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CODE OF PRACTICE FOR

CANNING OF FISH

SRI LANKA STANDARDS INSTITUTION

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CODE OF PRACTICE FOR CANNING OF FISH

SLS 902:1990

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SRI LANKA STANDARDS INSTITUTION,
53, Dharmapala Mawatha,
Colombo 3,
Sri Lanka.

DRAFTING COMMITTEE ON FOOD HYGIENE

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TECHNICAL SECRETARIAT
SRI LANKA STANDARDS INSTITUTION

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SRI LANKA STANDARD
CODE OF PRACTICE FOR CANNING OF FISH

FOREWORD

This Sri Lanka Standard was authorized for adoption and publication by the Council of the Sri Lanka Standards Institution on 1990-12-12, after the draft, finalized by the Drafting Committee on Food Hygiene, had been approved by the Agricultural and Food Products Divisional Committee.

In the canning of fish or any other food, failure to perform all processing operations may result in very substantial losses through spoilage of one kind or another, or in the production of canned food that might be harmful. It is therefore very important that fish or any other food canning operations are carried out with the assistance of technical advisors along with technical guidelines.

Manufacture/canning of other low-acid foods are covered in a separate Code of Practice.

Local fish canning industry is in its infancy stage and there is a potential for the growth of this industry in the future. This code is intended to provide useful guidelines for the fish canning industry including any new industrialist that would come-up in the future.

Assistance gained from the publications of the Codex Alimentarius Commission is greatly appreciated.

1 SCOPE

1.1 This code of practice contains the technological guidelines and essential requirements of hygiene concerning the production of heat processed canned fish and shellfish which have been packed in hermetically sealed rigid or semi-rigid containers.

1.2 Excluded are the manufacture of semi-preserves and pasteurized products and processes such as aseptic filling, continuous retorting or use of flexible pouches.

2 REFERENCES

SLS 614 : Potable water

SLS ... : Code of Practice for Handling of Fresh and Frozen Fish (Under Preparation)

3 DEFINITIONS

For the purpose of this code of practice the following definitions should apply:

3.1 **bleeders** : Very small vents through which steam escapes throughout the entire heat process. Bleeding provides a circulation of steam within the retort and ensures the elimination of any air that enters the retort with the steam.

3.2 **buckle** : Sealed and heat processed metal container of fish that has become permanently distorted by internal pressure during the heat processing or cooling or as a result of the formation of gas in the container.

3.3 **canned fish or shellfish** : Fish or shellfish packed in containers which have been hermetically sealed and sufficiently heated to destroy or inactivate all microorganisms that will multiply at any temperature at which the product is likely to be held and that will cause spoilage or that might be harmful. In this code the words "canned fish" include canned shellfish unless the context implies otherwise.

3.4 **chilling** : The process of cooling fish or shellfish to a temperature approaching that of melting ice.

3.5 **clean sea water** : Sea water which meets the same microbiological standards as potable water and is free from objectionable substances.

3.6 **cleaning** : The removal of food residues, dirt, grease or other objectionable material from surfaces.

3.7 **come-up time** : The time required to bring a loaded retort up to the specified processing temperature.

3.8 **contamination** : Direct or indirect transmission of objectionable matters to the fish or shellfish.

3.9 **disinfection** : The application of hygienically satisfactory chemical or physical agents and processes to clean surfaces with the intention of eliminating microorganisms.

3.10 **fish** : Any of the cold-blooded aquatic vertebrate animals commonly known as such. This includes Pisces, Elasmobranchs and Cyclostomes.

3.11 **flipper** : Sealed and heat processed container of fish which is normal in appearance but which may have its cover or bottom bulged outward if given a sharp jolt. A light inward pressure will cause the cover or bottom to spring back into its normal flat or slightly concave position.

3.12 **fresh fish or shellfish** : Freshly caught fish or shellfish which have received no preserving treatment or which have been preserved only by chilling.

3.13 headspace : The volume in the closed container not occupied by the product.

3.14 thermal process : The amount of lethal heat received by a product during the sterilization operation. Generally expressed as F_o value.

3.15 thermal processing time : The time that the sealed containers of fish are exposed to the specified processing temperature.

3.16 hermetically sealed containers : Containers which are designed and intended to protect the contents against the entry of microorganisms during and after heat processing.

3.16.1 *rigid containers* : The shape or contours of the filled and sealed container are neither affected by the enclosed product nor deformed by an external mechanical pressure of up to 0.7 kg/cm^2 (10 psig) - i.e. normal firm finger pressure.

3.16.2 *semi-rigid container* : The shape or contours of the filled, sealed container are not affected by the enclosed product under normal atmospheric temperature and pressure but can be deformed by an external mechanical pressure of less than 0.7 kg/cm^2 (10 psig) - i.e. normal firm finger pressure.

3.17 leaker : Sealed and thermal processed container of fish which has a defect that allows the passage of water, gas or microorganisms.

3.18 panelled container : Sealed and thermal processed cylindrical metal container of fish, the body wall of which has partly collapsed because it is not rigid enough to support the vacuum within or has been subjected to excessive internal pressure during cooling.

3.19 plant or establishment : The building or buildings, or parts thereof, used for or in connection with the manufacture or holding of food for human consumption.

3.20 potable water : Water of such chemical and bacterial quality that it is wholesome and fit for human consumption.

3.21 retort : A pressure vessel designed for thermal processing food packed in hermetically sealed containers either by saturated steam or by heated water with superimposed air pressure.

3.22 saturated steam : Pure steam in equillibrium with water at the same temperature. Under these conditions the temperature of the steam is entirely dependent on its pressure.

3.23 shellfish : Those species of molluscs and crustacea including cephalopods that are usually used for food.

3.24 shelling : The process of removing meats from molluscs or crustacea either mechanically or by hand.

3.25 springer : A sealed and thermal processed metal container of fish which has one bulging end. If this end is pushed into place the other will bulge.

3.26 stack-burn : A defect in canned fish resulting from inadequate cooling after the thermal process. This usually occurs in products which have been either stacked closely or cased while still warm.

3.27 Swell : A sealed metal container of fish which has both ends bulged by internal gas pressure.

3.28 suitable corrosion-resistant material : Impervious material which is free from pits, crevices and scale, is non-toxic and unaffected by sea water, ice, fish slime or any other corrosive substance with which it is likely to come in contact. Its surface must be smooth and it must be capable of withstanding exposure to repeated cleaning, including the use of detergents.

3.29 venting : The process of flushing the air out of steam retorts at the begining of a thermal process. It is done by allowing large volumes of steam to flow through the retort to drive and carry the air out through open vents at the top of the retort.

4 RAW MATERIAL

4.1 NO FISH OR SHELLFISH OR OTHER INGREDIENT SHOULD BE USED FOR THE PROCESSING OF CANNED PRODUCTS WHICH HAS UNDERGONE DETERIORATION OR ANY PROCESS OF DECOMPOSITION OR WHICH HAS BEEN CONTAMINATED WITH FOREIGN MATTER TO AN EXTENT WHICH HAS MADE IT UNFIT FOR HUMAN CONSUMPTION.

The raw material should be rejected if it is known to contain harmful, decomposed or extraneous substances which will not be removed to acceptable levels by normal procedures of sorting of preparation.

Fish or shellfish in a diseased condition should be discarded or the diseased portion removed. Only clean and sound fish or shellfish should be used for canning.

4.2 FRESH FISH AND SHELLFISH INTENDED FOR CANNING SHOULD RECEIVE THE SAME CARE AND ATTENTION FROM THE TIME OF CAPTURE UNTIL THEY ARE THERMAL PROCESSED AS THEY WOULD RECEIVE IF INTENDED FOR MARKETING AS FRESH FISH.

The processes and the principles involved in the preparation of fresh fish for canning are for the most part similar to those that would be involved in preparing them for marketing as fresh fish. Therefore, the recommendations of the Sri Lanka Standard Code of Practice for Handling of Fresh and Frozen Fish should be used as a guide for the handling and preparation of fresh fish for canning.

4.3 SHELLFISH THAT ARE STORED ALIVE SHOULD BE KEPT ALIVE IN A SANITARY ENVIRONMENT UNTIL THEY ARE PROCESSED. SHELLFISH THAT DIE, BECOME WEAK OR APPEAR ABNORMAL IN ANY WAY, SHOULD BE IMMEDIATELY REMOVED FROM THE LIVE STORE AND DISCARDED.

The meat of some species of crustacea, such as crab or lobster, deteriorates very rapidly after death and so it is often good practice to keep these species as well as some kinds of molluscs (oysters, clams and mussels) alive until they are processed.

Although some species can be kept alive in a dormant condition for long periods if they are kept moist and thoroughly chilled, it is generally more convenient to use ponds of floating cages (live wells) for storage.

It is important that the water in which shellfish are live-stored should be maintained at a tolerable temperature and oxygen level and kept free of harmful substances. Since molluscs frequently collect microorganisms from overlying water and concentrate them in their digestive systems, it is important that the water in which they are stored be of good sanitary quality.

Shellfish that die or become weak or abnormal should be removed from the live store immediately they are discovered to avoid the possibility of their tainting or otherwise harming the remaining stock. Dead, weak or abnormal shellfish taken from live store should not be used for canning or other food purposes. They should be discarded immediately so that they do not spoil good shellfish and in order to avoid the risk of them being processed accidentally and irretrievably mixed with good quality canned products.

4.4 THE STANDARDS FOR HANDLING, PREPARING FREEZING, STORING AND THAWING FISH AND SHELL FISH INTENDED FOR CANNING, SHOULD BE JUST AS HIGH AS THOSE APPLIED IN THE PROCESSING OF FISH INTO HIGH QUALITY PRODUCTS FOR THE FROZEN MARKET.

Canning will not correct quality defects in fresh fish. Neither will it correct or obscure fault such as rancidity or denaturation in frozen fish. Therefore, all the processes of freezing, storing and thawing fish to be used in canning should be in accordance with the recommendations of the Sri Lanka Standard Code of Practice for Handling of Fresh and Frozen Fish. The pre-cooking stage may as an acceptable operation simultaneously thaw the product.

4.5 FISH AND SHELLFISH INTENDED FOR CANNING SHOULD BE INSPECTED AS SOON AS IT IS RECEIVED AT THE CANNERY. SPOILED OR CONTAMINATED FISH SHOULD BE DISCARDED IMMEDIATELY, WHEREVER PRACTICAL, THE FISH OR SHELLFISH RECEIVED SHOULD BE SORTED INTO LOTS SIMILAR IN QUALITY AND INSUCH ATTRIBUTES AS SIZE, COLOUR OR TEXTURE AND THEN STORED APPROPRIATELY.

material which is not fit for canning should be discarded immediately so that it will not spoil good fish and to avoid the risk that it might be processed accidentally and irretrievably mixed with good quality canned products.

The raw material should be inspected again if under the applied storage conditions changes in quality can be expected.

4.6 WHERE FISH SUCH AS TUNA ARE BRINE-FROZEN ABOARD THE CATCHING VESSEL, CARE MUST BE TAKEN TO AVOID EXCESSIVELY HIGH SALT PENETRATION OF THE FLESH.

Since it is not always practical to leak the salt out of fish, a high salt content in the raw material accepted for canning may result in unsatisfactory flavours in the final product. If the salt penetration has been excessively high the flesh may be denatured to the extent that fish are not suitable for canning. Assessment of salt content should be made at the time brine-frozen fish are received by the cannery.

Salt penetration into brine-frozen fish can be controlled to some extent by pre-chilling the fish prior to placing them into freezing brine and by keeping the brine temperature as low as practical during the freezing operation and separating the fish from the brine soon after they are frozen.

4.7 WHERE IT IS CONSIDERED IMPRACTICAL TO ICE FISH ABOARD THE CATCHING VESSEL, FISH SHOULD BE BROUGHT TO THE CANNERY QUICKLY AND PROCESSED EVERY SOON AFTER THEY ARE LANDED

Fatty fish used for canning such as herring, mackerel, pilchard, sprat or sardine are often taken fairly close to a cannery and under such conditions icing aboard the vessel may be considered impractical or unnecessary. However, if these fish are feeding, the enzymes in their gut this will cause very rapid deterioration after death and this will be enhanced if they are crushed and the digestive juices allowed to permeate the flesh.

In such cases the practicability of using refrigerated sea water holds or boxing the fish on the vessel to avoid excessive pressure should be seriously considered.

In any event the fish should be brought to the cannery quickly and processed without delay.

4.8 SMALL FISH THAT HAVE BEEN FEEDING INTENSIVELY AT THE TIME THEY ARE TAKEN FROM THE WATER SHOULD NOT BE CANNED UNLESS THE FEED CAN BE REMOVED

If the gut of a fish is filled with feed at the time it dies the enzymes present will commence to digest the flesh of the fish as well as the feed.

Small fish are generally gutted by pulling the intestines through the throat cavity when the head is removed. This method is not efficient if the gut is full. However, if feed is left in the fish it will spoil quickly and frequently the flesh next to the body cavity will disintegrate. The appearance and flavour of the canned product will be adversely affected often to the extent that the product will be unmerchantable.

In some instances feedy fish can be impounded and kept alive long enough for their guts to empty before they are taken out of the water.

5 PLANT FACILITIES AND OPERATING REQUIREMENTS

5.1 Plant Construction and Layout

5.1.1 *General considerations*

5.1.1.1 CANNING OPERATIONS SHOULD BE PLANNED, AND CANNERIES DESIGNED TO HAVE SUFFICIENT CAPACITY TO PROCESS SUPPLIES OF FISH AT THE FORESEEABLE AVERAGE RATE OF DAILY DELIVERY, AND SHOULD NOT BE OPERATED BEYOND THEIR FULL RATED CAPACITY FOR ANY EXTENDED PERIOD

Most fish canning operations are subject to some fluctuations in their supply of raw material and in some fisheries these fluctuations may be very large. Since good quality raw material is essential for the prodction of good quality canned fish, canneries should not accept more fish than they can handle expeditiously. Supplies of fresh fish should be handled, chilled and stored in accordance with the recommendations of the Sri Lanka Standard Code of Practice for Handling of Fresh and Frozen Fish and they should not be held for very long before they are processed.

In some instances it may be practical for a cannery to freeze surplus supplies when fish are abundant and hold them in frozen storage for canning at a time when fresh fish are less plentiful. If this is done, losses in quality due to improper freezing or faulty storage should be avoided by following the recommendations of the Sri Lanka Standard Code of Practice for Handling of Fresh and Frozen Fish.

Where supplies of fish are known to fluctuate considerably and particularly where fisheries are seasonal, it may be difficult to decide on what the capacity of a cannery should be. If a cannery is to be self sustaining, provision of a large reserve capacity which is seldom fully used is difficult to justify. On the other hand the reserve capacity should be large enough to quickly process the expected peaks in a fluctuating fish supply without operating the plant above its full rated capacity for any extended period. If a cannery is operated above its designed capacity, operating efficiency will decling and declays in processing, which will have an adverse effect on the quality of the product, are likely to occur. Furthermore, there is a serious risk that shutdowns through failure or overloaded equipment may cause substantial losses of material or product and may even necessitate a lengthy suspensions of the canning operation.

5.1.1.2 CANNERIES SHOULD BE ADEQUATELY EQUIPPED TO ENSURE THAT THE CANNING OPERATION CAN BE CARRIED OUT WITHOUT THE PRODUCT BEING DELAYED AT ANY STAGE THROUGH LACK OF PROCESSING CAPACITY.

Fresh fish spoils slowly at chill temperatures and at the higher ambient temperatures which are quite general in canneries the rate of spoilage is increased. It is therefore important that the whole canning operation should be carried out as soon as possible after the fish are received or are taken from frozen storage and there should be no delay in passing the partly prepared products from one stage of processing to the next.

Under normal operating conditions each processing stage should be capable of handling the output of the previous stage without delay and should have some reserve capacity to quickly deal with any backlogs which may occur from time to time. There should be sufficient standby replacements for all processing equipment such as butchering machines, can-filling equipment and sealing machines to allow for servicing and to ensure that no processing operations will be stopped or slowed by breakdown. There should also be a sufficient number of retorts to allow routine maintenance and repair work to be carried out without interfering with the cannery operations.

5.1.1.3 CANNERIES SHOULD BE DESIGNED AND EQUIPPED SO THAT ALL HANDLING AND PROCESSING OPERATIONS CAN BE CARRIED OUT EFFICIENTLY AND ALL MATERIALS AND PRODUCTS CAN PASS FROM ONE STAGE OF PROCESSING TO THE NEXT IN AN ORDERLY MANNER AND WITH MINIMUM DELAY WITHOUT CROWDING OF EQUIPMENT AND PERSONNEL.

To converse their quality, fish or shellfish should be packed, sealed and heat-stabilized as soon as possible after they have been removed from chilled or frozen storage, or in the case of those varieties which are live stored, as soon as possible after they have been shelled or butchered.

A great deal of care should be taken in planning the layout and equipment of a cannery to ensure that there is sufficient space and suitable facilities to carry out each processing operation efficiently and to move products and materials through the various stages in an orderly manner. Use should be made of conveyors and other mechanical moving devices wherever these are economically practical. Bottle necks in the routing should be avoided and particular care should be taken that the routing to and from the retorts is not such that there is a possibility that unprocessed canned fish will become mixed with processed products and bypass the retorts.

Passageways should have sufficient capacity to carry all necessary traffic and provide easy access to all equipment.

5.1.2 *Cannery Construction and Sanitary Design*

5.1.2.1 CANNERIES AND SURROUNDING AREA SHOULD BE SUCH AS CAN BE KEPT REASONABLY FREE OF OBJECTIONABLE ODOURS, SMOKE, DUST OR OTHER CONTAMINATION. THE BUILDINGS SHOULD BE SUFFICIENT IN SIZE WITHOUT CROWDING OF EQUIPMENT OR PERSONNEL, WELL CONSTRUCTED AND KEPT IN GOOD REPAIR. THEY SHOULD BE OF SUCH DESIGN AND CONSTRUCTION AS TO PROTECT AGAINST THE ENTRANCE AND HARBOURING OF INSECTS, BIRDS OR OTHER VERMIN AND TO PERMIT READY AND ADEQUATE CLEANING

The location of a cannery, its design, layout, construction and equipment should be planned in detail with considerable emphasis on the hygienic aspect, sanitary facilities and control.

National or local authorities should always be consulted in regard to building codes, hygienic requirements of the operation and sanitary disposal of sewage and plant waste.

The food handling area should be completely separate from any part of the premises used as living quarters.

5.1.2.2 FLOORS SHOULD BE HARD SURFACED, NON-ABSORBENT AND ADEQUATELY DRAINED

Floors should be constructed of durable, waterproof, non-toxic, non-absorbent material which is easy to clean and disinfect. They should be non-slip and without crevices and should slope evenly and sufficiently for liquids to drain off to trapped outlets fitted with a removable grill. If floors are ribbed or grooved to facillitate traction, any grooving of this nature should always run towards a drainage channel.

The junctions between the floors and walls should be impervious to water and should be coved or rounded for ease of cleaning.

Concrete, if not properly finished, is porous and can be affected by animal oils, strong brines, various detergents and disinfectants. If used, it should be dense, of a good quality and with a well-finished waterproof surface.

5.1.2.3 DRAINS SHOULD BE OF AN ADEQUATE SIZE, SUITABLE TYPE, EQUIPPED WITH TRAPS AND WITH REMOVABLE GRATINGS TO PERMIT CLEANING

Suitable and adequate drainage facilities are essential for removal of liquid or semiliquid wastes from the plant. There should not be any floor area where water might collect in stagnant pools. Drains should be constructed of smooth and impervious material and should be designed to cope with the maximum flow of liquid without any overflowing and flooding.

Each drainage inlet should be provided with a deep seal trap which is appropriately located and easy to clean.

Drainage lines carrying waste effluent except for open drains should be properly vented, have a minimum internal diameter of 10 cm (4 in.) and, if required, run to a catch basin for removal of the solid waste material. Such a basin should be located outside the processing area and should be constructed of waterproof concrete or other similar material, designed to the local specifications and approved by the local authority having jurisdiction.

5.1.2.4 INTERNAL WALLS SHOULD BE SMOOTH, WATERPPROOF, RESISTANT TO FRACTURE, LIGHT COLOURED AND READILY CLEANABLE

Acceptable materials for finishing walls inside are cement render, ceramic tiles, various kinds of corrosion-resistant metallic sheeting such as stainless steel or aluminium alloys and a variety of non-metallic sheetings which have adequate impact resistance, desirable surface qualities and are easily repairable.

All sheeting joints should be sealed with a mastic or other compound resistant to hot water and cover strips should be applied where necessary.

Wall-to-wall and wall-to-floor junctions should be coved or rounded to facilitate cleaning.

Walls should be free from projections and all pipes and cables should be sunk flush with the wall surface or neatly boxed in.

5.1.2.5 WINDOWS SILLS SHOULD BE KEPT TO A MINIMUM SIZE, BE SLOPED INWARD AT 45^{o} AND BE AT LEAST 1 METRE (3 FEET) FROM THE FLOOR

Window sills and frames should be made of a smooth, waterproof material and, if of wood, should be kept well painted.

Internal window sills should be sloped to prevent storage of miscellaneous materials or accumulation of dust and should be constructed to facilitate cleaning.

Windows should be fitted with whole panes and those which open should be screened. The screens should be constructed so as to be easily removable for cleaning and should be made from suitable corrosion-resistant material.

5.1.2.6 ALL DOORS THROUGH WHICH THE PRODUCT IS MOVED SHOULD BE SUFFICIENTLY WIDE, WELL CONSTRUCTED OF A SUITABLE MATERIAL AND SHOULD BE OF A SELF-CLOSING TYPE

Doors through which fish or shellfish and their products are moved should be either of corrosion-resistant metal, or sheathed with a corrosion-resistant metal or made from other suitable material with adequate impact resistance and, unless provided with an effective air screen, should be of a self-closing type.

Both the doors and the frames of the doorways should be of a smooth and readily cleanable surface.

Doors through which the product is not moved, such as those providing staff access, should be appropriately surfaced at least on the processing area side to allow for ease of cleaning.

5.1.2.7 CEILINGS SHOULD BE DESIGNED AND CONSTRUCTED TO PREVENT ACCUMULATION OF DIRT AND CONDENSATION AND SHOULD BE EASY TO CLEAN

Ceilings should be at least 3 metres (10 ft.) in height, free from cracks and open joints and should be of a smooth, waterproof, light coloured finish.

In buildings where beams, trusses, pipes or other structural elements are exposed, the fitting of a suspended ceiling just below is desirable.

Where the roof beams and trusses cannot be covered, the underside of the roof may constitute a satisfactory ceiling providing all joints are sealed and the supporting structures are of a smooth, well-painted and light coloured surface, easily cleanable and constructed to protect the fish products from falling debris, dust or condensate.

5.1.2.8 PREMISES SHOULD BE WELL VENTILATED TO PREVENT EXCESSIVE HEAT, CONDENSATION AND CONTAMINATION WITH OBNOXIOUS ODOURS, DUST, VAPOUR OR SMOKE

Special attention should be given to the venting of areas and equipment producing excessive heat, steam, obnoxious fumes, vapours or contaminating aerosols. The air-flow in the premises should be from the more hygienic areas to the less hygienic.

Good ventilation is important to prevent condensation and growth of moulds in overhead structures.

Ventilation openings should be screened and, if required, equipped with proper air filters.

Windows which open for ventilation purposes should be screened. The screens should be made easily removable for cleaning and should be made from suitable corrosion-resistant material.

5.1.2.9 A MINIMUM ILLUMINATION OF 220 lUX IN GENERAL WORKING AREAS AND NOT LESS THAN 540 lUX AT POINTS REQUIRING CLOSE EXAMINATION OF THE PRODUCT SHOULD BE PROVIDED AND SHOULD NOT ALLTER COLOURS

Lightbulbs and fixtures suspended over the working areas where fish or shellfish is handled in any step of preparation, should be of the safety type or otherwise protected to prevent food contamination in case of breakage.

5.1.3 *Sanitary Facilities*

5.1.3.1 AREAS WHERE FISH OR SHELLFISH IS RECEIVED, STORED OR HANDLED SHOULD BE SEPARATED FROM AREAS IN WHICH FINAL PRODUCT PREPARATION IS CONDUCTED TO PREVENT CONTAMINATION OF THE FINISHED PRODUCT

Separate rooms or well-defined areas of adequate size should be provided for receiving and storing of raw materials and for operations like heading and gutting fish, thawing, washing, shelling and cleaning.

Manufacture or handling eof edible products should be entirely separate and distinct from the areas used for inedible materials. The food handling area should be completely divorced from any part of the premises used as living quarters.

Receiving and storage areas should be clean and readily capable of being maintained in a clean condition and should provide protection for the raw products against deterioration and contamination.

5.1.3.2 A SEPARATE REFUSE ROOM OR OTHER EQUALLY ADEQUATE STORAGE FACILITIES SHOULD BE PROVIDED ON THE PREMISES

If offal or other refuse is to be collected and held before removal, adequate precautions should be taken to protect it against rodents, brids, insects and exposure to warm temperatures.

A separate refuse room for storing waste in water-tight containers or offal bins should be provided. The walls, floor and ceiling of such a storage room and the area under the elevated bins should be constructed of impervious material which can be readily cleaned.

Where waste material is held in containers outside the establishment, the containers should be lidded. A separate enclosure should be provided for their storage with easy access for vehicles loading and unloading. Stands for the containers should be of solid, hard and impervious material which can be easily cleaned and properly drained.

If containers are used in large numbers, a mechanical washing plant might be advisable to provide for routine washing. Containers should be capable of withstanding repeated exposure to normal cleaning processes.

5.1.3.3 ANY BY-PRODUCT PLANT SHOULD BE ENTIRELY SEPARATE FROM THE CANNERY WHICH IS PROCESSING FISH AND SHELLFISH FOR HUMAN CONSUMPTION

The layout and construction of a cannery should be such as to ensure that the areas in which fish and shellfish intended for human consumption are held, processed and canned are used for that purpose only. Any processing of by-products or non-fish or shellfish products should be conducted in separate buildings or in areas which are physically separated in such a way that there is no possibility for contamination of fish and shellfish or their products.

5.1.3.4 AN AMPLE SUPPLY OF COLD AND HOT POTABLE WATER CONFORMING TO SLS 614 AND/OR CLEAN SEA WATER UNDER ADEQUATE PRESSURE SHOULD BE AVAILABLE AT NUMEROUS POINTS THROUGHOUT THE PREMISES AND AT ALL TIMES DURING THE WORKING HOURS

All water available for use in those parts of an establishment where fish and shellfish are received, held, processed, packaged and stored should be potable water conforming to SLS 614 or clean sea water and should be supplied at a pressure of no less than 1.4 kg/cm2 (20 lb/in^2).

An adequate supply of hot water of potable quality at a minimum temperature of 82°C (180 °F) should be available at all times during the plant operation.

The cold water supply used for cleaning purposes should be fitted with an in-line chlorination system allowing the residual chlorine content of the water to be varied at will in order to reduce multiplication of microorganisms and prevent the build-up of fish odours.

Water used for washing or conveying raw materials should not be recirculated unless it is restored to a level of potable quality.

5.1.3.5 WHEN IN-PLANT CHLORINATION OF WATER IS USED THE RESIDUAL CONTENT OF FREE CHLORINE SHOUD BE MAINTAINED AT NO MORE THAN THE MINIMUM EFFECTIVE LEVEL FOR THE USE INTENDED.

Chlorination systems should not be relied upon to solve all sanitation problems. The indiscriminate use of chlorine cannot compensate for unsanitary conditions in a processing plant.

5.1.3.6 ICE SHOULD BE MADE FROM POTABLE WATER OR CLEAN SEA WATER AND SHOULD BE MANUFACTURED, HANDLED AND STORED SO AS TO PROTECT IT FROM CONTAMINATION

If ice is used in the operation of a cannery or is supplied to the fishermen, it should be made from potable water or clean sea water. When vessels are taking ice to sea, only fresh clean ice should be taken on board at the beginning of each voyage. Ice left from the previous voyage should be discarded and removed from the vessel.

A special room or other suitable storage facilities, should be provided to protect the ice from contamination and excessive meltage. Dust, flakes of paint, bits of wood or sawdust, straw and rust are the most frequent impurities transferable by ice into the final product.

Care must be taken to ensure that ice used to chill fish or fishery products does not contaminate them.

5.1.3.7 WHERE A NON-POTABLE AUXILIARY WATER SUPPLY IS USED THE WATER SHOULD BE STORED IN SEPARATE TANKS AND CARRIED IN SEPARATE LINES, IDENTIFIED BY CONTRASTING COLOURS AND LABELLED, AND WITH NO CROSS-CONNECTIONS OR BACK-SIPHONAGE WITH THE LINES CARRYING POTABLE WATER

Non-potable water may be used for such purposes as producing steam, cooling heat exchangers and fire protection. It is very important that both systems of storage and distribution of potable and non-potable water are entirely separate and there is no possibility for cross-contamination or for inadvertent usage of non-potable water in the fish or shellfish processing areas. Only potable water should be used for the supply of hot water. The same requirement for the separation of systems would apply to clean sea water when it is used in the processing of fish.

5.1.3.8 ALL PLUMBING AND WASTE DISPOSAL LINES, INCLUDING SEWER SYSTEM, SHOULD BE LARGE ENOUGH TO CARRY PEAK LOADS AND SHOULD BE PROPERLY CONSTRUCTED

All lines should be watertight and have adequate deep seal traps and vents. Disposal of waste should be effected in such a manner as not to permit contamination of potable water or clean sea water supplies.

Sumps or solid matter traps of the drainage system should preferably be located outside the processing area and so designed as to allow them to be emptied and thoroughly cleaned at the end of each working day.

The plumbing and the manner of waste disposal should be approved by the official agency having jurisdiction.

5.1.3.9 PROPER FACILITIES FOR WASHING AND DISINFECTION OF EQUIPMENT SHOULD BE PROVIDED

Facilities should be present in every cannery for cleaning and disinfection of trays, removable cutting boards, containers and other similar equipment and working implements. Such facilities should be located in a separate room or in designated areas in the workrooms where there is an adequate supply of hot and cold potable water or clean sea water, under good pressure, and where there is proper drainage.

Any containers and equipment used for offal or contaminated materials should not be washed in the same area.

5.1.3.10 ADEQUATE AND CONVENIENTLY LOCATED TOILET FACILITIES SHOULD BE PROVIDED

Toilet rooms should have walls and ceilings of a smooth, washable, light coloured surface and floors constructed of impervious and readily cleanable material. Toilet facilities should be well lit, ventilated and kept in a hygienic condition at all times. Adequate supplies of toilet paper should be available in each toilet cubicle.

The doors leading to the toilet rooms should be of a self-closing type and should not open directly into the fish processing areas.

The hand washing facilities in the toilet rooms should be of a type not requiring operation by hand and should have an adequate supply of hot and cold potable water or clean sea water and liquid or powdered soap should be provided. Suitable hygienic means of drying the hands such as single use towels should be available. Where paper towels are used a sufficient number of dispensers and receptacles for used towels should be provided.

Notices should be posted requiring personnel to wash their hands after using the toilets.

The following formula could be used in assessing the adequacy of toilet facilities in relation to the number of employees:

1	to	9	employees: 1 toilet
10	to	24	employees: 2 toilets
25	to	49	employees: 3 toilets
50	to	100	employees: 5 toilets

for every 30 employees over 100 - 1 toilet

5.1.3.11 FACILITIES SHOULD BE AVAILABLE IN THE PROCESSING AREAS FOR EMPLOYEES TO WASH AND DRY THEIR HANDS AND FOR DISINFECTION OF PROTECTIVE HAND COVERINGS

In addition to hand washing facilities available in toilet rooms a number of washbasins with an adequate supply of hot and cold potable water or clean sea water and liquid or powdered soap should be provided wherever the process demands. They should be located in full view of the processing floor and should be of a type not requiring operation by hand or be fed by a continuous flow of potable fresh or clean sea water. Single use towels are recommended, otherwise the method of drying hands should meet the requirements of the official agency having jurisdiction. The facilities should be kept in a hygienic condition at all times.

5.1.3.12 STAFF AMENITIES CONSISTING OF LUNCHROOMS, CHANGING-ROOMS OR ROOMS CONTAINING SHOWER OR WASHING FACILITIES SHOULD BE PROVIDED

Where workers of both sexes are employed, separate facilities should be present for each except that the lunchroom may be shared. As a general guide the lunchrooms should provide seating accommodation for all employees and the changing rooms should provide enough space for lockers for each employees without causing undue congestion. Clothing and footwear not worn during working hours must not be kept in any processing area.

5.1.3.13 STORAGE FACILITIES SHOULD BE AVAILABLE FOR THE PROPER DRY STORAGE OF PACKAGING MATERIALS

Separate facilities for the storage of cartons, wrappings or other packaging materials should be provided in order to protect them against moisture, dust or other contamination.

5.1.3.14 IF POISONOUS OR HARMFUL MATERIALS, INCLUDING CLEANING COMPOUNDS, DISINFECTANTS, SANITAZERS AND PESTICIDES ARE STOCKED, THEY SHOULD BE KEPT IN A SEPARATE ROOM DESIGNATED AND MARKED SPECIALLY FOR THIS PURPOSE

All such materials must be prominently and distinctly labelled so that they can be easily identified. The room should be kept locked and the materials contained in it should be handled only by personnel trained in their use.

5.2 Equipment and utensils

5.2.1 ALL WORK SURFACES AND ALL CONTAINERS, TRAYS, TANKS OR OTHER EQUIPMENT USED FOR PROCESSING FISH OR SHELLFISH SHOULD BE OF SMOOTH, IMPERVIOUS, NON-TOXIC MATERIAL WHICH IS CORROSION-RESISTANT AND SHOULD BE DESIGNED AND CONSTRUCTED TO PREVENT HYGIENIC HAZARDS AND PERMIT EASY AND THOROUGH CLEANING. IN GENERAL THE USE OF WOOD FOR THIS PURPOSE IS NOT RECOMMENDED

Contamination of fish or shellfish during procesing can be caused by contact with unsatisfactory surfaces. All food contact surfaces should be smooth, free from pits, crevices, loose scale and substances harmful to man, unaffected by salt, fish juices or other ingredients used, and capable of withstanding repeated cleaning and disinfection. Wood could be used for cutting surfaces only when no other suitable material is available. Machines and equipment should be designed so that they can be easily dismantled to facilitate thorough cleaning and disinfection.

Containers used for holding fish should preferably be constructed of plastic or corrosion-resistant metal, and if of wood, they should be treated to prevent the entry of moisture and coated with a durable, non-toxic paint or other surface coating that is smooth and readily washable. Wicker baskets should not be used.

Stationary equipment should be installed in such a manner as will permit easy access and thorough cleaning and disinfection.

Fish washing tanks should be designed to provide a constant change of water with good circulation, to have provisions for drainage and to be easily cleaned.

Equipment and utensils used for inedible or contaminated materials should be identified as such and should not be used for handling edible products.

5.2.2 OPERATIONS SUCH AS DRESSING, WASHING AND HEADING AND PORTIONING FISH AND FILLING CONTAINERS SHOULD BE DONE BY MACHINES WHEREVER THESE ARE AVAILABLE AND THEIR USE IS ECONOMICALLY PRACTICAL

Well-designed machines are available for many fish processing operations and they often perform task better, quicker, more cheaply and with less risk of contamination than if the work was done by hand. Where such machines are expensive, careful analyses of the cost of doing the operation by hand and by machines should be made to establish whether or not the cost is justified.

5.2.3 CANNERIES SHOULD HAVE ADEQUATE, CLEAN, DRY STORAGE SPACE FOR THEIR SUPPLIES OF CONTAINERS AND SUITABLE CONVEYOR SYSTEMS TO TRANSPORT THEM TO FILLING MACHINES OR PACKING TABLES WITHOUT EXPOSURE TO CONTAMINATION

Storage arrangements should be such that containers are not moved out of their clean, dry storage until just before they are needed for filling. Conveyor systems should be designed and installed in such a way that the containers are not exposed to contamination while being moved from storage to the packing area. Separate facilities for the storage of wrapping material, cartons and labels should be provided where such materials are used or stored on the premises.

5.2.4 IN THE INTEREST OF SAFETY AND TO ENSURE THAT THE CANNERY'S THERMAL PROCESSING CAPABILITY IS ADEQUATE, THE DESIGN, SIZE AND EQUIPMENT OF RETORTS AND THEIR OVERALL CAPACITY SHOULD MEET WITH THE APPROVAL OF RECOGNIZED AUTHORITIES ON THERMAL PROCESSING AND ALL INSTALLATIONS SHOULD BE MADE UNDER COMPETENT SUPERVISION

All cannery retorts are pressure vessles and as such must be designed, installed and maintained in accordance with recognized standards developed for the protection of the workers, the plant and the public. In most instances adherence to the safety standards will be required by law and by the insurance underwriters and in most cases the installations will be subject to official inspection.

There are two general methods of heat treating canned fish (see Appendix A), that is by using saturated steam at a controlled pressure or by using water heated under pressure to well above its normal boiling point. The latter method is required for the thermal treatment of products in glass or aluminium containers.

Both of these methods can be carried out in either vertical (top loading) or horizontal (end loading) retorts. The choice between vertical and horizontal retorts will usually be made to suit the particular requirements. Vertical retorts take less floor space. Horizontal retorts are particularly suited to larger canning operations. They often have two doors so that they can be loaded at one end and unloaded at the other to avoid congestion.

The length of time required to inactivate or to destroy harmful or spoilage microorganisms in canned fish depends very critically on the temperature at which it is processed and the time required is greatly increased by lowering the temperature. Therefore, the processing temperature must always be specified along with the processing time and it is vitally important that the slowest heating point (cold point) of every container be exposed to that temperature for the whole of the processing period.

Steam gives off a great deal of heat when it condenses and the temperature at which this occurs depends solely on the pressure of the steam itself.

Therefore, the temperature of a retort filled with steam, to the exclusion of all air, can be controlled very precisely with a pressure regulator. However, it is the overall pressure on the retort that is regulated and any air present will contribute to this pressure. Therefore, if air is present the partial pressure and hence the temperature of the condensing steam will be somewhat lower than might be assumed from the pressure. This happens while the retort is being filled with steam, but if the steam inlets, air vents and bleeders are the correct size and in the proper location, the entering steam will soon flush out all the air and this will become aparent from the thermometer and pressure readings. However, there is a danger that, if the retort is not properly designed, equipped, loaded or operated. localozed air pockets may form and prevent parts of the load from attaining the proper processing temperature. Such an occurrence would not necessarily be indicated by the thermometer and pressure readings.

When canned products are processed in water under pressure, the temperature control is by a mechanical device which regulates the supply eof steam used to heat the water. Uniformity of temperature throughout the retort load is maintained by a forced circulation of the water. The efficiency of this circulation will depend on the design of the retort and the design and location of the water, air and steam inlets.

It should be apparent from the foregoing that the design of retorts and their equipment is a highly technical matter and that technical guidance should be sought in making the decision as to type and detailed specifications of the retorts best suited to a particular operation. It should also follow that the installation and fitting of retorts should always be done by skilled tradesmen under competent direction.

5.2.5 CRACKING BLOCKS, MALLETS AND OTHER MEAT EXTRACTING DEVICES USED IN PROCESSING SHELLFISH SHOULD BE CONSTRUCTED OF NON-ABSORBENT AND CORROSION-RESISTANT MATERIAL

It is important that cracking blocks, mallets or meat extracting rollers be constructed of a non-absorbent and crevice-free material so that they will not become saturated with juices harbouring micro organisms which would give rise to off-odours and be a source of contamination.

Corrodible material will eventually deteriorate rending proper cleaning impossible and may also contaminate the product.

5.2.6 FISH TRANSPORT VEHICLES SHOULD BE DESIGNED TO ALLOW ADEQUATE ICING OF FISH, TO PROTECT FISH FROM WARMING UP DURING TRANSPORT AND SHOULD BE OF SUCH MATERIAL AND CONSTRUCTION AS TO PERMIT EASY AND THOROUGH CLEANING

Vehicles used for transporting fresh fish or shellfish should be designed and constructed to ensure constant protection to the fish against contamination by dust, exposure to higher temperatures and the drying effects of sun or wind. Even where ice is very cheap and journey times or distances are relatively short, the use of an insulated vehicle provides an additional insurance against inadequate icing or unforeseen delays. The walls, roof and the floor of the vehicle should be insulated. The thickness of insulation employed will depend on the outside temperatures normally encountered. It should be remembered that insulation cannot help to cool the fish but helps to keep it at the temperature at which it was put into the vehicle.

Vehicles used for the transport of frozen fish should be capable of maintaining the fish at a temperature appropriate for the particular product.

For the purpose of cleaning, the vehicles transporting fish should have the walls, floors and roofs made of a suitable corrosion-resistant material with smooth and non-absorbent surfaces. Floors should be adequately drained.

5.3 Hygienic operating requirements

5.3.1 GENERAL HYGIENIC REQUIREMENTS FOR AN ESTABLISHMENT WHERE CANNED FISH OR SHELLFISH IS PRODUCED FOR HUMAN CONSUMPTION SHOULD BE SIMILAR TO THOSE RECOMMENDED FOR A FRESH FISH PROCESSING PLANT

All fish and shellfish, equipment, containers and all surfaces which come in contact with fish should be treated in a hygienic manner as set out in the Sri Lanka Standard Code of Practice for Handling of Fresh and Frozen Fish.

Conveyors, runways and other conveying equipment used in handling canned fish or shellfish should be maintained in good repair and should be kept clean and dry.

5.3.2 THE BUILDING, EQUIPMENT, UTENSILS AND OTHER PHYSICAL FACILITIES OF THE PLANT SHOULD BE KEPT CLEAN, IN GOOD REPAIR AND SHOULD BE MAINTAINED IN AN ORDERLY AND HYGIENIC CONDITION

All surfaces with which fish or shellfish come in contact should be cleaned and preferably hosed down with potable water or clean sea water as frequently as necessary to ensure cleanliness of the areas. It is important that the cleaning method used will remove all residues and the disinfecting method will reduce the microbial population of the surface being cleaned.

The use of cold or hot potable water or clean sea water alone is generally not sufficient to accomplish the required result. It is desirable, if not essential, that aids such as suitable cleaning and disinfecting agents together with manual or mechanical scrubbing wherever appropriate be used to assist in achieving the desired objective. After the application of cleaning and disinfecting agents, the surfaces which come in contact with fish should be rinsed thoroughly with cool potable water or cool clean sea water before use.

Cleansing agents and disinfectants used should be appropriate to the purpose and should be so used as to present no hazard to public health and should meet the requirements of the official agency having jurisdiction.

5.3.3 REMOVAL OF SOLID, SEMI-SOLID OR LIQUID WASTES FROM FISH UNLOADING, HOLDING AND PROCESSING AREAS SHOULD BE ON A CONTINUOUS OR HEAR CONTINUOUS BASIS USING WATER AND/OR APPROPRIATE EQUIPMENT SO THAT THESE AREAS ARE KEPT CLEAN AND THERE IS NO DANGER OF CONTAMINATING THE PRODUCT

All waste materials resulting from the operation of a cannery should be disposed of as soon as possible in a way that they cannot be used for human food and in a manner that they cannot contaminate food and water supplies and offer harbourage or breeding places for rodentws, insects or other vermin.

Containers, flumes, conveyors, bins or storage bays used for removal, collection or storage of fish offal and other waste should be cleaned frequently with potable water or clean sea water containing an appropriate amount of free chlorine.

All waste material from containers and vehicles should be removed in such a way as not to cause any contamination and not to create nuisance.

Arrangements for the disposal of trade refuse and inedible waste should be approved by the appropriate official agency having jurisdiction.

5.3.4 EFFECTIVE MEASURES SHOULD BE TAKEN TO PROTECT AGAINST THE ENTRANCE INTO THE PREMISES AND THE HARBOURAGE ON THE PREMISES OF INSECTS,RODENTS, BIRDS OR OTHER VERMIN

An effective and continuous programme for the control of insects, rodents, birds or other vermin within the establishment should be maintained. The cannery and surrounding areas should be regularly examined for evidence of infestation. Where control measures are necessary, treatment should be under the direct supervision of personnel with a thorough understanding of the hazards involved, including the possibility of harmful residues being retained by the fish, shellfish or their products, and the chemical, biological or physical agents used should meet the requirements of the official agency having jurisdiction.

The use of insecticides, during the plant operation, without any provisiones for collection of dead insects, should be discouraged. Instead, the use of adhesive insect traps or very efficient "black light insecticutor" lamps with the attached collecting trays, is recommended. Insect traps should not be located directly over the processing areas and should be away from windows and doors.

All rodenticides, fumigants, insecticides or other harmful substances should be of an approved type and should be stored in separate locked rooms or cabinets and handled only by properly trained personnel.

5.3.5 DOGS, CATS AND OTHER ANIMALS SHOULD BE EXCLUDED FROM AREAS WHERE FISH OR SHELLFISH ARE RECEIVED, HANDLED, PROCESSED OR STORED

Dogs, cats and other animals are potential carriers of diseases and should not be allowed to enter or to live in rooms where fish, shellfish or their products are handled, prepared, processed or stored.

5.3.6 ALL PERSONS WORKING IN A CANNERY SHOULD MAINTAIN A HIGH DEGREE OF PERSONAL CLEANLINESS WHILE ON DUTY AND SHOULD TAKE ALL NECESSARY PRECAUTIONS TO PREVENT THE CONTAMINATION OF THE FISH, SHELLFISH OR THEIR PRODUCTS OR INGREDIENTS WITH ANY FOREIGN SUBSTANCE

All employees should wear appropriate to the nature of their work, clean protective clothing including a head covering and footwear all of which articles are either washable or disposable. The use of waterproof aprons, where appropriate, is recommended.

Gloves used in the handling of fish should be maintained in a sound, clean and sanitary condition and should be made of an impermeable material except where their usage would be incompatible with the work involved.

Hands should be washed thoroughly with soap or other cleansing agent and warm water before commencing work on every occasion after visiting a toilet before resuming work and whenever necesary. The wearing of gloves does not exempt the operator from having thoroughly washed hands.

Any behaviour which can potentially contaminate the fish such as eating, smoking, chewing of tobacco or other materials and spitting should be prohibited in any part of the fish handling areas.

A notice as follows should be displayed in plain capital letters, in some conspicuous place in the establishment.

"EATING, SMOKING, CHEWING OF TOBACCO MATERIALS AND SPITTING IS PROHIBITED IN ANY PART OF THE FOOD HANDLING AREAS".

5.3.7 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 TRANSPORTING OF FISH OR SHELLFISH

Plant management should require that any person afflicted with infected wounds, sores, or any illness, notably diarrhoea, should immediately report to management. Management should not allow any person known to be affected with a disease capable of being transmitted through food, or known to be a carrier of such a disease, or while afflicted with infected wounds, sores or diarrhoea to work in any area of a cannery in a capacity in which there is a likelihood of such a person contaminating fish or shellfish with pathogenic organisms.

Minor cuts and abrasions on the hands should be immediately treated and covered with a waterperoof dressing of contrasting colour and of a nature that it cannot be accidently detached; but if infection should occur subsequently, the worker should not be allowed to handle the fish. Adequate first-aid facilities should be provided.

5.3.8 CONVEYANCES USED FOR TRANSPORTING FISH SHOULD BE CLEANED AND DISINFECTED IMMEDIATELY AFTER EACH USE AND SHOULD BE SO MAINTAINED AS NOT TO CONSTITUTE A SOURCE OF CONTAMINATION FOR THE PRODUCT

The cleaning of vehicles, together with receptacles and equipment thereon, should be planned to a regular routine. Hosing, scrubbing and cleaning with potable water or clean sea water to which a suitable detergent and/or disinfectant has been added is usually necessary.

5.4 Operating practics and production requirements

5.4.1 General consideration

5.4.1.1 CANNED FISH PRODUCTS SHOULD BE GOOD QUALITY FISH, WELL PREPARED IN SUITABLE SEALED CONTAINERS AND PRESERVED BY HEAT SO THAT THEY WILL REMAIN ATTRACTIVE AND SAFE TO EAT FOR A LONG TIME UNDER NORMAL CONDITIONS

Canned fish is a convenience food and the user expects that it can be transported and stored under quite ordinary conditions and that it will still be an attractive food which is safe to eat several years after it has been produced. To meet these requirements it is necessary to use good raw materials and suitable containers and to take great care that all the manufacturing processes are carried out properly.

5.4.1.2 ONLY GOOD QUALITY FISH OR SHELLFISH SHOULD BE ACCEPTED FOR CANNING

The raw material should be rejected if it is known to contain harmful, decomposed or extraneous substances which will not be removed to acceptable levels by normal procedures of sorting or preparation.

It should be kept in mind that, except for the fact that the container protects the product from recontamination which would lead to spoilage, the canning processes are similar in effect to those processes the consumers might use in preparing fresh or frozen fish for their own table. Canning cannot correct faults that are due to the poor physiological condition of the fish, poor handling practices, lengthy storage or storage under inadequate conditions.

Therefore, fish or shellfish which even after preparation are not good enough to be sold as fresh or frozen fish are not good enough to be processed into canned fish.

5.4.1.3 CANNERIES SHOULD REGULATE THE VOLUME OF FRESH FISH OR SHELLFISH THEY RECEIVE SO THAT THEIR SUPPLIES DO NOT BECOME TOO LARGE TO BE PROCESSED WHILE THE FISH ARE IN PRIME CONDITION

Fresh fish should always be processed as soon as possible after capture. The length of time that fish can be satisfactorily held in chill storage at the cannery before processing will depend on the species and very greatly on the length of time already elapsed since capture, and on the care with which they were handled during transport to the cannery. Canneries should limit the amount of fresh fish or shellfish they accept to the amount that they can process while the fish are still in good condition. The length of time that they will have to be held before they can be canned should be taken into consideration in judging whether fish are of sufficiently high quality to accept for canning.

Where the volume of fresh fish available for canning is subject to large fluctuations, the feasibility of freezing and storing surpluses for canning during slack periods might be considered.

5.4.2 *Butchering and similar preparatory processes*

5.4.2.1 WHERE FISH ARE GUTTED, HEADED, SKINNED, BONED OR PORTIONNED FOR CANNING, THESE OPERATIONS SHOULD BE DONE IN A CLEAN AND HYGIENIC MANNER AND SHOULD BE CARRIED OUT CAREFULLY TO AVOID SPOILING THE QUALITY OF THE PRODUCT OR WASTING MATERIAL

Preparatory operations leading to the finished product should be so timed as to permit expeditious handling of consecutive units in production under conditions which would prevent contamination, deterioration, spoilage or the development of infectious or toxigenic microorganisms.

Gutting should be done very thoroughly so that no viscera are left to spoil the quality including the appearance and the flavour of the final product. All cuts should be made cleanly and precisely to remove waste and bruised flesh without leaving ragged surfaces or needlessly wasting the edible material.

Mechanical methods of gutting and heading should be used wherever they are practical, particularly in the processing of smaller fish.

5.4.2.2 RAW FISH SHOULD BE THOROUGHLY WASHED IN COOL POTABLE WATER OR CLEAN SEA WATER IMMEDIATELY AFTER THEY HAVE BEEN SUBJECTED TO ANY DRESSING OPERATION SUCH AS GUTTING, HEADING, SCALING, SKINNING OR PORTIONING

Spoilage microorganisms are mainly in the intestines and on the skin of fish but may be spread over all surfaces by any cutting operation. Their numbers can be greatly reduced by thoroughly washing the carcase in cool potable water or cool clean sea water. This will also remove slime and blood which might otherwise taint or discolour the final product.

If containers are used for washing gutted fish, a continuous flow of cold potable water or clean sea water, sufficient to prevent the accumulation of contaminating materials, should be provided from the inlets at the bottom of the container.

5.4.2.3 LOBSTER AND CRAB WHICH ARE BROUGHT TO THE CANNERY ALIVE SHOULD BE PROCESSED AS QUICKLY AS POSSIBLE AFTER THEY ARE SLAUGHTERED

Crabs and lobsters deteriorate very quickley after death, particularly if the enzyme producing viscera are not removed or the meat is not chilled. However, lobsters and some kinds of crabs are generally cooked alive, in which case primary enzyme action is halted immediately. In some fisheries, crabs are usually slaughtered, eviscerated and washed before they are cooked. Slaughter and evisceration are usually done in the same operation. It is important that the viscera be completely removed, the carcase washed to remove entrails and blood and passed to the cooker without delay. Thorough removal of blood wil avoid blue discolouration of the meat after it has been canned.

5.4.2.4 BRINING AND SALTING OR SMOKING OF FISH AND SHELLFISH PRIOR TO CANNING SHOULD BE CARRIED OUT AS RECOMMENDED BY THE CODES OF PRACTICE DEALING WITH THESE METHODS OF FISH PROCESSING

To ensure that such processes are conducted in a sanitary manner and, at the same time, the quality of the product is protected and the wastage, bacause of improper methods of handling, is eliminated, the recommendations of the codes of practice written for these methods of processing should be used for guidance.

5.4.2.5 OYSTERS AND OTHER BI-VALVE MOLLUSCS SHOULD BE WASHED BEFORE THEY ARE SHELLED AND THE MEATS WASHED AGAIN IMMEDIATELY AFTERWARDS

When oysters or clams are taken from wet storage they will have mud, sand and their own faecal matter on the exterior and between the lips of their shells. This should be washed away to avoid the contamination of the meats as much as possible when the shells are opened.

Oysters or clams are often opened by steaming for a few minutes. This will cook the meats slightly and make them reasonably firm. In other cases, the live bi-valves are opened with a knife, the meat removed, washed and then blanched.

In either case the meat should be washed immediately to remove any sand, shell or other foreign matter. If containers are used for washing molluscs in the shell or their meats, a continuous flow of cold potable water or clean sea water, sufficient to prevent the accumulation of contaminating materials, should be provided from the inlets at the bottom of the container. Raw meats should not be allowed to stand in fresh water since they will absorb it and become swollen; they will lose the moisture again when cooked.

5.4.2.6 PERTICULAR CARE SHOULD BE TAKEN TO ENSURE THAT SHELL FRAGMENTS ARE REMOVED FROM SHELLFISH MEAT

Fragments of shell left in shellfish meats are very objectionable to consumers and in some circumstances they may be dangerous.

Fragments of shell can readily be separated from molluscan meat by washing in clean water. While there seems to be very little trouble with shell fragemnts in most kinds of crustacea meats, it is difficult to avoid getting some shell mixed with the leg and claw meat during the shucking of some species of crab. These fragments are difficult to see and consequently to separate by hand.

However, separation may be made by passing the meat through a bath of saturated brine. The meat will float but the shel will sink. If this method is used the amount of salt picked up by the meat will have to be taken into consideration when the product is seasoned.

Crab shell fluoresces (glows) under ultraviolet light and this property can be used to find fragments mixed with fresh crab meat. Crab meat in early stages of decomposition also fluoresces under ultraviolet light. If the inspection tables are equipped with ultraviolet light the source should be so located that the rays cannot shine directly into the eyes of the workers.

5.4.3 *Precooking and smoking*

5.4.3.1 METHODS USED TO PRECOOK OR SMOKE FISH OR SHELLFISH FOR CANNING SHOULD BE CHOSEN TO BRING ABOUT THE DESIRED EFFECT WITH A MINIMUM DELAY AND A MINIMIUM AMOUNT OF HANDLING

There are several reasons for precooking fish or shellfish prior to canning (see Appendix A). In nearly every case, however, one of the desired effects is rid the flesh of moisture which would otherwise cook out during the final thermal process and remain as a free liquid in the sealed container.

Precooking can be carried out in hot water or brine, steam, hot air, radiant heat or in hot oil, but usually the nature of the material and the reason for which the precooking is done will strongly influence the choice of method. For example, live lobsters can be very conveniently cooked in boiling water but it is much more practical to precook large whole fish or crates of oysters in a steam chamber.

Cooking temperature is very easily controlled if boiling water or steam is used but there may be serious mechanical difficulties in cooking large quantities of fish in boiling water. Steam is very convenient because of the ease with which material can be moved in or out of the cooking chamber. Steam delivers large amounts of heat at a controlled temperature right on the surfaces of the product so cooking is done fairly rapidly. However, steam cooking may, in some instances, leave the surfaces too moist. In such cases the product surfaces may be dried off by finishing the cooking in hot air.

Small fish such as sardines, are often precooked sometimes in hot oil, or smoked to give them a particularly desirable flavour or texture. Other products are also sometimes smoked, barbecued or cooked by radiant heat.

In some cases precooking conditions products, such as oyster meats, crustacea meats and tuna, for handling during the subsequent processing operations. In other cases, the precooking creates problems becuase the cooked product is very difficult to handle without damage even after it has cooled.

Means should be found to reduce the amount of handling subsequent to precooking wherever practical. Methods have been devised to precook small fish such as sardines after they have been packed in their containers. Equipment is available which will pass them through cooking tunnels, invert them to drain without spilling the fish, continue the cook in the inverted position, upright them, fill them with hot oil, seal them and deliver them for the final heat processing.

5.4.3.2 THE AMOUNT OF PRECOOKING SHOULD NE CONTROLLED TO ATTAIN CONSISTENTLY THE OPTIMUM EFFECT REGARDLESS OF THE SIZE OR INITIAL TEMPERATURE OF THE FISH

Cooking coagulates the protein in fish tissue and releases aqueous fluid which is lightly bound in the flesh. The extent to which this occurs depends largely on the temperature reached in the flesh. If fish are not heated sufficiently the desired effect will not be achieved, but too much heat wil reduce the quality of the product and also the yield.

Usually the temperature of the precook apparatus is closely controlled and the amount of cooking determined by the length of the cooking period. Since it will take longer to heat larger fish to a given centre temperature, fish precooked together in batches should be very similar in size. It also follows that they should all be at the same temperature when they enter the cooker.

The optimum amount of precooking for particular products can be ascertained from technical literature, technical advisors or by experiment.

The amount of precook can be indicated by the temperature reached at the centre of the fish and this can be related experimentally to cooking times for specific sizes of fish. Precooks can also be controlled directly by monitoring the temperature at the centre of one or more specimens and terminating the process when the proper temperature is reached.

5.4.3.3 ONLY GOOD QUALITY VEGETABLE OILS SHOULD BE USED IN PRECOOKING FISH FOR CANNING. COOKING OILS SHOULD BE CHANGED FREQUENTLY

Where sardines or other fish are precooked in oil care must be taken that the oil does not impart an undesirable flavour to the product. Only good quality bland edible vegetable oil should be used. It should be changed frequently because it gradually develops flavours if it is heated for long periods.

In some cases the oil may become diluted with oil which cooks out of the fish. If the concentration of fish unsaturated fish oil becomes appreciable it may contribute a strong flavour to the product or spoil its appearance. Unsaturated oil has the property of drying like paint oil on exposure to air particularly when it is hot. This may result in fatty adhering to the surfaces of the fish.

5.4.3.4 COOLING OF PRECOOKED OR HOT SMOKED FISH OR SHELLFISH SHOULD BE DONE AS QUICKLY AS PRACTICAL AND UNDER CONDITIONS WHERE CONTAMINATION OF THE PRODUCT CAN BE AVOIDED

Freshly precooked or hot smoked fish or shellfish are practically free of spoilage microorganisms but during a large part of the cooling period they are within the temperture range in which any that are present will multiply rapidly and may cause spoilage and/or possible health hazards.

Cooling times should, therefore, be kept as short as possible and every effort should be made to avoid contamination of the product during this period.

Where fish have to be held until they cool, they should be held in especially designated, clean, dust-free areas where there is a good circulation of air and from which vermin and other possible sources of contamination can be excluded.

Where water is used to cool crustacea for immediate shucking, it should be potable water or clean sea water. The same water should not be used for cooling more than one batch.

5.4.4 *Use of brine and other dips*

5.4.4.1 WHERE FISH OR SHELLFISH ARE DIPPED OR SOAKED IN BRINE OR INSOLUTIONS OF OTHER CONDITIONING OR FLAVOURING AGENTS IN PREPARATION FOR CANNING, SOLUTION STRENGTH AND TIME OF IMMERSION SHOULD BOTH BE CAREFULLY CONTROLLED TO BRING ABOUT THE OPTIMUM EFFECT.

Fish or shellfish are frequently dipped or soaked in solutions of salt, organic acids or other agents as part of their preparation for canning (see Appendix A.)

These dips accomplish many purposes. Strong brines toughen surface textures, organic acids bind ammonium and copper ions and other agents contribute to flavour or alter qualities of the product. The effect of these solutions depends not only on their strength, but also on the time they are in contact with the product.

Recommended strengths of dip solutions and immersion times for particular products can be obtained from technical literature or from fishery research institutes or they may be determined by experiment. Since consistency in flavour and in other product qualities is very important, the specified strengths of dip solutions and times of immersion should be carefully adhered to.

5.4.4.2 DIP SOLUTIONS SHOULD BE REPLACED AND DIP TANKS AND OTHER DIPPING APPARATUS THOROUGHLY CLEANED AT FREQUENT INTERVALS

Since the active ingredients in dip solutions become absorbed, exhausted or diluted as they accomplish their purposes, they become less effective with continued use. They also become contaminated by material that washes or dissolves off the product and scraps will collect in the dip tank. The solutions may, therefore, soon contain very large numbers of microorganisms, particularly if they are not well chilled. Therefore, dip solutions should be checked after each use for their strength and for contamination with microorganisms and the dip tanks should be empties, thoroughly cleaned and refilled with fresh solutions frequently or when necessary.

5.4.4.3 CARE SHOULD BE TAKEN TO ASCERTAIN WHETHER OR NOT THE INGREDIENTS USED IN DIPS WILL BE PERMITTED IN CANNED FISH IN THE COUNTRIES WHERE THE PRODUCT WILL BE MARKETED

The use of some chemicals which are considered harmless in one country may for some reason be prohibited or severely restricted in another. It is, therefore, necessary that information concerning regulations in the countries where products are being marketed should be obtained before deciding on the use of a food chemical in a dip solution or as an additive.

5.4.5 *Container filling and sealing*

5.4.5.1 THE CONTAINERS IN WHICH FISH 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 for canned fish should meet the following requirements:

a) They should protect the contents from contamination by micro organisms or any other substance;
b) Their inner surfaces should not react with the contents in any way that would adversely affect the product on the containers;
c) Their outer surfaces should be resistant to corrosion under any likely conditions of storage;
d) They should be suffciently durable to withstand the mechanical and thermal stresses encountered during the canning process and to resist physical damage during distribution;
e) They should be of convenient size and shape to suit the product and the market; and
f) They should be easy to open and to empty.

Containers for canned fish are usually made from tinplate, aluminium alloy or glass, and each of these materials imposes some particular requirements and limitations on the canning practice. The effect of these must be taken into consideration along with relative costs and consumer preferences in making the decision as to whether to use tinplate, aluminium or glass containers.

5.4.5.2 WHERE BATCHES OF FRESH FISH OR SHELLFISH MUST BE HELD PRIOR TO PACKING INTO CONTAINERS, THEY SHOULD BE THOROUGHLY CHILLED

There should be no unnecessary delay between the time fish or shellfish enters a cannery and the time the canned product is heat stabilized. However, if a delay in processing becomes necessary any batches that are held up should be thoroughly chilled to conserve their quality.

5.4.5.3 CONTAINERS FOR CANNED FISH SHOULD BE OF A SUITABLE SIZE AND SHAPE FOR THE AMOUNT AND KIND OF PRODUCT BEING PACKED AND SHOULD BE LINED WITH A SUITABLE PROTECTIVE ENAMEL WHERE NECESSARY

The particular advantages and disadvantages of using tinplate, aluminium or glass containers are dealt with in detail in Appendix A to this code under the "Factors affecting Quality". It is equally important that the containers should be of the proper shape and size to suit the nature of the product and to hold the proper amount.

Containers of canned fish should be almost completely filled. Shallow metal containers with relatively large flexible covers need little or no headspace but other containers may require up to 6 percent or more empty space by volume to allow for the expansion of the contents during the thermal process.

The amount necessary will depend partly on the nature of the contents and partly on the shape, flexiblity and strength of the container and on whether it will be processed in steam or in water under pressure. It is not generally desirable for the headspace to be any larger than necessary for this will allow the contents to be shaken too much when the container is moved and will also increase the risk of the container being panelled if the vacuum is too high. Furthermore, many countries have fair trade laws which require that containers of food offered for sale must be very well filled.

It, therefore, becomes apparent that in good canning practice the volume of the container determines, within rather narrow limits, what the weight of the content should be. Therefore, the canner's choice in package weights is quite strictly limited by the size of the available containers.

It is also important that the shape of the container should suit the nature of the product. Shallow containers with wide openings are particularly suitable for packing sardines or other small fish or other products that must be attractively arranged and packed tightly to avoid damage if the package is shaken. Cylindrical containers are more practical for packing portions of large fish, such as salmon or tuna. Care should be taken to ensure that containers have suitable protective enamel coatings where these are required by the nature of the product.

5.4.5.4 CONTAINERS AND COVERS SHOULD BE INSPECTED IMMEDIATELY BEFORE DELIVERY TO THE DILLING MACHINES OR PACKING TABLES TO ENSURE THAT THEY ARE CLEAN, UNDAMAGED AND WITHOUT VISIBLE FLAWS

In most instances containers and covers are clean when they are delivered to canneries in sealed packages and if properly handled and stored they will not usually need to be washed before use. However, containers and covers should be inspected carefully for cleanliness and if any are found not to be clean the whole lot should be washed or effectively cleaned in some other way before they are used. In washing glass containers care must be taken to avoid breakage through rough handling or thermal shock.

It is 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. This is particularly important in the case of glass containers which might possibly contain fragments of glass that are difficult to see and so might otherwise go undetected. If containers are delivered to filling machines or packing tables by conveyor, it is usually possible to have them inverted mechanically during their travel.

Care should also be taken to remove faulty containers. These include containers that have been dented or pierced, containers with defective side or bottom seams or with scratches or flaws in their enamel. If these are filled, material will be wasted and there is always a danger of damaged containers jamming a filling or sealing machine and necessitating a shut-down.

Slightly faulty containers may also cause trouble by becoming leakers after they have been filled, thermal processed and stored.

Covers for containers which are to be opened with keys or by pull tabs should be examined carefully to ensure that the scoring is evenly done and deep enough for the container to be opened easily but not so deep that the cover will tear during sealing, thermal processing or under the mechanical strains the container would normally encounter during distribution.

5.4.5.5 PRECAUTIONS SHOULD BE TAKEN TO ENSURE THAT CONTAINERS FOR CANNED FISH ARE USED ONLY FOR THEIR INTENDED PURPOSE

Canneries should have strict rules against the use of canned fish containers for any purpose other than packing fish. There is always a temptation to take containers for use as ash trays, small waste containers, receptacles for small machine parts or for other similar purposes. This should be avoided because there is a considerable risk that such containers may accidentally find their way back onto the production line and result in the packing of canned fish in the same container with very objectionable or possibly dangerous material.

5.4.5.6 EMPTY CONTAINERS FOR CANNED FISH SHOULD BE REMOVED FROM THE PACKING ROOM AND FROM CONVEYORS TO THE FILLING MACHINES BEFORE THE CANNERY IS WASHED DOWN BETWEEN SHIFTS AND AT THE END OF A PROCESSING PERIOD

If containers are left on the packing tables or in conveyor systems during clean-up, they are likely to become splattered with dirty water or debris, particularly if high pressure hoses are used in cleaning.

It is usually possible to anticipate the shutdown and control the flow of containers to the filling machines or packing tables so that few are left in the conveyor lines or in the racks when the operation stops. Those left should be either removed or so shielded that they will not become contaminated or obstruct the cleaning.

5.4.5.7 WHERE CANNED FISH IS PACKED BY HAND THERE SHOULD BE A STEADY SUPPLY OF RAW MATERIAL AND EMPTY CONTAINERS WITHIN CONVENIENT REACH OF EACH PACKER. FILLED CONTAINERS SHOULD BE INSPECTED AND REMOVED TO THE SEALER FREQUENTLY. BUILDUP OF EITHER RAW MATERIAL OR FILLED CONTAINERS AT THE PACKING TABLE SHOULD BE AVOIDED

Production should be higher and workmanship better if the packers have comfortable and convenient working facilities. Supplies of raw fish and empty containers should be within easy reach and there should be a convenient way of removing filled containers.

Since any delay in processing will have an adverse effect on quality, there should be no large backlog of raw material or filled containers at the packing table. The packers should use up the raw fish in the order it comes to them.

The output of the can-filling personnel should be inspected regularly so that faults can be corrected and a high standard of workmanship achieved.

Packing should be carried out in a clean and hygienic manner and under conditions that preclude the introduction of contamination into the product.

5.4.5.8 FILLING MACHINES USED TO PACK FISH OR SHELLFISH FOR CANNING SHOULD BE CLOSELY ATTENDED WHEN THEY ARE OPERATING AND THE MACHINE MANUFACTURERS' INSTRUCTIONS CONCERNING THEIR OPERATION, ADJUSTMENT AND MAINTENANCE SHOULD BE CAREFULLY FOLLOWED

Many different types of fish destined for canning can now be packed by machines which have been especially designed for the particular kind of product. In general, these machines are very satisfactory if they are properly serviced.

However, some operate at very high speeds (some salmon filling machines will fill more than 200 containers per minute) and if they get out of adjustment a large batch of poorly packed containers will be accumulated very quickly. Since these will probably have to be repacked by hand a major bottleneck will occur and the quality of products may suffer because of the resultant delay.

It is, therefore, prudent to follow the manufacturer's operating and maintenance instructions very closely and to have filling machines closely attended so that they can be adjusted or shut down quickly if they start to function badly.

5.4.5.9 THE QUALITY AND THE AMOUNT OF INGREDIENTS USED TO FLAVOUR OR OTHERWISE ENHANCE CANNED FISH OR SHELLFISH SHOULD BE CAREFULLY CONTROLLED TO BRING ABOUT THE OPTIMUM DESIRED EFFECT

Many kinds of ingredients are used in the manufacture of canned fish products. Salt and many spices are used to improve flavour, fillers to improve texture, and food chemicals to adjust acidity, improve texture, act as sequestering agents or for other purposes. Oils, sauces and other packing media are used to enhance the product.

Ingredients may be added at various stages in the processing. If dry ingredients are used they should be fully rehydrated before the thermal-processing commences. In the case of fish pastes, fish puddings or other comminuted fish products, the ingredients such as salt, oil, spices and fillers, will usually all be added during a blending operation. In other cases, ingredients may sometimes be used as dips but generally they are dispensed into the container just before it is filled with the product or else just before it is closed. In some cases, sauce or oil is dispensed in two stages, part of it into the empty container and the rest after the other contents have been packed. This permits a more rapid and more even absorption of the packing medium by the fish.

Since it is important that a canned fish product should not be variable in its flavour, texture or similar attributes, the quality and amount of added ingredients needs to be carefully controlled. The use of low quality packing oils or other ingredients may give a bad impression which will be damaging to the reputation of the product out of all proportion to the saving in costs.

Organic acids and other food additives are often used in the form of dips as mentioned earlier, but in some circumstances they may be added to the canned product in solution or as an ingredient of a sauce or broth. The advice of canning technologists should always be obtained when the use of food additives is being considered.

If fish has been brine-frozen or stored in refrigerted brine the amount of salt absorbed should be determined and taken into consideration when salt is added to the product for flavouring.

Salt and some other flavouring ingredients can be obtained in the form of pellets having a specific weight. In most cases, however, powdered or liquid ingredients are added as the containers pass under automatic dispensers which deliver a measured volume. These devices should be checked regularly to ensure that they consistently deliver the correct amount.

5.4.5.10 CONTAINERS OF CANNED FISH SHOULD BE CHECKED BEFORE THEY ARE CLOSED TO MAKE CERTAIN THAT THEY HAVE BEEN PROPERLY FILLED AND WILL MEET ACCEPTED STANDARDS FOR WEIGHT OF CONTENTS

Good canning practice requires that the volume (and hence the weight) of fill be controlled very closely to suit the size of the container (see Appendix A).

Overfilled containers with too little headspace may be damaged in the thermal processing or they may become flippers or springers. In either case they will not be merchantable. Underfilled containers may cause difficulty because they contain less than the usual label declaration or because the slack fill gives the consumer a bad impression even if the weight declaration on the label is correct. Furthermore, the contents of underfilled containers are more likely to have their texture altered by being shaken up if the canned fish is roughly handled.

Weight control is usually not very difficult in the filling of small shallow containers with fish such as sardines. In such cases, little or no headspace is required since the flexible cover permits enough expansion during thermal processing if the container has not been very obviously overfilled.

Large containers and in some cases even small containers are difficult to fill accurately to the correct weight, particularly if the product consists of fish or fish portions which are variable in size and shape. It is not generally practical to weigh each container at the time it is filled.

However, very good control can be obtained by passing the filled open containers over an inspection table where experienced staff can remove, weigh and repack containers which look to be overweight or underweight.

The most satisfactory method of checking weights is by the use of a machine set into the conveyor system which weighs each can and separates those that are under (and/or over) a selected limit. These machines are designed to remove under-weights or overweights or both. However, they have to be well attended to see that the weighing surfaces are kept clean and the machine is in adjustment.

5.4.5.11 ALL CANNED FISH SHOULD BE INSPECTED FOR QUALITY AND WORKMANSHIP JUST BEFORE THE CONTAINERS ARE CLOSED

This inspection should take place just before the covers are put on or before the liquid packing medium has been poured over the contents. Containers which contain poor quality material or are unattractively packed or packed in such a way that the contents might possibly prevent a proper seal being made should be removed and repacked. This repacking can usually be done in conjunction with the repacking of containers that have been found to be underweight or overweight.

5.4.5.12 ALL CANNED FISH SHOULD BEAR INDELIBLE CODE MARKINGS FROM WHICH ALL IMPORTANT DETAILS CONCERNING ITS MANUFACTURE CAN BE DISCOVERED

Markings on the containers in code from which the type of product, the cannery where it was produced and the production date can be determined are usually sufficient to satisfy legislative requirements or trading arrangements, but some countries may require that all or part of this information be clearly legible.

It should be borne in mind that mishaps can occur which will result in the canning of poor quality products. If some poor quality canned fish is mixed with a whole day's prodution a major loss may occur. Therefore, it may be desirable to use a coding system whereby each day's production can be separated into a number of differently coded lots. If this is done, it will be possible to minimize losses in case of a mishap by removing the affected code lots. The balance of the day's production can then be sent to market.

For smaller canneries a coding system which will indicate the date and the approximate time when the canning was done will usually be quite sufficient. However, larger canneries may find it very useful to have a coding system from which the particular processing line and sealing machine and possibly the particular batch of fish can also be identified. Such a system, supported by adequate cannery records, can be very helpful in any investigation to discover the causes when canned fish is found to be poor in quality.

The best way to ensure that coding is correct is to mark the containers during the actual processing operation. This can be done most conveniently be embossing the code on the covers just as they are fed into the machine which fastens them to the containers. Embossing equipment must be carefully adjusted so that the dies do not press too deeply and damage the container.

5.4.5.13 CANNED FISH SHOULD BE PRODUCED WITH SUFFICIENT VACUUM TO PREVENT THE CONTAINERS FROM BULGING UNDER ANY CONDITION OF HIGH TEMPERATURE OR LOW ATMOSPHERIC PRESSURE LIKELY TO BE ENCOUNTERED DURING THE TRANSPORT, STORAGE OR MARKETING OF THE PRODUCT

It is difficult and hardly necessary to create a vacuum in shallow containers that have relatively large flexible covers. Usually almost all the air is excluded from such containers when they are sealed so they are unlikely to bulge under ordinary changes in temperature or atmospheric pressure unless they have been overfilled.

In the case of deeper containers, a vacuum of 6.8 cm of mercury (13.0 kPa) is generally acceptable although preferably it should be somewhat higher. On the other hand, a vacuum of more than 25 cm of mercury is not generally desirable, since it may cause the container to panel, particularly if the headspace is large. High vacuum may also cause contaminants to be sucked into the container if there is a slight imperfection in the seam.

Vacuum may be obtained by preheating the contents before sealing either in an exhaust box or by adding hot packing liquid, by displacing the air in the headspace with steam just as the cover is applied, or by sealing the container while it is in an evacuated chamber (see Appendix A). Any of these methods will be found to be quite suitable. The choice will generally be made on the basis of local preferences and costs and on the availability of various kinds of equipment.

5.4.5.14 SEALING MACHINES SHOULD BE CLOSELY ATTENDED WHILE THEY ARE IN OPERATION AND THEIR OUTPUT INSPECTED FREQUENTLY TO ENSURE THAT GOOD SEALS ARE MADE AND THAT SEAMS ARE WELL FORMED WITH DIMENSIONS WITHIN THE ACCEPTED TOLERANCES FOR THE PARTICULAR CONTAINER

Sealing the container is one of the most critical processes in canning. If seams are not tight and secure the whole canning effort and all the materials used will be wasted. It is therefore wise to give particular attention to the operation and maintenance of sealing equipment and to the routine inspection of its output.

Sealing machines designed or adjusted for one type of container should not be used to close another type without being modified or readjusted as necessary. Because of differences in the metal the tools required for forming seams in aluminium containers are usually slightly different than those used for closing similar tinplate containers.

Whatever the type of sealing equipment, the manufacturer's instructions concerning its operation, maintenance and adjustment should be followed meticulously. Metal container manufacturers are usually ready to make detailed recommendations not only on the adjustment and operation of the sealing machine, but also for the examination of finished seams. Such examination will include frequent visual inspection of seams, preferably at intervals not to exceed 30 minutes, regular measurement of seam dimensions, recording of the results and the occasional pulling apart of samples to see that they are properly formed. Regular and careful examination of seams will usually lead to the discovery of worn parts or bad adjustment before the fault becomes so serious that the seams are not acceptable (see Appendix A).

5.4.5.15 FILLED AND SEALED METAL CONTAINERS SHOULD BE THOROUGHLY WASHED BEFORE THERMAL PROCESSING

The outside surfaces of containers often become smeared with fish juices or solids during the filling operation. If this is not removed before the thermal process, it may become baked onto the container and be very difficult to remove.

Washing may be done with sprays of hot water at about 60 ^{o}C (140 ^{o}F) or by conveying the containers through a bath of hot water containing a suitable cleaning agent.

Glass containers of canned fish would be difficult to wash without risk of breaking the seal. However, the washing of glass containers is not necessary because they are thermal processed in water.

5.4.6 *Thermal processing and cooling*

5.4.6.1 EVERY CANNERY SHOULD DEVELOP PROCEDURES WHICH WILL PREVENT UNPROCESSED CANNED FISH FROM BEING ACCIDENTALLY TAKEN PAST THE RETORTS INTO THE STORAGE AREA WITHOUT BEING THERMAL PROCSSSED

Accidents occasionally occur in which trays, baskets or trolleys of unprocessed canned fish bypass the retort and become mixed with properly processed products. The unprocessed product will decompose and eventually burst its containers. This may cause a great deal of damage to other products with which it is stored.

Canneries with horizontal retorts that have doors on each end can usually arrange passages in such a way that canned fish coming from the sealing machines must go through a retort in order to get to the casing and storage area. However, it may be very difficult to avoid some congestion at the retorts, if they are of the single door horizontal or the vertical type.

In such cases, the cannery should develop a procedure suitable to its own particular layout, which will prevent unprocessed canned fish from accidentally bypassing the retort.

Some system of marking trolleys or baskets of unprocessed canned fish may be necessary. Specially treated cards which change colour permanently if they are heated to a specific temperature are available. If these cards are placed with the batches of unprocessed canned fish before they are brought to the retort area they will serve later to indicate which batches have been heat treated. However, they should not be used to indicate whether or not the thermal treatment has been sufficient.

5.4.6.2 THERMAL PROCESSING SHOULD BE COMMENCED AS SOON AS POSSIBLE, WITHIN 30 MINUTES AFTER THE CONTAINERS HAVE BEEN SEALED

Spoilage of canned fish in sealed containers can take place fairly quickly at cannery temperatures particularly in temperate and warmer climates. Even very slight spoilage becomes quite noticeable because any odours gases produced will be retained in the container and will consequently affect the product.

Therefore, canned fish should be thermal processed to inactivate spoilage microorganisms as soon as possible after the containers are sealed. If production rates are low, the product should be thermal processed in partly filled retorts rather than held for the long period it might take to fill the retort completely. In this case the thermal process required for adequate sterillization may be changed. Therefore a separate thermal process should be established for partly filled retorts.

5.4.6.3 GREAT CARE SHOULD BE TAKEN TO ENSURE THAT ALL THERMAL PROCESSING OPERATIONS ARE ADEQUATE TO INACTIVATE ANY HARMFUL ORGANISMS THAT MIGHT BE PRESENT

The thermal processing of canned foods is a very critical process: too little heat will make it unsafe whereas too much will affect the quality. All thermal processing operations should be based on heat penetration tests carried out by competent canning technologists so that thermal processes give adequate protection against the survival of spores of Clostridium botulinum.

Close supervision of thethermal processing operation and careful attention to details are necessary, otherwise failures may occur due to poor organization, carelessness or ignorance of the principals involved.

5.4.6.4 INSPECTIONS SHOULD BE MADE PERIODICALLY TO ENSURE THAT RETORTS ARE EQUIPPED AND OPERATED IN A MANNER THAT WILL PROVIDE THOROUGH AND EFFICIENT THERMAL PROCESSING

Inspections should be made periodically to ensure that each retort is properly equipped, and is being loaded and operated in such a manner that the whole load is brought up to processing temperature quickly and maintained at that temperature through out the whole of the processing period. These initial tests are made by using thermocouples or other remote thermometers to measure the temperature at various parts of the load during the whole process period. They should be made under the guidance of a canning technologist.

The necessity of flushing all the air out of steam retorts in order to attain the controlled processing temperature has been mentioned earlier. This is done by venting, that is by allowing large volumes of steam to flow through the retort and out through open vents, driving and carrying the air with it. If the vents are too small, too few or not properly located or if the venting is not carried out long enough, air pockets may remain and parts of the retort will fail to attain the proper processing temperature. Pockets of air may also be left within baskets, crates or trolleys of canned fish and prevent the latter from being properly processed if the sides, dividers or spacers are not sufficiently perforated to allow steam to flow freely throughout the load.

It is therefore important that the flow of steam (and consequently heat) through out each retort should be studied by an expert and the steam distribution, when venting and loading arrangements modified if necessary to reduce the time required to exhaust all air and ensure an even distribution of heat. The minimum safe come-up time should also be determined and reassessed regularly for each retort under all loading conditions (see Appendix A.)

These studies should be repeated for each size of containers and whenever the retort equipment and loading arrangements are changed.

5.4.6.5 RETORTS SHOULD BE OPERATED ONLY BY PROPERLY TRAINED PERSONNEL

It is extreamly important that the thermal processing of canned fish be done correctly. Retort operators should understand the principles involved and realized the need for following the processing instructions closely and for using meticulous care in timing, determining temperatures and pressures and in making records. Therefore, thermal processing and associated processing operations should be performed and supervised only by properly trained personnel.

5.4.6.6 EVERY STEAM RETORTS SHOULD BE EQUIPPED WITH AN ACCURATE MERCURY THERMOMETER, A PRESSURE GAUGE AND, WHERE PRACTICAL, A TIME AND TEMPERATURE RECORDER. AN ACCURATE CLEARLY VISIBLE CLOCK SHOULD BE INSTALLED IN THE RETORTING ROOM. RETORT TEMPERATURES SHOULD ALWAYS BE DETERMINED FROM THE MERCURY THERMOMETER, NEVER FROM THE TEMPERATURE RECORDER OR FROM THE PRESSURE GAUGE

It is important that retort temperatures should always be accurately known and a standardize mercury thermometer should be installed for this purpose. In steam retorts the thermometer should be installed through the retort shell close to a bleeder so as to ensure the steady flow of steam pass its bulb during the whole time the retort is in operation. The thermometer should be tested regurlarly to ensure that it is accurate.

The use of time-temperature recorder is recommended and the temperature diagrams should be kept so that in the event of any claims the records can be consulted.

If a time and temperature recorder is used its bulb should be located in a current of steam close to the mercury thermometer. The pen of the recorder should be kept in adjustment to agree with the mercury thermometer, but the retort temperature should never be read from the recorder pen.

5.4.6.7 THE TEMPERATURE OF HOT WATER RETORTS SHOULD BE CONSTANTLY CONTROLLED. EACH RETORT SHOULD HAVE ACCURATE MERCURY THERMOMETERS TO MONITOR TEMPERATURES IN BOTH THE COOKING AND COOLING RANGES AND, WHERE PRACTICAL, A TIME AND TEMPERATURE RECORDER

The temperature of retorts which use hot water under pressure is controlled by adjusting the steam and the air pressure and this can be done better by an automatic regulator than by hand. The temperature should be monitored regularly, however, and for this purpose the retort should be equipped with an accurate mercury thermometer reading both in the cooking and cooling ranges.

5.4.6.8 LARGE CANNERIES USING STEAM RETORTS SHOULD CONSIDER INSTALLING AUTOMATIC RETORT CONTROLS WHEREVER THE CAPITAL OUTLAY CAN BE JUSTIFIED

Automatic control systems are available which take over the control of a retort as soon as the doors are closed. These devices control the steam input, the venting and the duration of the thermal process. They have safety devices that ensure that the correct processing temperature is reached before process timing is started and give an alarm if the temperature falls during the process.

Retorts with automatic controlls need to have an operator in attendence but are less liable to incur process errors than they would be if they were manually controlled.

5.4.6.9 PERMANENT RECORDS OF THE TIME, TEMPERATURE AND OTHER PERTINENT DETAILS SHOULD BE KEPT CONCERNING EACH RETORT LOAD

Such records will be very useful in providing management with a check on the thermal processing operations and will be invaluable if some questions arises as to whether certain lots had received adequate thermal processing.

The records should be made at the time of processing and should indicate the date, the retort number, the kind of product, the code, the size of container, the time the steam was turned on, the time the processing temperature was reached, the time the steam was turned off and appropriate information concerning the water cooling. Temperature and pressure should also be recorded and the record should be cross referenced with the temperature recorder chart.

5.4.6.10 THE WELL-TESTED PUBLISHED THERMAL PROCESSES FOR STANDARD CANNED FISH PRODUCTS SHOULD BE CAREFULLY FOLLOWED BUT ONLY AFTER COMPETENT EXPERTS HAVE CONFIRMED THAT THE VALUES ARE APPROPRIATE FOR THE PARTICULAR RETORTS TO BE USED. THE ADVICE OF COMPETENT AUTHORITIES SHOULD BE SOUGHT IN DETERMINING PROPER THERMAL PROCESSES FOR NEW PRODUCTS OR PRODUCTS IN NEW TYPES OF CONTAINERS

Optimum thermal processes for most standard canned fish products have been worked out by food canning research laboratories and their safety has been well proven by many years experience in the industry. These specified processes should be followed meticulously, as any changes for example in the temperature of fill, the composition of fill, size of containers or fullness of the retort may markedly affect the safety of the process and may have very serious consequences. If any changes are made, competent technologists should be consulted as to the need for re-evaluation of the process.

The methods used to determine the optimum safe thermal process for a new product or a new type of container are very complicated and should be undertaken only by well qualified technologists with proper laboratory facilities.

5.4.6.11 THE TIMING OF A THERMAL PROCESS SHOULD NOT BE COMMENCED UNTIL THE MINIMUM SAFE VENTING TIME HAS ELAPSED AND THE TEMPERATURE OF THE RETORT HAS BEEN RAISED EXACTLY TO THE SPECIFIED PROCESSING LEVEL

Process times are based on the premises that the steam or water surrounding the product is kept at the proper temperature for the whole of the time period. The timing should therefore not be commenced until the specified thermal processing temperature has been reached, and the conditions to maintain uniform temperature through out the retort achieved.

Uniform temperature through out a steam retort will not be achieved unless the retort is properly vented to remove all air. Proper venting is determined by the minimum safe venting time and the temperature that should be attained in this period. These venting conditions should be established for each retort. A great deal more steam is required during venting than during the processing period and it is general practice to bypass the steam inlet governor during venting. The vents and the bypass should not be closed until both the time and temperature conditions for venting have been satisfied. The pressure gauge should also be checked. If the retort has been properly vented its pressure should correspond to that of saturated steam at the temperature indicated by its thermometer.

Thus, the processed timing should not be commenced unless the established venting temperature has been reached, minimum venting time has elapsed and unless the thermometer indicates that the specified process temperature has been exactly reached.

5.4.6.12 PRODUCTS IN DIFFERENT SIZE CONTAINERS SHOULD NOT BE PROCESSED TOGETHER IN THE SAME RETORT LOAD

Heat penetration to the centre of large containers generally takes longer and therefore a longer thermal process is required. If products in containers of different sizes are processed together the process time specified for the larger containers will be required for safety. This may result in overcooking and loss in quality of the product in the smaller containers.

5.4.6.13 WHEN PROCESSING PRODUCTS 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

Closures on glass containers are not generally very strong mechanically and their needs to be a slight vacuum in the headspace to maintain a tight seal. Consequently the product should never be exposed to a temperture that will eliminate this vacuum, unless it is also subjected to additional external pressure.

Therefore, the initial temperature of the water in the retort should be slightly lower than that of the containers at the time they are sealed. Air pressure should be applied to the retort before the water temperature is raised.

Care must also be taken that the water temperature is not so low that there is danger that the glass will be damaged by thermal shock.

5.4.6.14 AFTER THERMAL PROCESSING CANNED FISH SHOULD, WHEREVER PRACTICAL, BE WATER COOLED UNDER PRESSURE. ONLY POTABLE CHLORINATED WATER SHOULD BE USED FOR THIS PURPOSE

The pressure cooling (that is cooling with water in the retort while it is kept under pressure) avoids the strains on the container which would otherwise be caused by the unbalanced pressure in the headspace after the steam pressure has been removed.

Products in glass or aluminium containers are processed in hot water under pressure and are cooled by carefully introducing cooler water in the retort before the air pressure on the retort is removed. The temperature of the products in glass must, of course, be reduced to a point where there is a vacuum in the container before the pressure on the retort is removed. It is also desirable to terminate thermal processes in steam retorts by pressure cooling. This not only reduces the strains on the containers, but prevents the product from being overcooked by the residual heat and also makes it more quickly available for casing.

Furthermore, problems with struvite will often be avoided if canned fish is cooled rapidly. Struvite, which is magnesium ammonium phosphate, forms from the natural constituents of some fish products during the thermal process and crystallizes out of solution and lodges in the flesh when the products cool. The slower the cooling, the larger the crystals will be. Struvite is perfectly harmless nurtritionally, but if the crystals are large enough they may feel like grit in the mouth and some consumers may mistake them for glass. However, if cooling is done rapidly the crystals formed will be very small and these problems will usually be avoided.

When water cooling is done solely to prevent overcooking or to hurry the handling it is sometimes done outside the retort in cooling canals. Where this method is used there should be continuous replacement of the cooling water to prevent build-up of organic or microbial contaminants.

Cooling should always be done with potable water because momentary lapses in the seal may occasionally occur during a themal or mechanical shock and there is risk that non-sanitary water might contaminate the contents of some containers. Water used in cooling should be chlorinated sufficiently to avoid contamination of the product.

Water cooling should not reduce the temperature of the container below the point at which its surfaces will be dried quickly by the residual heat. Cooling to an average product temperature of about 38°C (100°F) is generally satisfactory but slightly higher temperatures may be required in humid weather. Where water for cooling the cans is chlorinated in the plant, there should be a sufficient contact time to reduce the microbial content to a level which will not lead to contamination of the can contents during cooling. In some countries a contact time of 20 minutes is used. Checks should be made to ensure the presence of residual free chlorine at all cooling water outlets. Where water is recirculated it should be re-chlorinated.

It is desirable to maintain residual free available chlorine levels of 2-4 mg/l after 20 min contact time in order to be confident of holding total aerobic counts at less than 100 organisms/ml of cooling water. Free available chlorine should be still detectable in the cooling water at the completion of the cooling cycle. At all times records of free available chlorine levels should be maintained to provide confirmation that cooling water chlorination procedures were adequate.

5.4.6.15 WHERE CANNED FISH PRODUCTS ARE NOT COOLED IN WATER AFTER THERMAL PROCESSING THEY SHOULD BE STACKED IN SUCH A WAY THAT THEY WILL COOL RAPIDLY IN AIR. THEY SHOULD NOT BE LABELLED, CASED OR HANDLED UNNECESSARILY UNTIL THEY ARE QUITE COOL.

If canned fish is not cooled substantially soon after thermal processing it will continue to cook and its texture and flavour may be impaired. This fault, which is known as stackburn, will almost certainly occur if the product is put in cases while it is hot or piled so closely that it retains its heat for a long time.

Rough handling of canned fish while it is hot can be very detrimental to its texture and it may, in some instances, cause leakage at seams or soldered seals of containers.

If canned fish is not water cooled it should be stacked in such a way that there is a good circulation of air through the pile and it should not be labelled or cased until it is quite cool.

5.4.7 Labelling, casing and storing

5.4.7.1 THERMAL PROCESSED CANNED FISH SHOULD NOT BE TOUCHED BY HAND UNNECESSARILY BEFORE THEY ARE COOLED AND THOROUGHLY DRY. THEY SHOULD NEVER BE HANDLED ROUGHLY OR IN SUCH A WAY THAT THEIR SURFACES, PARTICULARLY THEIR SEAMS, ARE EXPOSED TO CONTAMINATION.

Canned fish will usually be soft while it is warm and may break up badly if the containers are shaken. Seams may leak momentarily if containers are subjected to thermal or physical shocks. If the seams are wet or dirty when this occurs, microbial contaminats may be drawn into the container. Even slight dents close to a seam are liable to cause leaks, some of which may become resealed after the contents have been contaminted. Therefore, canned products should not be moved unnecessarily until they are cool and dry. If necessary the drying may be hurried by blowing air over the containers. There runways for the conveyance of cans after thermal -processing become wet they should be regularly disinfected throughout the production period.

When canned fish is moved, care should be taken to avoid mechanical shocks that may cause dents or put momentary strains on the seams. Conveyors and other equipment for handling canned fish should be kept clean and dry so that they do not dirty the containers. Cylindrical containers should not be rolled on their double seams.

5.4.7.2 CANNED FISH 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 are sound and the product meets the standards for weight of contents, vacuum, workmanship and wholesomeness. Texture, colour, odour, flaour and condition of the packing medium should be assessed.

This examination should be made as soon as practical after the product has 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.

Containers of canned fish or shellfish should be inspected once again before or during the labelling and casing and defective containers withdrawn.

5.4.7.3 THE MATERIALS USED FOR LABELLING AND CASING CANNED FISH SHOULD NOT BE CONDUCIVE TO CORROSION OF THE CONTAINER. CASES SHOULD BE THE CORRECT SIZE AND STRONG ENOUGH TO PROTECT THE PRODUCT DURING DISTRIBUTION

Tinplate will corrode if it is kept moist for a long time particularly in the presence of mineral salts or substances which are even very weakly alkaline or acidic. Labels or label adhesive which are hygroscopic (that is, capable of attracting moisture out of the air) and therefore liable to promote rusting of tinplate should be avoided as should pastes and adhesives that contain acids or mineral salts.

Cases should be thoroughly dry. If they are made of wood it should be well seasoned. They should be the proper size so that the containers fit snugly and are not subject to damage by movement within the case. They should also be strong enough so that they are not broken or spilled under normal conditions of transport.

5.4.7.4 CODE MARKS APPEARING ON CONTAINERS OF CANNED FISH SHOULD ALSO BE SHOWN ON THE CASES IN WHICH THEY ARE PACKED

The cases should be marked so that it will not be necessary to pull them open to learn the identity of their contents. This will greatly expedite sampling or the separation of certain codes where this becomes necessary.

Code marks shown on the case will simplify the verification of shipments where code identifications are used on bills of sale or other shipping documents.

5.4.7.5 CANNED FISH SHOULD BE SO STORED THAT IT WILL BE KEPT DRY AND NOT EXPOSED TO EXTREMES OF TEMPERTURE

Tinplate containers wil eventually corrode if they are kept continuously moist or held under conditions of high humidity. Paper labels and fibreboard cartons will also be adversely affected by the dampness.

The quality of canned fish may also be adversely affected by storage at a high temperature. Reaction between canned fish and metal containers are very greatly accelerated by increasing temperture. Some products in which reactions with the container are insignificant even when stored for a year or more at temperatures of 20 ^{o}C (68 ^{o}F) or less, could become quite distasteful if stored for a month at a temperature of 40 ^{o}C (104 ^{o}F) or higher.

Extremely cold storage conditions should also be avoided. Freezing may burst glass containers or damage the texture of some product packed in metal containers. Furthermore, metal containers, which have become thoroughly chilled in storage, may become badly moistened by condensate and subsequently corroded if they are removed to a warmer storage or shipped to a warm moist climate.

5.4.7.6 CANNED FISH PRODUCTS SHOULD BE ALLOWED TO MATURE BEFORE THEY ARE OFFERED FOR SALE

It takes a few days or in some cases a few weeks or more for the salt, spices and other ingredients to become evenly distributed and for packing oils or sauces to become absorbed into the solid contents. Only when this equilibrium is reached will the product have its full flavour and in some instances its desired texture. Products should not be offered for sale until this stage is reached.

5.5 Sanitary control programme

5.5.1 IT IS DESIRABLE THAT EACH CANNERY IN ITS OWN INTEREST DESIGNATES A SINGLE INDIVIDUAL WHOSE DUTIES ARE PREFERABLY DIVORCED FROM PRODUCTION, TO BE HELD RESPONSIBLE FOR THE CLEANLINESS OF THE ESTABLISHMENT

Such a person or his staff should be a permanent part of the organization or employed by the organization and should be well trained in the use of special cleaning tools, methods of dismantling equipment for cleaning and in the significance of contamination and the hazards involved.

A permanent cleaning and disinfection schedule should be drawn up to ensure that all parts of the estallishment are cleaned appropriately and that critical areas, equipment and material, are designated for cleaning and/or disinfection daily or more frequently if required.

5.6 Labortory control

5.6.1 IN ADDITION TO ANY CONTROL BY THE OFFICIAL AGENCY HAVING JURISDICTION, IT IS DESIRABLE THAT EACH CANNERY IN ITS OWN INTEREST SHOULD HAVE ACCESS TO LABORATORY CONTROL TO ESTABLISH HYGIENIC QUALITY OF THE PRODUCTS PROCESSED

The extent and type of such control will vary with the food product as well as the needs of management. Such control should reject all foods that are unfit for human consumption.

Analytical procedure used should follow recognized standard methods in order that the results may be readily interpreted.

APPENDIX A
FACTORS AFFECTING QUALITY

A.1 GENERAL

The enzymes and microorganisms which cause fish to spoil are fairly readily destroyed or inactivated by heat. Therefore, fish products which are packed and sealed in containers that will protect them from re-contamination and then heated sufficiently. will remain stable for a long time at any temperature at which the product is likely to be held.

Thermal stabilization of the product and its protection against re-contamination are the essential conditions that must be achieved in canning. There are also many other processing requirements that must be met to ensure that canned fish products will be wholesome, palatable and otherwise acceptable to the consumer.

The basic requirements for the manufacture of satisfactory canned fish products are as follows:

(a) the fish and other ingredients used should always be of high quality;
(b) all handling and processing operations should be carried out carefully without needless delay and under high standards of sanitation;
(c) the thermal process should be sufficient to ensure the destruction or inactivation of all microorganisms that will multiply at any temperature at which the product is likely to be held and cause spoilage or might be harmful: and
(d) The container should be of suitable construction and should be properly filled and sealed so that the contents are protected from contamination. Its inner surfaces should be resistant to undesirable chemical reactions with the contents and its outer surfaces resistant to corrosion under likely conditions of storage.

The importance of using high quality fish as raw material for canning can hardly be over-emphasized. Canning is essentially a cooking process, the end result of which is much the same as if the fish had been prepared and cooked by the consumer. Therefore, fish with any quality defect which makes it unacceptable or unsatisfactory for direct sale to consumers other than a bruise, discoloration or similar fault that can be trimmed away is also unsuitable for canning. It follows then that the same care is required in the handling of fish on the vessel and on shore whether it is intended for canning or for processing into fresh or frozen fish products. Furthermore, many of the processes used in butchering, portioning and otherwise preparing fish for canning are similar to those used in preparing fresh fish products for market. Consequently, many of the recommendations contatined in the Sri Lanka Standard Code of Practice for handling of fresh and frozen fish are equally applicable in the preparation of fish for canning.

While the quality of fresh fish can be conserved for some time by careful handling and thorough chilling, it is nevertheless at its best soon after capture and the less delay in canning the better the product will be. Some delays in processing are inevitable and indeed delays are sometimes intentional as in the case where shrimp are held a day or so in ice to allow autolytic action to loosen the meat from the shell so that peeling will be easier, or in keeping a stock of fish in iced buffer storage so that the cannery can operate continuously between deliveries. However, such delays should be kept as short as possible and in no case should they be longer than would be permitted if the fish were being prepared for sale as fresh fish. The fish, of course, should be kept thoroughly chilled during the entire holding period.

In some instances where supplies of fish are seasonal or are subject to large day-by-day variations in the volumes of landings or, as in the tuna fisheries, where the fish are taken long distances at sea, it is necessary for canneries to utilize frozen stocks to keep operating continuously. Frozen fish to be used for canning should meet the same quality criteria as fresh fish - if it is not good enough to be cooked and served immediately to a discriminating consumer it is not good enough to be canned. The same care should be used in preparing, freezing and storing fish whether it be used for canning of marketed as frozen fish. Recommendations concerning the best accepted methods of preparing, freezing, packaging, storing, transporting and thawing fish for market or further processing are contained in the Sri Lanka Standard Code of Practice for handling of fresh and Frozen fish.

Batch lots of canned fish must be as uniform as possible in quality and particularly in appearance, texture and flavour. Regular consumers choose the particular brands or types of product with which they are familiar and they expect the contents of each container they open to be quite similar to the last. Therefore, products which cannot establish and maintain a reputation for consistency in such characteristics as appearance, colour workmanship, texture, size of piece and flavour are more difficult to sell to the public and are consequently less attractive to the whoesale buyer.

Differences in colour, texture or flavour are often due to natural differences in the raw material. Usually these differences cannot be avoided, but the desirability of keeping the output as uniform as possible should be kept in mind when fish are being acquired for canning. Where notable differences do exist, the raw fish should be segregated into batches which will have fairly uniform characteristics when canned and these batches should be identifiable from the coding on the containers of the final product. The quality of canned fish can be seriously affected by the way in which the raw material is prepared for canning. Preparatory processes such as brining, precooking, smoking or drying must be very carefully controlled to ensure that the desired effect of the process is uniformly achieved.

The quality of the other ingredients used is also important. Good quality materials used as packing media, sauces, fillers, spices or flavourings will enhance the flavour and appearance of the product and so increase its acceptability. Cheaper but poorer quality ingredients, on the other hand, may creat a poor impression of the product and so reduce its acceptability out of all proportion to the saving in cost. Furthermore, low quality ingredients may carry larger numbers of microorganisms or mould spores and thus create problems in the thermal treatment of the product. If the ingredients used are variable in their flavour or physical properties or if the amount added to the product is not carefully controlled, there may be a noticeable variability in the flavour, texture or appearance, which will detract from the general quality of the final product. If fish has been in contact with brine, its salt content should be determined, and taken into account when additional salt is added to the product. It should also be borne in mind that, in some circumstances, the prolonged contact of fish flesh with sea water may lead to the occurence of struvite crystals in the final product.

Since it is not usually practical to keep fish thoroughly chilled while it is being, prepared for canning, delays that take place during the preparatory processing may account for serious reduction in the quality of the finished products. The canning operation should be arranged so that the time lapse between removal of the raw material from chilled or frozen storage and the thermal treatment of the final product in sealed containers is as short as possible. When delays in the preparatory processing do become necessary, a special effort should be made to chill the fish as much as possible. Not only will the quality of the product suffer from unnecessarily long exposures to higher temperatures but there may be some risk that the microorganisms in the product will proliferate to the extent that the normal thermal treatment would not be sufficient to stabilize the product. Particular care should be taken to avoid delays between the time the containers have been sealed and the time they are thermal processed since stale odours and flavours will develop very readily in the product at this stage. Furthermore, damage to quality after the containers have been closed may not be discovered until they are opened by consumers.

A.2 **PRECOOKING**

Fish are very often precooked as part of their preparation for canning and usually for one or more of the following reasons:

a) to rid the flesh of fluid which would otherwise cook out during the thermal process and remain in the container as an undesirable free liquid;
b) to release body oil if the fish are excessively fat or if the oil has a very strong flavour;
c) to improve texture or to condition the flesh for further processing;
d) to obtain specific textural and flavour effects such as by frying in oil; and
e) to make shellfish meat firmer and to loosen it from the shell.

Cooking can be done in a number of ways such as in hot brine, in steam, in hot air, in hot oil or by radiant heat and sometimes two or more of these methods are used in combination or in sequence.

If fish are not precooked sufficiently the desired effect is not achieved but if they are overcooked there wil be loss in flavour and the yield will also be greatly reduced. It is therefore necessary to control the amount of cooking very carefully by regulating the cooking time and temperature.

Optimum cooking times and temperatures can be determined experimentally and the time required at a specified temperature can be related to the size of fish. For larger fish the amount of cooking may also be determined by measuring the temperature reached at their centres.

Since the cooking time required will depend on the size and the initial temperature of the fish, care should be taken that batches of fish which are to be cooked together should be similar in size and at approximately the same initial temperature.

Larger fish such as tuna are generally precooked whole in a steam chamber but in some fisheries they are cut into portions and precooked in brine. The precooking of tuna-like fish reduces their moisture content and rids the flesh of rather strongly flavoured oil. It also causes the flesh to separate from the bone and makes it sufficiently friable to be readily separated for canning.

Small fish such as sardines or herring are cooked primarily to rid them of moisture which would otherwise become a free liquid in the container and which would spoil the appearance, texture or flavour of the finished product. Traditionally sardines were cooked in oil but methods utilizing steam or hot air are now commonly used in the precooking of all varieties of small fish. The fish may be laid out on wire mesh trays called grills or flakes for cooking or they may be cooked after packing in their final container. The latter method has some advantage since it avoids further handling of cooked products which are usually fairly easily damaged. Very often fish are cooked first in steam to raise the temperature quickly and then in hot air to carry away the excess moisture which would otherwise remain on the surfaces.

If fish are precooked after packing, the containers must be inverted and the water and oil which cooks out drained away without spilling the fish. There are equipment for precooking containers of packed fish continuously. In one process the packed containers are steam heated for a period, inverted to drain away the liquid, cooked for a further period, uprighted, filled with hot oil, sealed and then delivered for thermal processing.

Lobster and crab are cooked to coagulate the protein and break the adherence between the muscle tissue and the shell so that the meat can be removed easily. Lobsters, and in some cases crabs, are cooked alive in boiling water which may contain about 3 to 5 percent salt. Crabs frequently have the back shell and viscera removed before being cooked either in a light brine or by direct contact with steam. In some fisheries, shrimp are cooked before peeling, but in others they are peeled raw and then cooked to condition the meats and cause them to curl.

Oysters and clam meats are usually precooked to make them firm and rid them of excess moisture. The cooking process is often used as the means of killing the animal and causing the shell to open. Sometimes it is done with boiling water but in larger operations it is usually done with steam. Continuous steam cooking tunnels or columns are sometimes used and these may be equipped to collect the clam juice which may be added back to the canned product or concentrated and sold as clam nectar.

If fish are precooked before packing they will need to be cooled so that the flesh becomes firm enough for them to be handled without damage. During a large part of this cooling period the fish will be within the temperature range where the proliferation of microorganisms and chemical spoilage can take place very quickly. Cooling should therefore be done as quickly as practical and the next stage of processing commenced immediately.

Cooling should take place in an area which is suitable for the purpose, where there is a good circulation of cool air and where the fish can be well protected from contamination by dust, insects or by contact with other unsanitary substances. In some instances it is also necessary to protect the fish from oxidation during cooling.

A.3 PREPARATORY DIPS

In the course of its preparation for canning, fish is often soaked in solutions containing flavouring or conditioning agents. Brine dips are most common but dips containing other permitted food additives are sometimes used.

To accomplish their purpose, dip solutions must be kept at their proper strength and the length of time the product is soaked must be carefully controlled. Where the use of a dip solution is being considered, the assistance of experienced fisheries technologists should be sought to determine the most suitable formula and dipping procedure. It is important to ascertain that the additive being considered is permitted both in the country where the canning takes place and in the countries where the product will be sold.

Weak brines are often used to adjust the salt content of the product but stronger solutions may also be used to remove blood and to improve the texture of fish surfaces by dehydrating them slightly. Strong brines are also used to separate fragments of shell out of crabmeat (the meat will float and the shell sink).

Other additives are sometimes used to improve the texture of the product, to acidify it slightly, to prevent certain natural ingredients from producing undesirable flavours or discolourations or to suppress the formation of struvite.

Dips will not only become ineffective but they may also become a serious source of contamination if they are not properly attended. With continued use, the solutions will become diluted and will collect debris washed or dissolved off the material being treated, and may soon contain very large numbers of microorganisms - particularly if they are not kept fairly cool. It is therefore important that dip solutions be changed very frequently and that dip tanks be thoroughly cleaned each time the solution is changed.

The amount of additive a product will pick up in a dip is sometimes difficult to control. Therefore if an additive is being used for the effect it has during or after the thermal process it will often be preferable to add it to the product through an accurate dispensing unit just before the containers are sealed rather than by using a dip.

A.4 CONTAINERS

Canned fish containers are most commonly made from either tinplate, aluminium sheet, laminated aluminium foil or glass. While each of these materials imposes some particular requirement on the canning process, any of them will be quite satisfactory if the proper processing practices are followed.

Tin plate, which is mild steel sheet that has been coated with tin on both sides has been used since very early in the development of the canning process and containers of this material are still the kind most commonly used by the industry. It is particularly suitable because of its strength, toughness and malleability and because it can be soldered to make very strong side seams for cylindrical containers. The tin coatings also help protect the container from corrosion by its contents or by the atmosphere.

At one time the coatings of tin were heavy enough to prevent corrosive action with the container from affecting most kinds of fish products for several years. However, in more recent times lighter coatings are used which are supplemented by enamel coatings to prevent undesirable reactions between the container and its contents.

Special enamels have been developed to minimize reactions between the active constitutents of canned fish products and their containers. These are usually baked onto the tinplate before it is cut and formed but there are some types which are applied to the finished container. Application of these latter types is more costly but they provide a better protection since the seams are covered and the enamel is not stretched or otherwise damaged during the forming of the container. It is important that for seafood approved enamels are used and also that they are not damaged either during the manufacture of the container or by rough handling during transport or in the cannery.

Abrasions, gaps or thin areas in the enamel will permit reactions between the tinplate and the contents to occur and these may affect quality in several ways. A common type of reaction results in the formation of a blcak iron sulphide stain on the surface of the food or on the inside wall of the contaier. These stains are not harmful but they detract from the appearance of the product. Iron sulphide stains are more common in some kinds of fishery products than others and there is some evidence that they occur more frequently if the raw material has commenced to deteriorate before canning. Some of the commonly used enamels contain substances which will reduce the occurrence of these stains by absorbing sulphur to form colourless compounds. Other special enamels are used if the product is acidic or contains substances that might cause particular corrosion problems.

If the canned product contains acidic ingredients, failure of the protective enamel may lead to reactions with the metal in which hydrogen gas is formed. If sufficient gas is generated its pressure will cause the container to become a swell.

In other instances constituents may be present which will react with the tin causing it to dissolve off the container and become incorporated in the food. If this "detinning" is extensive, the product may develop an objectionable flavour and the loss of tin from the container surfaces may lead to other forms of corrosion.

Rigid aluminium containers have become quite widely used by some segments of the canning industry. They are light in weight and attractive in appearance. In some regions and under some circumstances aluminium may be more economical than tinplate. However, aluminium alloys are not as strong as tinplate and are not easily soldered or welded and so it is difficult to form aluminium sheet into the strong side seam required for a cylindrical container intended for thermal processing at a high temperature. Therefore, the aluminium containers generally used in fish canning are the shallow drawn type and even these require special procedures to prevent them from being damaged by the internal pressures generated during the thermal process.

The exterior surfaces of aluminium containers resist corrosion by the atmosphere very well under normal storage conditions. Interior surfaces are generally treated to create an oxide layer (anodized) and then coated with enamels formulated especially to suit the particular type of product. Slight reactions between aluminium containers and their contents cause little damage because the by products are not harmful and do not discolour either the product or the container. However, extensive corrosion by the contents may result in the formation of swells or weaken the container to the point that it may leak.

Semi-rigid containers of aluminium foil laminated on the inside with polypropylene are also being used for canned fish. Although this type of container can be purchased, they are usually formed in special presses at the cannery from rolls of sheet aluminium laminate.

These containers are light in weight, attractive in appearance and easy to open. Since they are rather subject to damage if roughly handled, products in these containers are generally distributed in individual paperboard cartons for extra protection.

Semi-rigid containers are filled and handled in much the same way as other metal containers but a different closure is used. They are stacked only two deep in perforated trays in the retorts and are thermal processed in super heated water in the same manner as other aluminium or glass containers.

Although they are not used very extensively in the fish canning industry, glass containers do have properties that make them particularly suitable for some products. Since glass does not react with foodstuffs even in the presence of air and since most glass containers can be repeatedly opened and closed they are convenient for fish pastes or similar producrs where part of the contents may be kept a day or so after the container has been opened.

Some consumers may be attracted to products packed in glass containers that they can later put to other uses. The fact that glass containers are transparent can also be used to promote the sale of attractively packed products. However, glass containers should not be used if there is any risk that the product wil be discoloured or otherwise adversely affected by light.

Glass containers are quite easily broken if they are subjected to mechanical or thermal shock and particular care must be taken during the canning process to avoid rough handling or exposure to sudden changes in temperature. Breakages will also occur if products in glass containers are allowed to freeze transport or storage.

Covers generally consist of metal caps sealed to the glass with resilient gaskets and held in place by a mechanical fastening, by the vacuum in the container or by a combination of both vacuum and a mechanical fastening. In any case the covers are not very strongly held to the containers and special processing methods are required to prevent them from being forced off during the thermal process.

It is necessary, of course, to prevent corrosive reaction between the metal container cover and the contents from taking place. This is done either by enamelling the cover or by separating it from the contents with a suitable paper or plastic liner.

It is important that containers of canned fish should not be distorted or damaged in any way during the canning process for, regardless of the quality of the food, the product wil not be merchantable if the containers are not quite normal in appearance. This is so because most consmuers associate abnormal containers with a risk that the product may be spoiled or even harmful. This attitude is reasonable because it is not possible to tell from a visual examination whether flippers, springers or swells have been caused by overfilling, low vacuum, production of hydrogen by reaction of the contents with the container or by gas evolved from the spoiling contents. Neither is it possible to determine visually whether or not the seams of dented or distorted containers have developed very minute leaks or have been strained to the extent that they may fail before the product is consumed.

During mechanical or thermal shock, seams may sometimes open for just long enough to admit a small amount of contaminating substance and then reseal. In such cases, some time may elapse before spoilage will develop to the extent that the container will become swollen.

The fact that containers do not swell is not a certain indication that there has been no spoilage. There are some microorganisms which will spoil canned fish without the production of gas.

A.5 FILLING

In filling containers, account must be taken of the fact that the contents will expand or contract in volume more than the container will with changes in temperature. This means that the amount of headspace in containers of canned fish will be decreased as the temperature is raised and increased as the temperature is lowered. Some small shallow containers with relatively large flexible covers can expand to accommodate appreciable changes in the volume of the contents and usually should be adequately filled but not overfilled. Most containers need some headspace to prevent them from bursting or becoming permanently distorted during the thermal process. The amount of headspace required will depend on a number of factors including the size and type of the container and the nature of the product.

On the other hand, there may be difficulties if the headspace is too large. Panelling as a result of too high vacuum or too high external pressure during cooling is likely to be more severe if the headspace is large. Large headspace will also permit free movement of the contents during handling and this may be detrimental to the appearance and texture of the product. Furtheremore, the product may appear to be deceptively packaged if the containers are not filled reasonably close to their capacity. Some countries have regulations governing minimum fills of containers.

A.6 VACUUM

It is generally desirable to create a partial vacuum in containers of canned fish at the time they are sealed. This serves two purposes; it avoids excessive pressure from entrapped gas during the thermal processing and it also reduces the likelihood that internal gas pressure will cause metal containers to swell if stored in warm places or exposed to low atmospheric pressures. Glass containers usually have closures that depend, at least in part, on the vacuum within to hold the cover in place tightly enough to maintain the seal.

Since no headspace is necessary if a container can expand sufficiently to accommodate the contents during the thermal process, shallow containers with flexible covers are usually completely filled. In such cases no measurable vacuum is necessary because there will be very little or no air or gas in the container at the time it is sealed.

Very high vacuums are not generally desirable particularly if the headspace in the container is relatively large. A high vacuum may cause the walls of larger metal containers to become partly collapsed or panelled and increases the risk of contaminating material being drawn into the container through weak seams or other closures.

A vacuum is created by removing part of the air when the container are sealed. The traditional and still one of the most practical ways of doing this consists of heating the container and its contents to about 55 ^{o}C(130 ^{o}F) or higher before sealing.

Raising the temperature causes air to be displaced from the container by its own expansion, by the increase in the water vapour pressure and by the expansion of the solid and liquid contents. Since the pressure of the water vapour and remaining air will be in equilibrium with the atmosphere when the container is sealed it will be less than atmopheric-pressure when the container has been cooled to normal ambient temperature (after it has been thermal processed). The loss in pressure is due partly to the reduction in water vapour pressure with reduced temperatrure and partly to the lower pressure of the residual air as a result of its cooling and also its expansion as the volume of headspace is increased at the lower temperature.

The heating of canned fish to achieve a vacuum is usually done by conveying it through a steam filled tunnel or exhaust box. The amount of steam and the length or speed of the conveyor are adjusted to attain the desired amount of heating. Metal containers usually have their covers attached very loosely before entering the exhaust box and they must be sealed immediately after they come out to avoid unnecessary cooling and resultant reduction in the amount of vacuum obtained.

If canned fish products are to contain added brines, sauces or packing oils, a vacuum may be obtained by adding these hot just before the containers are sealed. However, care must be taken to avoid damaging the quality of packing oils or sauces by overheating or by keeping them hot from long periods prior to use.

"Broguing" was once the standard method of obtaining a vacuum in soldered metal containers but has fallen into disuse with the development of the solderless double seam closure. The method is still useful, however, in reclaiming good quality canned fish in metal containers which have no vacuum due to overfilling or some other processing failure.

In broguing, the sealed containers are heated sufficiently to create a substantial internal pressure, then punctured to allow air, steam and some liquid to escape and then resealed with solder and thermal processed again. These operations should be carried out quickly and the thermal processing should be for the same time and at the same temperature as when the product was being canned.

Vacuum may also be attained in canned products without preheating by using steam to flush the headspace and displace the air around the container while the cover is being applied and sealed in place. This method is widely used in well mechanized canneries and is adaptable to making vacuum closures on high speed canning lines.

Vacuum sealing machines are also quite widely used in some sections of the fish canning industry and some types are capable of vacuum sealing several hundred metal containers a minute. Containers with lids clinched loosely in place are conveyed through an air lock and sealed in a chamber which is kept under substantial vacuum by an exhaust pump. They are then carried out through an exit air lock.

A.7 CLOSURES

The closing of canned fish containers is a very crucial matter, for if the entry of contaminating substances is not prevented, the product will spoil and both the materials and the canning effort will be wasted. In some instances faulty closures may fail to seal completely the container, in which case recontamination and subsequent spoilage will occur very soon. In other cases poor closures result in seals which either break completely or open momentarily if the container is subjected to thermal shock, or rough handling, in which case spoilage may not occur until after the product has been stored or passed into the distribution channels.

The so-called "double seam" closure (see Appendix B) is nearly always used to seal metal containers of canned foods which are to be thermal processed. The seal is effected in two operations. In the first, the edge of the metal cover which has a coating of rubber-like sealing compound on its underside is folded so that it forms what is called the "cover hook" around the flared lip of the container body. In the second operation, the cover hook and enclosed lip are folded down against the container so that and interlocking "body hook" is formed and both hooks are closed so tightly that a strong joint is formed and the edge of the container lip is well embedded in the sealing compound within the fold of the cover hook. Since the cover is recessed slightly within the container wall, the seam consists of five thicknesses of metal, three folds of the cover and two of the body wall.

The equipment used for making double seam closures ranges from simple hand operated devices to power driven machines which can accept, seal and discharge 300 or more containers per minute. While they vary in capacity and other features, seamers all operate by pressing the cover and container lip into the desired folds between very precisely shaped machine parts and, as mentioned earlier, the seam is formed in two stages.

A properly formed double seam makes a very strong closure and a very reliable seal. However, small deviations from the correct size or shape of the folds which can be caused by seamers that are worn or out of adjustment may result in weak or leaky seams. It is therefore very important that the closing equipment be operated and maintained by competent staff and in accordance with the instructions and standards of its supplier and those of the container manufacturer. Since the consequences of poor seaming may be very serious, it is prudent to watch the output of all closing machines very carefully. A thorough examination of sample closures should be made at frequent regular intervals so that any deviations from the proper shape or dimensions or seams will be discovered and corrected before any unacceptable seams are produced.

Semi-rigid containers are heat-sealed in special equipment which uses high pressure as well as heat to make the seal. This equipment should be operated and maintained in accordance with the manufacturers instructions.

There are many types of covers for glass containers, and as mentioned earlier several methods are used to hold them in lace. In most cases special equipment will be required to fasten the covers to the containers. Manufacturers will provide instructions on how the containers or covers they supply should be sealed. These instructions should be followed carefully.

A.8 HEAT TREATMENT

Careful control of the amount of heat treatment is extremely important. If the product is not heated sufficiently it may spoil or it might become of potential health hazard; if the heat treatment is too severe, the quality may be reduced by over-cooking.

Fish is a low acid food and as such, supports the growth of spore forming microorganisms including many that will cause spoilage and some that might be extremely harmful to the consumer. There is an accepted public safety standard that all low acid canned foods that do not contain suitable bacterial inhibitors, shall receive sufficient heat treatment to destroy the spores of *Clostridium botulinum* which is one of the most heat resistant of the harmful microorganisms that might be present in the food.

Microorganisms vary in their sensitivity to heat and this may also be affected by the nature of the medium in which they occur, but many of the spore formers that will grow on fish and cause spoilage or become harmful will survive for along time at temperatures close to 100 ^{o}C, (212 ^{o}F), however, the thermal death rates of these types increase very greatly as temperature is raised.

Under laboratory conditions the spores of *C.botulinum* will survive for several hours at the temperature of boiling water, but will die off in a little over half an hour at a temperature of 110 ^{o}C (230 ^{o}F), in less than nine minutes at 116 ^{o}C (240 ^{o}F) and in less than three minutes at 121 ^{o}C (250 ^{o}F).

It must be emphasized that these death times are only valid if the spores are exposed directly to the heat. It will take very much longer to destroy similar spores in canned products by exposure to heat at the temperature in question.

In view of this, it is necessary to thermal process canned fish at temperatures in the range 110 ^{o}C to 121 ^{o}C (230 ^{o} to 250 ^{o}F). The higher temperatures are often preferred because of the saving in time and also because it is found that the texture, colour or flavour of some products may be preserved better by heating for a shorter time at a higher temperature. In other cases processing for a longer time at a lower temperature is better for the quality of the product.

Detailed discussion of the effect of heat on microorganisms is beyond the scope of this code but it has been illustrated that they die off much more rapidly at higher temperatures. It follows that thermal death rates will change very substratially as the temperature of the medium rises or falls.

This means that the effectiveness of a thermal process depends on the rate at which heat is absorbed by the product and how quickly the temperature of its coldest part comes up to the desired processing temperature.

A considerable amount of research has been done on the thermal processing of canned foods and methods are available whereby canning technolgists can assess the effectiveness of a thermal process if they have information relating the temperatures of the slowest heating point (cold point) of the product with time throughout the entire process period. This data can be obtained by using thermo-couples in test containers.

It is very important that the proper combination of processing time and processing temperature be chosen to provide an adequate heat treatment for each particular product and each particular container. The assistance of experts in canning technology should be obtained when determining the amount of heat treatment required. It is equally important much more difficult to take all the precautions necessary to ensure that products will always receive the correct amount of thermal processing. Errors in timing or in the operation of retorts are by far the most common causes of canned fish being underprocessed. Such errors may be very costly unless the underprocessing is discovered very soon after it occurs, spoilage may commence and the whole batch become a total loss. Indeed, if it has been boxed or otherwise mixed with other batches the loss may be even greter. Even more serious is the possibility that products which are only slightly underprocessed may go undeteced and become a health hazard.

The internal pressure which occur during and immediately after thermal processing are sufficient to cause serious strains on canned fish containers. During the actual heating period the steam pressure in the retort presses the exterior surfaces of the container, opposing and, in effect, neutralizing the water vapour pressure within the container. Even so, there may still be a very substantial unbalanced internal pressure exerted by the air enclosed in the container. The air which is at atmospheric pressure or lower at the time the container is sealed will greatly increase in pressure not only because its temperature is raised but also because it will be compressed by the expansion of the solid and liquid contents. Obviously this internal pressure will be greater if there is little or no vacuum or if the headspace is very small.

The internal pressure from entrapped gas is sufficient to distort some types of aluminium containers or damage their seams. It will also force the cover off many types of glass containers. To avoid this, canned fish in aluminium or glass containers is thermal processed in special retorts using superheated water under sufficient pressure to balance the pressure inside the container. At the end of the heating process cool water is gradually introduced into the retort and the overpressure is reduced slowly as the product is cooled.

In the conventional steam retort, the most critical stresses occur at the moment the steam pressure on the retort is relieved at the end of the process. By this time the canned fish will be thoroughly heated and the pressure of gas and water vapour within the container will be somewhat greater than the opposing steam pressure. If the steam pressure is suddenly released the stress from the internal pressure may become so great that the containers will be permanently distorted or the seams damaged.

Small steel (tinplate) containers are usually capable of withstanding this stress if the steam pressure is reduced slowly, but larger containers should be cooled enough to relieve the internal stresses before the external pressure is removed. During this process, known as pressure cooling, the pressure is maintained either by air or by steam. If steam is used it is introduced at the top of the retort which is gradually flooded with cooling water introduced below a layer of condensate.

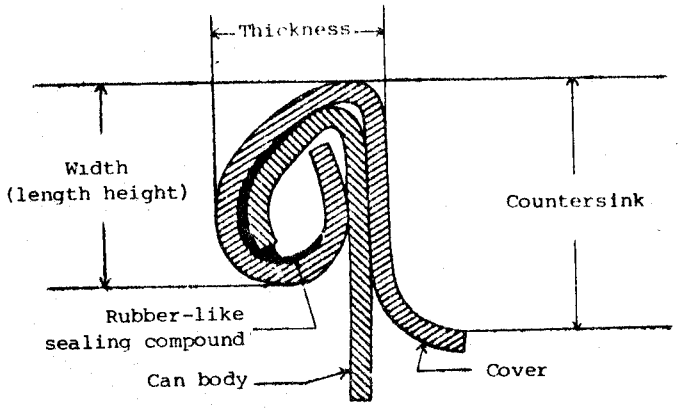
It has been mentioned earlier that the seams or other closures of canned fish containers may sometime leak momentarily during stress from thermal or mechanical shock such as may occur if cooling is done quickly with water. If there is a partial vacuum in the container at the time this momentary leak occurs a small amount of air or water will enter and there is a risk that the contents may become recontaminated with microorganisms which will cause spoilage or which may be harmful.

For this reason, it is very important that the water used for cooling thermal processed canned foods should be of potable quality. A small free chlorine content should be maintained so that there is no build up of microorganisms in water which is used for cooling either in retorts or in cooling tanks outside the retort. Water cooling should be stopped while the product is still warm enough for the container surfaces to dry off fairly quickly.

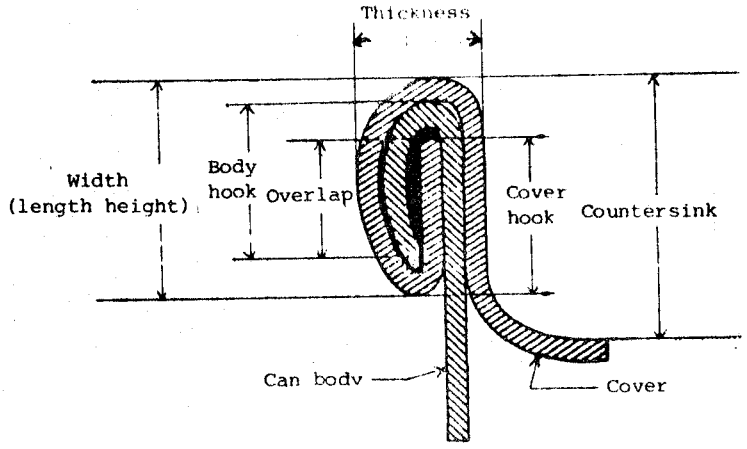
Aside from the necessity of relieving strains by reducing the pressure within the container, reasonably quick cooling is often required to prevent the retained heat from adversely affecting the flavour, colour or texture of the product. This effect, which is called stack-burn may occur if canned products that have not been water-cooled are put into cases while still hot or are stacked close together so that the heat is retained for a long time.

APPENDIX B

SCHEMATIC DIAGRAM OF "DOUBLE SEAM"



FIRST OPERATION
ROLL SEAM



SECOND OPERATION
ROLL SEAM

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