, Labels & Ingredients).

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 matters introduction into the product. To avoid microbial proliferation, waiting periods before further processing should be minimised.

16.3.4 Thawing (Processing step 5)

Refer to section 8.1.4 (Control Thawing)

16.3.5 Fish and shellfish preparatory processes (Processing step 6)

16.3.5.1Fish preparation (gutting, trimming...)

Potential Hazards: *Microbiological contamination biochemical development (histamine)*
Potential Defects: *Objectionable matters (viscera, skin, scales, ... in certain products), off flavours, presence of bones, parasites...*
Technical Guidance:

Refer to sections 8.1.5 (Washing and Gutting) and 8.1.6 (Filleting, Skinning, Trimming and Candling); and also:

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

16.3.5.2Preparation of molluscs and crustaceans

Potential Hazards: *Microbiological contamination, hard shell fragments*
Potential Defects: *Objectionable matters*
Technical Guidance:

Refer to sections 7.7 (Heat Treatment/Heat Shocking of Molluscan Shellfish in Establishment; and also:

- when live shellfish are used, 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 PRE-COOKING AND OTHER TREATMENTS

16.4.1 Pre-Cooking

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

16.4.1.1General Considerations

- methods used to pre-cook 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, pre-cooking 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 pre-cooking, wherever practical;
- if eviscerated fish is used, then the fish should be arranged in the belly down position for pre-cooking 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 pre- cooked according to technical guidance laid down in sections 7 (Processing of Molluscan Shellfish), 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 pre-cooking.

16.4.1.1.2 Pre-cooking Schedule

- the pre-cooking method, in particular, in terms of time and temperature, should be clearly defined. The pre-cooking schedule should be checked;
- fish pre-cooked 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 Pre-cooking Oils and Other Fluids

- only good quality vegetable oils should be used in pre-cooking fish or shellfish for canning (see Codex Standard for Named Vegetable Oils (CODEX STAN 210-1999), Codex Standard for Olive Oils and Olive Pomace Oils (CODEX STAN 33-1981, Rev. 2-2003) and Codex Standard for Fats and Oils not Covered by Individual Standards CODEX STAN 19-1981, Rev.1 1999);
- cooking oils should be changed frequently in order to avoid the formation of polar compounds. Water used for pre-cooking 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, which are packed when still hot, cooling of pre-cooked 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 crustacea 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 (Processing of smoked fish)

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 optimum 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)

16.4.2.1Filling

Potential hazards : *microbiological growth (waiting period), microbiological survival growth and recontamination after heat processing due to incorrect filling or faulty containers, foreign material.*

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 faulty containers, because they can jam a filling or sealing machine, or cause trouble during heat processing (bad sterilisation, leaks);
- empty containers should not be left on the packing tables or in conveyor systems during clean up of premises to avoid contamination or splashes;
- where appropriate, to prevent microbial proliferation, containers should be filled with hot fish and shellfish (> 63°C, for example for fish soups) or should be filled quickly (the shortest possible waiting period) after the end of the pre-treatments;
- 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 sterilisation schedule. A regular filling is important not only for economical reasons, but also because the heat penetration and the 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 as the end product meets the regulatory provisions or the accepted standards concerning weight of contents;
- where canned fish and shellfish is packed by hand, there should be a steady supply of fish, shellfish and eventually other ingredients. Build-up 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 received particular care. The machine manufacturers' instructions should be carefully followed;
- the quality and the amount of other ingredients such as oil, sauce, vinegar...should be carefully controlled to bring about the optimum desired effect;
- if fish has been brine-frozen or stored in refrigerated brine, the amount of salt absorbed should be taken into consideration when salt is added to the product for flavouring;
- filled containers should be inspected:

  - to ensure that they have been properly filled and will meet accepted standards for weight of contents
  - and to verify product quality and workmanship just before they are closed;
- manual filled products such as small pelagic fish should be carefully checked by the operators to verify that container flanges or closure surface have not any product residues, which could impede the formation of a hermetic seal. For automatic filled products, a sampling plan should be implemented.

16.4.2.2Sealing

Sealing the container and covers are one of the most essential processes in canning.

Potential hazards : *subsequent contamination due to a bad seam*

Potential defects : *unlikely*

Technical guidance

- the operation, maintenance, regular inspection and adjustment of sealing machines should received particular care. The sealing machines should be adapted and adjusted for each type of container and each closing method which are used. Whatever the type of sealing equipment, the manufacturers or equipment supplier's instructions 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 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;
- 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 to create vacuum, competent technologists should be consulted;
- regular inspections should be made during production to detect potential external defects on containers. At intervals sufficiently close to each other in order to guarantee a closure in accordance with specifications, 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, which 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.

16.4.2.3Coding

Potential hazards: *subsequent contamination due to damaged containers*

Potential defects: *loss of traceability due to an incorrect coding.*

Technical guidance

- 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 due to damaged containers.*

Potential defects: *Unlikely*

Technical guidance

- containers after closure should always be handled carefully in such a way as to prevent every damage capable to cause defects and microbiological recontamination;
- if necessary, filled and sealed metal containers should be thoroughly washed before heat processing to remove grease, dirt and fish or shellfish stains on their outside walls;
- to avoid microbial proliferation, the waiting period should be as short as possible;
- if the filled and sealed containers must be held for a long time before heat processing, the product should be held at temperature conditions which minimise microbial growth;
- every cannery should develop a system, which 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-Acid and Acidified Low-Acid Canned Foods (CAC/RCP 23-1979, rev. 2 in 1993) 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 Clostridium botulinum.*

Potential defects: *survival of micro-organisms responsible of decomposition*

Technical guidance

16.4.4.1Sterilisation Schedule

- to determine the sterilisation schedule, at 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 sterilisation schedule is established for a certain product in a container of a given size;
- Proper heat generation and temperature distribution should be carried out. Standard heat processing procedures and experimentally established sterilisation 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.

16.4.4.2Heat 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 sterilisation 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 were held at refrigerated temperatures because of a too long waiting period before heat processing, the sterilisation 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-Acid and Acidified Low-Acid Canned Foods (CAC/RCP 23-1979, rev. 2 in 1993);
- if canned fish and shellfish in different size containers are processed together in the same retort load care must be taken to ensure 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.

16.4.4.3Monitoring of Heat Processing Operation

- during the application of heat processing, it is important to ensure that the sterilisation process and factors such as container filling, minimal internal depression at closing, retort loading, initial product temperature, etc. are in accordance with the sterilisation 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, 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 due 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. In case of recycling, 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 minimise 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 of 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 due 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 it is 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 due 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 “Labelling”

Potential hazards : *subsequent recontamination due to the damage of containers or to an exposition 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 move 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 made in order 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 due to the damage of containers or to an exposition to extreme conditions*

Potential defects : *Unlikely*

Technical guidance

Refer to section 17 (Transportation); and also:

- transportation of canned fish and shellfish should be made in order 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 damages during transportation couldn't be sufficient;
- metal containers should be kept dry during transportation in order to avoid corroding and/or rust.

ANNEX I

POTENTIAL HAZARDS ASSOCIATED WITH FRESH FISH, SHELLFISH AND OTHER AQUATIC INVERTEBRATES

1 Examples of Possible Biological Hazards

1.1.1 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 parasitised by protozoans, but there are no records of fish protozoan disease being transmitted to man. Parasites have complex life cycles, involving one or more intermediate hosts and are generally passed to man 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 7 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 it.

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 man is *Anisakis simplex;* as the infective stage of the parasite is killed by heating (60°C for 1 minute) and by freezing (-20°C for 24 hours) in 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 inactivate 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 host of these trematodes is man 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 take place through the consumption of raw, undercooked or otherwise under-processed products containing the infective stages of these parasites. Freezing fish at -20°C for 7 days or at -35°C for 24 hours will kill the infective stages of these parasites.

1.1.2 Bacteria

The level of contamination of 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 will influence the microflora of finfish, the more important being water temperature, salt content, proximity of harvesting areas to human habitations, quantity and origin of food consumed by fish, and method of harvesting. The edible muscle tissue of finfish is normally sterile at the time of capture and bacteria are usually present on the skin, gills and in the intestinal tract.

There are two broad groups of bacteria of public health importance that may contaminate products at the time of capture - those that are normally or incidentally present in the aquatic environment, referred to as the indigenous microflora, and those introduced through environmental contamination by domestic and /or industrial wastes. Examples of indigenous bacteria, which 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 which have been isolated occasionally 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 where products are adequately cooked prior to consumption, food safety hazards are insignificant. 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.

1.1.3 Viral Contamination

Molluscan shellfish harvested from inshore waters that are contaminated by human or animal faeces may harbour viruses that are pathogenic to man. Enteric viruses that have been implicated in seafood-associated illness are the hepatitis A virus, caliciviruses, astroviruses and the Norwalk virus. 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 presence of the virus 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 or relaying are alternative strategies but longer periods are required for shellfish to purge themselves clean of viral contamination than for bacteria. Thermal processing (85-90°C for 1.5 min.) will destroy viruses in shellfish.

1.1.4 Biotoxins

There are a number of important biotoxins to consider. Around 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 ichtyohaemotoxin. The involved species are eels from the Adriatic, the moray eels, and the lampreys. In other species, the toxins are spread all over the tissues (flesh, viscera, skin); these are ichtyosarcotoxins. 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

And the other 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 over 400 species of tropical fish have been implicated in intoxication. The toxin is known to be heat stable. There is still much to be learnt 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 Amnestic Shellfish Poison complex (ASP) are produced by phytoplankton. They concentrate in bivalve molluscan shellfish which filter the phytoplankton from the water, and also may concentrate in some fish and crustacea.

Generally, the toxins remain toxic through thermal processing so the knowledge of the species identity and/or origin of fish or shellfish intended for processing is important.

Tetrodotoxin

Fish 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 frequent in the flesh. Differently from 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, apparently there are often indications of the involvement of symbiotic bacteria.

1.1.5 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.

1.2 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.

1.3 Physical Hazards

These can include material such as metal or glass fragments, shell, bones, etc.