SRI LANKA STANDARD 975 : 1992

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CODE OF HYGIENIC PRACTICE FOR FROZEN FISH

SRI LANKA STANDARDS INSTITUTION

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SLS 975 : 1992

Gr. 22

SRI LANKA STANDARDS INSTITUTION
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Sri Lanka Standards are subject to periodical revision in order to accommodate the progress made by industry. Suggestions for improvement will be recorded and brought to the notice of the Committees to which the revisions are entrusted.

This standard does not purport to include all the necessary provisions of a contract.

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SRI LANKA STANDARD
CODE OF HYGIENIC PRACTICE FOR FROZEN FISH

FOREWORD

This standard was finalized by the Sectoral Committee on Fish and Fishery Products and was authorized for adoption and publication as a Sri Lanka Standard by the Council of the Sri Lanka Standards Institution on 1992-12-17

This standard is an adoption of Codex Alimentarius Commission/Recommended International Code of Practice for frozen fish CAC/RCP-16-1978. The text of CAC/RCP-16-1978 was considered suitable for adoption as a Sri Lanka Standard without major changes.

This code contains the technological guidelines and essential requirements of hygiene for the production, storage and handling of frozen fish and fish fillets on board fishing vessels and on shore. It also deals with the distribution and display in retail cabinets of frozen fish and also with thawing of frozen fish for further processing.

Catching, handling and processing of fresh fish is covered in a separate Sri Lanka Standard Code of Practice.

During the formulation of this Code due consideration has been given to the relevant provisions made under the Sri Lanka Food Act No. 26 of 1980 and the regulations framed thereunder.

1 SCOPE

1.1 This code of practice applies to frozen fish and fish fillets, intended for human consumption.

1.2 It contains the technological guidelines and the essential requirements of hygiene for the production, storage and handling of frozen fish and fish fillets on board fishing vessels and on shore.

1.3 It deals with the distribution and display in retail cabinets of frozen fish and also with thawing of frozen fish for further processing or other industrial purposes.

1.4 Although the code does not deal specifically with the freezing of shellfish, fresh water fish and various precooked fishery products, most of the recommendations made would apply.

2 REFERENCES

SLS 614 Potable water
SLS 974 Code of hygienic practice for fresh fish

3 DEFINITIONS

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

3.1 **air blast freezer** : A freezer in which heat is removed from the product by a stream of rapidly moving cold air.

In the continuous type, the product is frozen as it is slowly conveyed through an air blast freezing chamber or tunnel. In other types the product is placed in the freezer on suitable trays or rakes which remain stationary during the freezing process. The air blast freezer can accommodate a wider range in shape and size of products than can the contact freezer.

3.2 **air lock** : An enclosed space with outer and inner doors at the entrance to a freezer store.

During entry or exit one door is closed before the other is opened, thus reducing the inflow of warm air and the outflow of cold air from the freezer store. Cold air curtains are sometimes used instead of air locks.

3.3 **brine freezer** : A freezer in which heat is removed from the product by immersion in low temperature brine.

3.4 **buffer freezer store** : A temporary holding freezer store.

Small batches of the product can be held for a short period of time if, for any reason, they cannot be loaded into the main freezer storage space immediately after freezing; the temperature should be -18 °C or lower.

3.5 **chill store** : A store in which the raw material can be stored at a temperature of melting ice for a short period, if for one reason or another it cannot be frozen immediately.

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

3.7 **chilled sea water** : Clean sea water whose temperature is 0°C or slightly below.

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

3.9 **cleaning** : The removal of objectionable matter from surfaces.

3.10 **contact freezer or plate freezer** : A freezer in which heat transfer occurs by contact between the product and metal plates through which the refrigerant passes.

Two types, in use today, are the vertical contact plate freezer, mostly freezing large blocks of whole or gutted fish, and the horizontal contact plate freezer, in which smaller fish or fillet blocks or packages of fish or fillets are frozen. Pressure is used to bring the plates to bear on the product or package to ensure food surface contact during freezing.

3.11 **contamination** : Direct or indirect transmission of objectionable matters to the fish or fish products.

3.12 **cryogenic freezer** : A freezer in which heat is extracted from the product by the direct contact with liquified gas or vapour.

Examples are liquid nitrogen and refrigerant R-12 freezers.

3.13 **defrosting** : The process of removing frost and ice from freezer and freezer store refrigerated plates or coils, by the introduction of heat, or by brushing and scraping.

This is done because coatings of frost or ice greatly reduce the efficiency of these cooling surfaces. Contact freezers also require defrosting to allow for efficient loading and unloading.

3.14 **dehydration** : The loss of moisture from frozen products through evaporation.

This may occur if the products are not properly glazed, packaged or stored. Dehydration adversely affects the appearance and surface texture of the product and is commonly known as "freezer burn".

3.15 **denaturation** : The change which takes place slowly in the protein of fish during frozen storage and which adversely affects the appearance, texture and flavour of the product.

The rate at which protein denaturation occurs decreases at lower storage temperatures.

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

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

3.18 **fish** : Any of the cold-blooded aquatic vertebrate animals commonly known as such.

This include Teleosts and Elasmobranchs.Aquatic mammals, invertebrate animals and amphibians are not included. It should be noted, however, that many of the recommendations given here also apply to certain invertebrates, particularly Cephalopods.

3.19 **freezing process** : A process which is carried out in appropriate equipment in such a way that the range of temperature of maximum crystallization is passed quickly. The quick freezing process shall not be regarded as complete unless and until the product temperature has reached -18 °C or lower at the thermal centre after thermal stabilization.

3.20 **freezer** : An equipment designed for freezing fish and other food products, by quickly lowering the temperature so that after thermal stabilization the temperature in the thermal centre is the same as the storage temperature.

3.21 **freezer store** : An insulated and refrigerated room specially designed for the storage of frozen products.

Freezer stores have sufficient refrigerating capacity to maintain a temperature of -18°C or lower for products already frozen, but are not designed to freez products or to cool them down to storage temperature.

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

3.23 **frozen fish** : Fish which have been subjected to a freezing process sufficient to reduce the temperature of the whole product to a level low enough to preserve the inherent quality of the fish and which have been maintained at this low temperature during transportation, storage and distribution up to and including the time of final sale. For the purpose of this code the terms "frozen", "deep frozen", "quick frozen", unless otherwise stated, shall be regarded as synonymous.

3.24 **glaze** : A thin protective layer of ice which is formed on the surface of a frozen product by spraying it with, or dipping it into, potable water or potable water with approved additives.

3.25 **gutted fish** : Fish from which the guts have been removed.

3.26 **jacketed freezer store** : A room which is maintained at a temperature of -18°C or lower by refrigerating the walls, ceiling and floor, usually by forced circulation of cold air through the sealed air space which is included between the insulation and the inner lining of the store.

3.27 **keeping time** : The length of time that fish will remain wholesome and acceptable as human food.

3.28 **packaging materials** : All those materials such as foils, films, waxpaper, cartons and boxes, used for covering and protecting the frozen fish or frozen fish products and which are approved by the official agency having jurisdiction.

3.29 **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.

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

3.31 **pounds or pens** : Areas in the fish hold and on deck divided off by stanchions and portable or fixed board structures, for the storage of fish.

3.32 **refrigerated brine** : Used for freezing, is generally a concentrated solution of food grade salt (sodium chloride) in potable water or clean sea water. It is cooled by a suitable refrigeration system. Salts other than sodium chloride are sometimes used.

3.33 **refrigerated sea water** : Clean sea water cooled by the addition of ice prepared from potable water or clean sea water and/or by a suitable refrigeration system. Its salt content is normally abour 3 percent.

3.34 **rigor mortis** : The stiffening of the muscles of an animal which results from a series of complex changes that take place in the tissues shortly after death. Immediately after death, the muscles are soft and limp and can be easily flexed. At this time, the flesh is said to be in pre-rigor condition. Soon the muscles begin to stiffen and harden and no longer contract by stimulation. The animal is then in rigor. After some hours or days, the muscles gradually begin to soften and become limp again. This is called the post-rigor condition.

3.35 **sharp freezer** : Refrigerated room in which fish are laid on shelves or hung on hooks. There should be forced circulation of air.

In some designs, refrigerant is passed through pipes beneath the shelves.

3.36 **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.

3.37 **thawing** : A process whereby heat is introduced into the frozen product, in order to raise it temperature above freezing point.

3.38 **white fish** : Species of fish with white flesh containing relatively little fat.

3.39 **whole fish** : Fish as captured, ungutted.

4 RAW MATERIAL REQUIREMENTS

4.1 *General Considerations*

4.1.1 FISH INTENDED FOR FREEZING SHOULD BE OF THE HIGHEST POSSIBLE QUALITY

Although there are many aspects that might be taken into account when defining what is meant by the "highest possible quality" fish, there are two major ones that should concern the fisherman as a primary producer:

1. quality of fish when caught; and
2. quality of fish on delivery to the buyer or the processor.

The first one is determined by the physical condition of the fish, and includes appearance, size, percentage of fat, amount of feed, damage to skin, presence of disease and of harmful substances. The second one will result from the methods and techniques employed in fishing, practices in handling and freezing, and conditions of storage in the freezer store.

The fisherman should discard any fish that is diseased or is known to contain harmful substances or 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.

Freezing and frozen storage cannot improve the quality of fish. At best, the process maintains the fish in much the same condition as it was immediately before freezing. It is therefore essential that the raw material be as fresh as possible.

5. FREEZING FISH AT SEA - FISHING VESSEL FACILITIES AND OPERATING REQUIREMENTS

5.1 *Fishing vessel construction and hygiene design*

5.1.1 *General Considerations*

5.1.1.1 THE FISHING VESSEL SHOULD BE DESIGNED FOR RAPID AND EFFICIENT HANDLING AND FREEZING OF FISH, EASE OF CLEANING AND DISINFECTION, AND SHOULD BE OF SUCH MATERIAL AND CONSTRUCTION AS TO MINIMIZE ANY DAMAGE OR CONTAMINATION OF THE CATCH

In designing a fishing vessel many factors, apart from the vessel's performance as a harvesting unit, should be considered. The fisherman's earnings are determined not only by the quantity of the fish caught but, to a great extent, by the quality of the catch delivered to the processing plant.

Fishing vessels should be designed and constructed so as to minimize contamination of fish with bilge water, sewage, smoke, fuel, oil, grease or other objectionable substances. Fish, if not frozen quickly after capture, should be protected against physical damage, exposure to high temperature and drying effects of sun and wind.

All surfaces with which the fish might come in contact should be suitable corrosion-resistant material.

A vessel that is to be designed for freezing fish at sea should be large enough to allow for installation of proper processing and freezing equipment and for an adequate freezer store.

Such a vessel, to justify its cost, should be able to fish in more distant areas and remain on the fishing grounds till fully loaded. Fish which is frozen and stored on the vessel should be of the same quality as if it were processed and stored in a shore establishment.

5.1.1.2 CONSTRUCTION AND HYGIENIC DESIGN OF THE FISHING VESSEL EQUIPPED FOR FREEZING OF FISH AT SEA SHOULD FOLLOW CLOSELY THE GUIDELINES FOR THE DESIGN OF THE FISHING VESSEL SPECIFIED IN THE SLS 974.

Most of the requirements for the construction and hygienic design of the vessel equipped to freeze at sea should be the same as for the vessel which delivers fresh fish chilled by ice or refrigerated sea water.

If the vessel is large enough to engage in the processing of fish prior to freezing, then its design, layout, construction and equipment should meet the requirements of shore establishments and the processing should be carried out under similar hygienic conditions as detailed in the SLS 974.

5.1.2 *Construction*

5.1.2.1 FISHING VESSELS EQUIPPED FOR FREEZING AT SEA SHOULD BE SO DESIGNED AS TO PROVIDE FOR EFFICIENT OPERATION EVEN DURING HEAVY LANDINGS

Considerable elasticity of operation may be attained by having adequate storage facilities for the incoming fish.

Fish holds or bins where fish can be kept sufficiently chilled before being processed should be incorporated into the design of the boat. Use of refrigerated sea water or refrigerated brine tanks, either as an integral part of the vessel or as separate installable equipment items may be of value in some fisheries. Such tanks, preferably several in number, could be used for chilling the catch or for bleeding, washing and prechilling of fish just before freezing.

5.1.2.2 ADEQUATE POUND OR PEN STORAGE SPACE SHOULD BE PROVIDED SO THAT THE FISH FROM ONE HAUL WILL NOT BE MIXED WITH THOSE FROM A PREVIOUS HAUL. FIRST-CAUGHT FISH SHOULD ALWAYS BE HANDLED FIRST

If the storage space for fresh fish is inadequate, fish from a number of hauls may be mixed, with the first-caught fish being buried under subsequent hauls. This can result in the lower lying fish remaining ungutted for long periods, often at fairly high temperatures. Inadequate pre-gutting storage may also lead to fish from later hauls lying on the open deck exposed to sun and wind.

5.1.2.3 DECK POUNDS OR PEN'S STANCHIONS AND DIVIDING BOARDS SHOULD BE CONSTRUCTED OF SUITABLE CORROSION-RESISTANT MATERIAL. THEY SHOULD BE ADEQUATE IN NUMBER AND HEIGHT TO PREVENT CRUSHING OF THE FISH, DUE TO EXCESS WEIGHT OR THE VESSEL'S MOTION AND TO HOLD THE ESTIMATED CATCH

In practice, wood is still used in many fisheries for deck pound boards, and steel for stanchions and other fixtures. Where this is the case, the wood should be treated to prevent the entry of moisture and should be coated with a durable, non-toxic paint or other non-toxic surface coating that is smooth and readily cleanable. Steelwork should be coated with anti-corrosion and non-toxic paint. Whenever possible, suitable corrosion-resistant materials should be used.

5.1.2.4 VESSEL HOLDS OR TANKS WHERE FISH ARE HELD BEFORE PROCESSING AND FREEZING SHOULD BE ADEQUATELY INSULATED WITH A SUITABLE MATERIAL. ANY PIPES, CHAINS OR CONDUITS PASSING THROUGH THE HOLD SHOULD, IF POSSIBLE, BE SUNK FLUSH OR NEATLY BOXED IN AND INSULATED

Adequate insulation will reduce the amount of heat entering the fish hold and consequently the rate of ice meltage. If the quality and structure of the insulation is poor, considerable ice meltage will take place near bulkheads and shipside. This may cause excessive leaching of the fish and, if the amount of ice is not sufficient, this will allow fish temperatures to rise, and any fish which come in contact with the ship's structure may develop a particularly offensive smell.

5.1.2.5 **FISH HOLD OR TANK LININGS SHOULD BE COMPLETELY WATER-TIGHT. THE INSULATION LAYER SHOULD BE PROTECTED BY A LINING MADE OF CORROSION-RESISTANT METAL SHEETS OR ANY OTHER EQUALLY SUITABLE NON-TOXIC MATERIAL HAVING WATER-TIGHT JOINTS**

It is most important to prevent water from carrying fish slime, blood, scales and offal to parts of the vessel where effective cleaning is virtually impossible. The melt water seeping through the fish hold lining will also reduce the efficiency of the insulation and this will, in turn, lead to the increase in the temperature of the fish. The insulation should be covered with corrosion-resistant metal sheets or any other equally suitable non-toxic corrosion-resistant material, having water-tight joints to ensure protection from such contamination. An effective drainage system should be able to remove the melt water into sump as fast as it acoumulates.

5.1.2.6 **WOODEN HOLDING TANKS OR HOLDS SHOULD BE LINED WITH A SUITABLE MATERIAL**

The lining of wooden tanks or holds should be similar to that described in Section 5.1.2.5. They should be sealed and coated with a suitable impervious and non-toxic material which is easy to keep clean and not difficult to repair.

5.1.2.7 **THERE SHOULD BE NO SHARP CORNERS OR PROJECTIONS IN THE HOLD OR TANK, AS THESE WILL MAKE CLEANING DIFFICULT AND MAY DAMAGE THE FISH**

Contamination with fish slime, blood, scales and guts will build up rapidly on surfaces, in corners or around projections which are not smooth and impervious.

Any ledges or projections resulting from the encasement of pipes, wires, chains and conduits, that are passing through the fish hold, should be so constructed as to minimize any physical damage to the fish, to allow free drainage and ease of cleaning.

5.1.2.8 **IN ALL VESSELS USING REFRIGERATED SEA WATER FOR CHILLING OR REFRIGERATED BRINE SYSTEMS FOR FREEZING FISH, TANKS, HEAT EXCHANGERS, PUMPS AND ASSOCIATED PIPING SHOULD BE MADE OF, OR COATED WITH SUITABLE CORROSION-RESISTANT MATERIAL. THEY SHOULD BE DESIGNED SO THAT THEY CAN EASILY BE CLEANED AND DISINFECTED**

With hard, non-porous surfaces such as stainless steel, aluminium-alloys or plastics, spoilage microorganisms, together with all the debris deposited during storage of the fish, can be readily removed if the operation is performed immediately, thus reducing the risk of contaminating later catches. It is important to avoid corners, cracks and edges in which filth can lodge.

The whole system should be so designed as to allow an easy introduction and effective circulation of the cleaning and disinfecting solutions. There should be no place where a proper cleaning cannot be carried out.

It is important to remember that with ice storage only part of a load may spoil but with refrigerated sea water or brine, any malfunctioning of the system or neglect on the part of operations, can result in the catch being rejectd for spoilage.

5.1.2.9 WHERE CLEAN SEA WATER OR BRINE AND ICE MIXTURES ARE USED FOR COOLING AND TEMPORARY STORAGE OF THE CATCH, THERE SHOULD BE ADEQUATE CIRCULATION OF THE LIQUID

Effective means of circulating the cold liquid round the mass of fish should be provided. If pumping facilities are inadequate some of the load may not be cooled properly, resulting in fish with highly unpleasant odours and flavours.

The holding tanks should be equipped with suction screen arrangements which are strong enough to withstand the pressure exerted by the brine-fish mixture as well as negative pressure (suction) created by the circulating pump. Such screens should be so designed and located as to allow a constant and unobstructed flow of cold brine or sea water.

5.1.2.10 REFRIGERATED SEA WATER OR REFRIGERATED BRINE TANKS SHOULD BE INSULATED TO MINIMIZE HEAT LEAKAGE FROM THEIR SURROUNDINGS

The temperature of the refrigerated sea water will be more uniform throughout the tank and more easily controlled if the heat leak from other sources is reduced by effective insulation.

5.1.2.11 REFRIGERATION PLANT AND SEA WATER OR BRINE CIRCULATING EQUIPMENT SHOULD BE ADEQUATE TO MAINTAIN THE TEMPERATURE OF THE FISH AT -1 ^{o}C

At the temperature of-1^{o}C maximum delay of spoilage is attained in fresh fish. If the temperature is reduced below -1^{o}C the fish may be damaged because of partial freezing. In practice it is extremely difficult to control the temperature so precisely, but a range of -1^{o}C to +2^{o}C is achievable.

There should also be a sufficient compressor capacity to prevent a significant rise in temperature of the prechilled sea water or brine solution when the holding tanks are being loaded with the freshly caught fish.

Rapid cooling of fish is the primary task of the system. Once the initial cooling of fish is accomplished, the subsequent maintenance of constantly low temperature requires only a fraction of the compressor's load. Thermal inertia of a large body of chilled fish and brine should prevent sudden and significant fluctuations in temperature.

5.1.2.12 THE FREEZER STORE ON BOARD THE FISHING VESSEL SHOULD BE ADEQUATE FOR THE INTENDED PRODUCTION AND SHOULD BE SO CONSTRUCTED AS TO PROTECT THE FROZEN FISH FROM FLUCTUATION IN TEMPERATURE, DEHYDRATION AND PHYSICAL DAMAGE

The freezer store should be designed and constructed by experts in the field, taking into consideration species of fish and type of product intended for storage, size of production, duration of fishing trips and the environmental conditions of the area of the boat's activity.

One can hardly overemphasize the importance of the careful and detailed planning that is required in the construction of the vessel's freezer store (see Appendix A.2).

Adequate size of the storage and capacity of refrigeration system, provision for an emergency, facilities for defrosting, automatic temperature controlling and/or recording devices are some of the most essential requirements.

The frozen fish stored on board the fishing vessel should be kept under the same conditions as the fish in a shore freezer store.

5.1.3 *Hygiene facilities*

5.1.3.1 AREAS OF THE DECK WHERE FISH ARE UNLOADED AND HANDLED, OR THE FISH HOLD WHERE FISH ARE STOWED, SHOULD BE USED EXCLUSIVELY FOR THESE PURPOSES

All such areas should be well defined, be readily capable of being maintained in a clean condition and should be kept clean.

Storage of fuel and other petroleum products, or of different cleaning and disinfectng agents, should be so arranged that there is no possibility of contamination of surfaces with which fish come in contact.

Any exposure, even for a short time, of fish to petroleum products, very often results in rejection and eventual destruction of the whole load. The bad odour and taste of fish contaminated with fuel of other similar compounds is very persistent and difficult to remove during the subsequent processing; such fish should therefore be discarded.

5.1.3.2 AN AMPLE SUPPLY OF COLD POTABLE WATER CONFORMING TO SLS 614 OR CLEAN SEA WATER UNDER ADEQUATE PRESSURE SHOULD BE AVAILABLE AT A SUFFICIENT NUMBER OF POINTS THROUGHOUT THE FISHING VESSEL. ON LARGE VESSELS ENGAGED IN FISH PROCESSING A SUPPLY OF HOT WATER AT A MINIMUM TEMPERATURE OF 65 °C SHOULD ALSO BE AVAILABLE

Only potable water or clean sea water should be used on fish and on surfaces with which fish might come in contact. Even if the fish is caught in polluted waters, as occasionally happens, that water should not be used for washing fish or for the preparation of refrigerated sea water or refrigerated brine.

Fish when alive is relatively resistant to a polluted environment but looses its natural defences when it dies after being caught.

5.1.3.3 A SYSTEM FOR INJECTING CHLORINE INTO THE LINES OF SEA WATER WHICH IS USED IN THE PROCESSING OF FISH OR FOR THE CLEAN-UP OF THE VESSEL SHOULD BE PROVIDED WHERE PRACTICABLE

It has been established in the fish processing industry that the injection of chlorine into a supply of cold water, used for general wash-up, helps to control microbial contamination.

The fishing vessels involved in handling or processing large quantities of fish might gain considerably in hygiene by having chlorine introduced into the water lines. Chlorine dosage should be around 10 ppm during the normal use and 100 ppm of residual concentration during the clean-up.

As a word of caution, the use of strongly chlorinated water in confined spaces such as a vessel's hold could prove objectionable to the operator. For that reason, a system for injecting chlorine should be capable of varying the amount of chlorine delivered.

There are a number of relatively inexpensive and easily operable instruments on the market that will perform this task with the minimum of maintenance.

The installation of a chlorine injection system might not be practical for small fishing boats.

5.1.3.4 DECK HOSES SHOULD BE SUPPLIED WITH CLEAN SEA WATER, AT ADEQUATE PRESSURE, BY A PUMP USED ONLY FOR CLEAN SEA WATER

A good supply of clean sea water, at adequate pressure, with an addition of chlorine, if possible, should be available for washing fish and for flushing and rinsing of decks, holds, gear and other equipment which comes in contact with the fish.

The intake for sea water should be well forward of and on the opposite side of the vessel from the toilet waste and engine cooling discharge. Sea water should not be pumped while the vessel is in harbour nor in areas where there is a danger of it being polluted. Clean sea water should be taken in while the vessel is in forward motion.

The piping for the clean sea water supply should have no cross-connections with the engine or condenser cooling system. It should be so constructed as to prevent any possibility of back-siphonage from the kitchen sink, wash basins or toilets.

5.1.3.5 ICE SHOULD BE MADE FROM POTABLE WATER CONFORMING TO SLS 614 OR CLEAN SEA WATER AND SHOULD NOT BE CONTAMINATED WHEN MANUFACTURES, HANDLED OR STORED

Ice made from water which is neither potabe water nor clean sea water may contaminate the fish with water-borne microorganisms or other objectionable or even harmful substances. Such contamination will result in loss of quality, reduced keeping time, or might create a definite health hazard.

Some of the larger fishing vessels might have their own ice-making machines. The water used in the ice manufacture should be either potable water or clean sea water. The sea water intake for the pump should be located on the opposite side away from the waste discharge and engine cooling water outlets of the boat. Chlorine injection into the lines or water storage tanks, or the use of UV lights for continual flow purification should be provided.

Both systems are easy and inexpensive to operate. The sea water for ice manufacture should only be taken from areas known to be relatively unpolluted and without any visible discolouration or suspension.

The ice making plant should be cleaned regularly and maintained in a clean, hygienic condition at all times.

5.1.3.6 TOILET FACILITIES AND ALL PLUMBING AND WASTE DISPOSAL LINE SHOULD BE SO CONSTRUCTED AS NOT TO CONTAMINATE THE FISH

All the plumbing and waste disposal lines servicing the vessel's toilets, hand wash-basins or kitchen sinks should be large enough to carry peak loads, be watertight and should not go through the fish holds where fish is being handled or stored.

5.1.3.7 ON LARGE FISHING VESSELS, ENGAGED IN FISHING AS WELL AS FISH PROCESSING AND FREEZING, SUITABLE WASHING FACILITIES SHOULD BE PROVIDED

Such facilities should be located in toilets and close to the fish handling or processing areas. They should be supplied with clean water, soap and towels (preferably disposable).

5.1.3.8 THE FISHING VESSELS SHOULD BE EQUIPPED WITH BRUSHES, SCRAPERS, WATER HOSES, SPRAY NOZZLES AND OTHER SUITABLE WASHING AND DISINFECTING EQUIPMENT

Although there is a variety of cleaning and disinfecting equipment available on the market, good quality hand brushes of several sizes and shapes are still the most inexpensive and versatile tools for cleaning operations. Brushes should be kept in a clean and sound condition, disinfected after each use (dipping in 50 ppm chlorine solution is recommended) and, when not used, should be stored in a dry state. Brushes could spread dirt and microogranisms. Microorganisms will proliferate in a dirty brush when stored in a wet condition. The use of steel-wool for scouring should be avoided as there is a constant danger of introducing small, sometimes hardly visible, bits of wire into the final product. If for some reason cleaning cannot be done effectively with a good brush, then plastic, brightly coloured scouring pads might be used.

The use of high pressure and high frequency oscillating water or detergent spraying equipment has been found to be quite effective in cleaning, but it usually requires an experienced operator to prevent damage to painted surfaces.

5.1.3.9 IF POISONOUS AND HARMFUL MATERIALS, INCLUDING CLEANING COMPOUNDS, DISINFECTANTS AND PESTICIDES ARE STORED ON BOARD THE VESSEL, THEY SHOULD BE KEPT IN A SEPARATE COMPARTMENT RESERVED AND MARKED SPECIFICALLY FOR THIS PURPOSE

Extreme caution must be exercised to prevent poisonous or harmful materials from contaminating the fish. All such materials should be prominently and distinctly labelled so that there can be no confusion between these and edible materials used aboard the vessel. Compartments in which these poisonous or harmful materials are stored should be kept locked and the materials contained in them should be handled only by personnel trained in their use.

5.2 *Equipment and Utensils*

5.2.1 ALL FISH STORAGE, HANDLING, CONVEYING, PROCESSING AND FREEZING EQUIPMENT USED ON BOARD FISHING VESSELS SHOULD BE DESIGNED FOR THE RAPID AND EFFICIENT HANDLING OF FISH, BE SUITABLE FOR EASY AND THOROUGH CLEANING AND SHOULD BE CONSTRUCTED SO AS NOT TO CAUSE CONTAMINATION OF THE CATCH

Some of the equipment currently used in the fishing industries is quite unsuitable for the purpose in which it is employed. More thought should be given to the design and layout of fixtures and plant. When obtaining equipment, only equipment which can be readily re-assembled for thorough cleaning, should be considered.

5.2.2 MECHANICAL CONVEYORS SHOULD BE INSTALLED, WHENEVER PRACTICAL, TO HANDLE THE FISH DURING PRE-FREEZING OPERATIONS

Manual methods of moving fish from one process to another, apart from being more costly in labour and less efficient, often result in damage to the skin and flesh, allowing the entry of microorganisms and thus hastening spoilage.

5.2.3 FISH WASHING AND CONVEYING EQUIPMENT SHOULD BE CONSTRUCTED OF SUITABLE CORROSION-RESISTANT MATERIAL AND SO DESIGNED AS TO PREVENT BRUISING OR OTHER DAMAGE TO THE FISH

Washers should be designed to give an adequate washing period, and should have a copious and continuous supply of cold clean sea water. In the tank type washer, water should enter the tank through a number of jets, placed so that a water swirl is formed in the washer, allowing dirty water and scum to spill off and drain away. Water used in fish washing and cooling should not be recirculated.

5.2.4 WHERE SIZEABLE QUANTITIES OF FISH ARE HANDLED ON BOARD LARGE FISHING VESSELS, THE USE OF MACHINERY DESIGNED TO CARRY OUT GUTTING AND CLEANING SHOULD BE CONSIDERED

In many fisheries there is a growing need to save manpower but this cannot be accomplished without the introduction of more mechanical aids for working the fishing gear and handling the catch. These two principal tasks have to be performed by the same crew.

Gutting, which is usually the most time consuming operation, could easily be carried out by a gutting machine. Such machines have been developed and have been used by some fishermen in various countries.

It is advisable, before large expenditure of capital is made, that such machinery should be tested, bearing in mind that it will be operating under extremely rigorous conditions with limited possibilities for proper maintenance or immediate repair.

5.2.5 FREEZING EQUIPMENT SHOULD BE RELIABLE AND SUITABLE FOR THE PARTICULAR FISH SPECIES AND PRODUCT

It is most important that all freezing be carried out in an orderly manner, using equipment that is of sufficient capacity and is suitable for the product. The freezers should have proper defrosting facilities and be designed so that they are easy to clean. Refrigeration equipment needs to be reliable and of robust construction. It should be capable of running for long periods with little attention, and should have automatic devices for shutting it down in an emergency.

Large blocks of whole fish are usually frozen in vertical contact plate freezers. Horizontal contact plate freezers are generally used to freeze smaller fish, fillet blocks and packages of fish or fillets. Air blast freezing, sharp freezing and freezing in brine are also used at sea. Some vessels rely entirely on blast freezers for freezing blocks of whole fish and fillets, and individual round fish while others use them only for freezing large fish which cannot be accommodated by the contact plate freezers.

Freezing by immersion in refrigerated brine is most commonly used for the preservation of large fish such as tuna, which are intended for canning. With this method it is important that the freezing medium should not impart any objectionable odours or flavours to the product, or affect its quality in any other way. When using sodium chloride brine, care should be taken to minimize salt penetration into the product by removing it from the brine as soon as freezing is completed.

5.2.6 CONTACT PLATE FREEZERS SHOULD INCORPORATE A SYSTEM FOR DEFROSTING THE PLATES TO FACILITATE LOADING AND UNLOADING OPERATIONS. AIR BLAST FREEZER COOLING SURFACES SHOULD ALSO HAVE DEFROSTING FACILITIES

Defrosting of contact freezers ensures clean, smooth plates for easy loading and unloading and provides for good contact between the fish and the freezing surfaces. A large accumulation of ice and frost on the plate surfaces will seriously reduce the rate of heat transfer from the fish.

In air blast freezers frost can build up rapidly on the cooling surfaces, reducing the heat transfer and restricting the flow of air. Defrosting at frequent intervals is necessary to ensure maximum freezer performance. Defrosting by a built-in warming device is much quicker and more thorough than manual defrosting and does not risk damage to the cooling surfaces.

5.2.7 LIFTS OR CONVEYORS SHOULD BE INSTALLED FOR MOVING THE FROZEN FISH FROM FREEZERS TO FROZEN STORAGE

If manual handling is used, frozen blocks or individually frozen fish, which are very brittle, may be damaged or broken.

5.2.8 CONTAINERS USED FOR UNLOADING AND TRANSPORTING FROZEN FISH SHOULD BE STRONG AND CONSTRUCTED FROM SUITABLE IMPERVIOUS MATERIALS

Materials employed should be capable of being thoroughly cleaned and should not present any hygienic hazards.

5.3 *Hygienic operating requirements*

5.3.1 BEFORE ANY FISH COMES ABOARD, AND BETWEEN EACH HAUL OF THE GEAR, DECKS, POUNDS OR PENS, BOARDS AND ALL OTHER DECK EQUIPMENT WHICH WILL COME IN CONTACT WITH FISH SHOULD BE HOSED DOWN WITH CLEAN SEA WATER AND BRUSHED TO REMOVE ALL VISIBLE DIRT, SLIME AND BLOOD

The purpose of this washing is to remove all traces of contaminating matters such as slime, blood, tar, oil, etc. which may cause discolouration and offensive odours in the fish. In most fisheries this cleaning can be carried out while the net is in the water.

It is also important to have the surface of the deck and deck pounds well precooled by hosing them down with cold clean water before the fish is unloaded. During the warm weather, the surface temperature of the deck can be very high. It would be bad practice, therefore, to dump the catch on such a deck without any concern for the quality of the fish, especially, those from the bottom layer which, in all probability, would remain for a longer time in direct contact with the hot surface of the vessel's deck.

5.3.2 ALL TUBS, TANKS, BARRELS AND OTHER EQUIPMENT USED IN HANDLING, GUTTING, WASHING, FILLETING AND CONVEYING OPERATIONS SHOULD BE THOROUGHLY CLEANED, DISINFECTED AND RINSED AFTER EACH CYCLE OF OPERATIONS

Any filth, slime, blood or scales allowed to dry and accumulate on surfaces with which fish comes in contact, will be very difficult to remove later, and will thus contaminate the subsequent loads of fish.

5.3.3 DURING FISHING TRIPS THE FISH HOLD BILGE SUMP SHOULD BE DRAINED REGULARLY. THE SUMP SHOULD BE ACCESSIBLE AT ALL TIMES

Bilge water containing blood and slime, if not regularly pumped out, will provide a good medium for the multiplication of microorganisms and give rise to offensive odours in the fish hold. The bilge sump should be cleaned and disinfected frequently.

5.3.4 SEA WATER WHICH HAS BEEN USED FOR COOLING ENGINES, CONDENSERS OR SIMILAR EQUIPMENT SHOULD NOT BE USED FOR WASHING FISH, DECK, HOLD OR ANY EQUIPMENT WHICH MIGHT COME IN CONTACT WITH FISH

The water used for cooling engines is usually at a higher temperature than fresh sea water, and might be contaminated with oil or other petroleum products, or contain rust and other by products of metal corrosion.

Such water, if used for washing, will accelerate considerably the spoilage of fish by raising their temperature and might impart objectionable taste, odour or undesirable discolouration.

5.3.5 WHERE GUTTING BENCHES ARE INSTALLED, THESE SHOULD BE PROVIDED WITH CHANNELS OR CHUTES WHICH HAVE A CONTINUOUS SUPPLY OF CLEAN SEA WATER TO CARRY THE GUTS OVER THE SHIPSIDE OR TO A SUITABLE CONTAINERS

Where fish are contaminated by offal and filth from the gutting operations, the spoilage rate will be increased and all surfaces with which the guts come in contact will also become contaminated. The installation of gutting benches makes the task easier, but care should be taken to ensure that the benches are kept in a hygienic condition.

In disposing of offal into the surrounding water, some consideration should be given to the possibility of a serious pollution problem especially if this is done in sheltered waters, close to public beaches or inhabited areas.

5.3.6 FISH GUTS SHOULD NOT BE ALLOWED TO CONTAMINATE OTHER FISH ON DECK

Fish guts contain digestive enzymes and spoilage microorganisms. If allowed to foul the rest of the catch, the spoilage rate will be increased. This contamination can be prevented by dropping guts into suitable water tight containers or chutes discharging over the ship side.

With bigger boats handling larger quantities of fish, the resulting offal could easily be processed into fish meal. Such machines have been developed for installation on board fishing vessels and are commercially available.

5.3.7 WHEN CLEANING AND HOSING OPERATIONS ARE CARRIED OUT WHILE THE VESSEL IS IN PORT, POTABLE WATER OR CLEAN SEA WATER SHOULD BE USED

Cleaning water should be free from contamination in amounts harmful to man. The total number of microorganisms in it should be low, and it ought not to contain any microorganisms of public health significance. Contamination of the fish by water-borne microorganisms and other undesirable substances will result in the loss of quality and might become a health hazard. Harbour water is usually heavily polluted, and should never be used for cleaning purposes. This is also true for water in the close vicinity of towns, villages, industrial plants, fish processing establishments and factory ships.

5.3.8 IMMEDIATELY AFTER THE CATCH IS UNLOADED, THE DECK AND ALL DECK EQUIPMENT SHOULD BE HOSED DOWN, BRUSHED, THOROUGHLY CLEANED WITH A SUITABLE CLEANING AGENT, DISINFECTED AND RINSED

Fish blood, guts, slime and dead fish left on the deck will support multiplication of microorganisms which may contaminate future catches. If allowed to dry, slime, blood and scales are very difficult to remove.

Thorough cleaning should always precede disinfection especially when chlorine is used as the disinfecting agent. Any organic matter which is not removed from the surfaces that are to be disinfected will rapidly combine with and neutralize the microorganism killing ability of chlorine or any other disinfectant.

5.3.9 **IN VESSELS USING REFRIGERATED SEA WATER OR REFRIGERATED BRINE SYSTEMS FOR THE HOLDING, CHILLING AND FREEZING OF THE CATCH, ALL TANKS, PUMPS, HEAT EXCHANGERS AND OTHER ASSOCIATED EQUIPMENT SHOULD BE CLEANED IMMEDIATELY AFTER DISCHARGING THE CATCH. POTABLE WATER CONFORMING TO SLS 614 OR CLEAN SEA WATER CONTAINING A SUITABLE CLEANING AGENT SHOULD BE CIRCULATED THROUGH ALL PARTS OF THE SYSTEM. TANKS SHOULD BE INSPECTED CAREFULLY AND CLEANED OUT BY BRUSHING IF NECESSARY**

Since anaerobic microorganisms are particularly active under tank storage conditions, a very high standard of hygiene is required to avoid their build up and the spread of infection from one tank to another.

Immediately after unloading, when surfaces are still wet, the holding tanks should be washed with cold potable water of cold clean sea water under adequate pressure, then scrubbed with a brush using an alkaline detergent solution, and rinsed with warm and cold potable water or clean sea water.

All pumps, pipes and heat exchangers should be thoroughly flushed with clean cold potable water conforming to SLS 614 or cold clean sea water, followed by circulating through the system either a hot alkaline solution or cold water to which a strong cleaning agent has been added. After rinsing with potable water or clean sea water, a suitable disinfectant should be circulated through the system. It has been regarded by many fishermen as good practice to leave a weak solution of a non-corrosive disinfectant in the system. This, of course, must be drained and rinsed out thoroughly with potable water or clean sea water before filling the tanks.

5.3.10 **WHERE REFRIGERATED SEA WATER IS USED FOR HOLDING OR CHILLING OF FISH, ONLY CLEAN SEA WATER SHOULD BE USED AND SHOULD BE CHANGED AS OFTEN AS POSSIBLE TO PREVENT THE ACCUMULATION OF CONTAMINATING MATERIALS**

Use of sea water contaminated with sewage or industrial discharges will affect the quality of the catch or render it unfit for human consumption. It is advisable for fishermen to check with the local authorities which areas are likely to be free of pollution. The intake for the vessel's sea water pump should be located on the opposite side away from sewage, waste discharge and engine cooling water outlets of the boat. Clean sea water should be taken in while the vessel is in forward motion.

5.3.11 ADEQUATE PRECAUTIONS SHOULD BE TAKEN TO ENSURE THAT HUMAN AND OTHER WASTES FROM THE FISHING VESSEL ARE DISPOSED OF IN SUCH A MANNER AS NOT TO CONSTITUTE A PUBLIC HEALTH AND HYGIENIC HAZARD

With man's increased concern for the protection of his environment, in some countries the disposal of any waste from any boat into the surrounding water is restricted by law.

Fisherman should be fully aware of their responsibilities in this regard. Discharge of animal, human or any other wastes form the fishing vessel into the sheltered waters close to man inhabited areas, or over the shellfish growing areas should not be practised.

5.3.12 EFFECTIVE MEASURES SHOULD BE TAKEN TO PROTECT THE FISHING VESSEL AGAINST INSECTS, RODENTS, BIRDS OR OTHER VERMIN

Rodents, birds and insects are potential carriers of many diseases which could be transmitted to man by contamination of fish. Fishing vessels should be regularly examined for evidence of infestation and, when required, effective control measures should be taken.

All rodenticides, fumigants, insecticides and other harmful substances should be used only in accordance with the recommendations of the appropriate official agency having jurisdiction.

5.3.13 DOGS, CATS AND OTHER ANIMALS SHOULD BE EXCLUDED FROM AREAS OF THE VESSEL WHERE FISH IS RECEIVED, HANDLED, PROCESSED AND STORED

Because of public health hazards, no surface of the fishing vessel and of the equipment thereon which comes in contact with fish should be exposed to contamination with animal hair or excreta.

5.3.14 FOOD SUPPLIES FOR THE VESSEL'S KITCHEN OR FOR THE CREW'S MESS SHOULD NEVER BE STORED IN ICE BINS WHERE FISH ARE KEPT

Storage of such materials in ice intended for fish might contaminate the ice and the fish.

5.4 *Operating practices and production requirements*

5.4.1 *Handling the catch before freezing*

5.4.1.1 **HANDLING THE CATCH SHOULD BEGIN AS SOON AS IT COMES ON BOARD. ANY FISH UNSUITABLE FOR HUMAN CONSUMPTION SHOULD BE REMOVED FROM THE CATCH AND KEPT SEPARATE**

Sorting the catch should be done as soon as the fish are taken on board, to remove as quickly as possible fish unsuitable for human consumption. Mixed species catches should also be sorted rapidly not only for the reason stated above but also to avoid possible damage due to abrasion, particularly where the catch contains spiny and rough skin species and to prevent transferring undesirable odours and tastes which may affect the organoleptic quality of the differing species.

5.4.1.2 **FISH SHOULD NOT BE TRAMPLED OR STOOD UPON, AND SHOULD NOT BE PILED DEEPLY ON DECK**

Any physical damage, whether by crushing, bruising, rubbing or scraping assists spoilage and reduces the value of the fish for subsequent food processing purposes.

5.4.1.3 **ALL FISH ON DECK SHOULD BE PROTECTED FROM SUN, FROST, AND THE DRYING EFFECTS OF WIND**

It is essential to prevent the fish temperatures from rising. Each degree of rise in temperature increases the rate of spoilage. If the catch is to be on deck for any length of time, it should be protected by an awning, ice, immersion in refrigerated sea water or even a wet, clean canvas or burlap. Drying will lower market value by spoiling the appearance and possibly inducing rancidity. Slow freezing of the catch on deck, in areas where very low temperatures are encountered, should also be avoided.

5.4.1.4 **FISH KEPT IN PRE-GUTTING STORAGE FACILITIES SHOULD NOT BE PILED TOO DEEPLY. STANCHION AND DIVIDING BOARDS SHOULD BE ADEQUATE TO PREVENT MOVEMENT AND CRUSHING OF THE FISH DUE TO THE VESSEL'S MOTIONS**

The stowage of fish in depth and in large undivided pounds or pens will result in damage to the catch by pressure and mass movement of fish with the motions of the vessel due to sea or weather conditions.

5.4.1.5 **FISH SHOULD BE MAINTAINED AT A TEMPERATURE AS NEAR AS POSSIBLE TO 0°C AT ALL TIMES UNTIL LOADED INTO THE FREEZER. CHILLING OF WHOLE OR GUTTED FISH SHOULD BE DONE RAPIDLY BY THE USE OF ICE OR BY IMMERSION IN OR SPRAYING WITH REFRIGERATED SEA WATER. RAPID CHILLING IS PARTICULARLY IMPORTANT IN WARM CLIMATES**

Thorough chilling will retard spoilage and minimize physical and chemical changes in the fish, and will result in the production of frozen products which, when thawed, will be comparable with the quality of the product before freezing. Keeping fish and fillets thoroughly chilled right up to the time they are frozen usually avoids the undesirable effects of rigor mortis.

5.4.1.6 WHEN FISH ARE TO BE BLED, THIS SHOULD BE DONE IMMEDIATELY AFTER THE FISH ARE LANDED ON DECK

Bleeding is usually quicker and more effective when carried out at a relatively low temperature or when the fish are still alive.

It is good practice with some fish to bleed them prior to gutting. On the other hand, in some fisheries, the fish are bled by gutting. In the latter case, the fish may bleed better if they are freshly caught.

If the bleeding and gutting is done on dead or "spent" fish, the fillets cut from such fish will have a pronounced reddish discolouration rather than the appearance of properly bled fish.

The thorough bleeding of white fish results in a frozen product which is whiter after thawing. In the case of cod, bleeding for about 20 minutes at chill temperatures is usually sufficient to produce a satisfactorily white product.

5.4.1.7 GUTTING SHOULD COMMENCE AS SOON AS THE CATCH COMES ON DECK

The reasons for prompt gutting are, firstly, to sever some of the main blood vessels allowing the fish to bleed and, secondly, to remove the stomach and gut which would otherwise cause a softening of the flesh and accelerate spoilage. Fish in which the guts are full of food, will spoil even more rapidly. Although immediate gutting is desirable with most, species, the catch in certain fisheries cannot be handled rapidly enough and advantages gained by gutting may be offset by quality loss resulting from rises in fish temperature. In such circumstances, it would be preferable to get the fish under cover and to chill quickly, rather than delay the chilling operation by gutting.

5.4.1.8 WHERE RAPID GUTTING IS NOT PRACTICABLE, WHOLE FISH SHOULD BE WASHED AND CHILLED AS SOON AS IT COMES ON DECK

This helps to remove filth, particularly gut content squeezed out of the fish in the net, and it helps to prevent excessive contamination during subsequent gutting and handling.

A thorough washing of the fish will reduce considerably the number of spoilage microorganisms and remove some of the protein digestive enzymes which come from the viscera of the fish.

5.4.1.9 GUTTING SHOULD BE COMPLETE AND CARRIED OUT WITH CARE. BAD GUTTING MIGHT BE WORSE THAN NO GUTTING AT ALL

Pieces of gut or liver, if not completely removed, will act as centres from which spoilage will develop. Enzymes from pieces of gut and liver will digest the flesh and facilitate the entry of microorganisms. Careless gutting, for example, cutting beyond the vent of a fish will also allow the entry of microorganisms into the flesh. Nevertheless, cuts should be adequate to allow easy access to the belly cavity and complete removal of guts.

5.4.1.10 SEPARATE AND ADEQUATE STORAGE FACILITIES SHOULD BE PROVIDED FOR THE FISH ROE, MILT AND LIVERS IF THESE ARE SAVED FOR LATER UTILIZATION

In some fisheries certain by-products of gutting operation are saved either for human food, like fish roe and milt, or for utilization in pharmaceutical industry, like fish liver used in vitamin extraction.

All these by-products should be stored separately from the fresh fish intended for human consumption and should be kept well chilled and protected from sun, rain, wind and frost. Partial freezing of roe might damage it.

5.4.1.11 IMMEDIATELY AFTER GUTTING, FISH SHOULD BE WASHED WITH COLD CLEAN SEA WATER OR POTABLE WATER CONFORMING TO SLS 614

Gutted fish, before being frozen, should be thoroughly washed with clean sea water (preferably refrigerated) or potable water conforming to SLS 614, to remove all blood, slime and pieces of gut. Fish blood coagulates rapidly and washing will facilitate more complete bleeding, which in turn will improve the appearance of the product. If tanks are used for washing gutted fish, a continual flow of potable water or clean sea water should be provided to prevent the accumulation of contaminating materials.

5.4.1.12 ON COMPLETION OF WASHING THE FISH, FURTHER HANDLING SHOULD BE CARRIED OUT WITHOUT DELAY

If freezing cannot be carried out immediately, the fish should be thoroughly iced or immersed in ice water to bring its temperature down to $0^{o}C$ as quickly as possible.

At higher temperatures a delay of one hour can have a serious effect on the quality of the final product.

Chilling of fish in bulk, by cold air or by top icing only, should be avoided.

5.4.1.13 FISH WHICH ARE WAITING TO BE FROZEN SHOULD BE STOWED UNDER CHILL CONDITIONS AND IN SUCH A WAY THAT THEY WILL NOT BE DAMAGED BY CRUSHING OR BY MOVEMENT DUE TO THE VESSEL'S MOTIONS

Deep bulk stowage of any fish awaiting freezing is likely to cause considerable damage to the flesh by pressure. If they are not kept chilled at this stage, the fish may quickly go into rigor, resulting in damage.

5.4.1.14 WITH BUFFER STOWAGE OF FISH, IN SOME FISHERIES REFRIGERATED SEA WATER SHOULD BE CONSIDERED INSTEAD OF ICED STOWAGE

Stowage in ice is, as yet, the most common method of keeping fish in a chilled condition, but chilling by immersion in or even spraying with refrigerated sea water involves less manual handling of the fish.

Large quantities of fish may be chilled more rapidly by immersion in tanks of refrigerated sea water or refrigerated brine than by icing and it is easier to keep them in chilled condition. Care should be taken that they are not packed too densely. It is essential that there is a good circulation of the cooling medium. This type of storage assists the bleeding of white fish prior to freezing. It also avoids pressure damage to fish resulting from deep bulk stowage in ice.

Recommendations on refrigerated sea water and refrigerated brine stowage for maintaining fish in a chilled condition are given in SLS 974.

5.4.1.15 WHERE BINS ARE USED TO STOW SMALL QUANTITIES OF FISH AT THE FREEZER LOADING AREA, EACH BIN SHOULD ONLY HOLD ONE SPECIES OR ONE SIZE RANGE OF THAT SPECIES

It facilitates the freezer loading operation if the fish in each bin or container are of the same species. It will also be advantageous to the merchant or shore processor since blocks can then be selected to meet special requirements as to size and species of fish.

5.4.1.16 THE PROCESSING SYSTEM SHOULD BE FLEXIBLE ENOUGH TO HANDLE FILLETS AT ANY OF THE RIGOR STAGES

It is still open to question whether fillets should be frozen before, during or after rigor. None of the rigor stages are clear cut,since it is gradual process beginning the moment the fish dies. For this reason, therefore, it is advisable to have a system of processing which is flexible enough to a handle fish at all stages of rigor and, if necessary, a labelling system which will enable the shore processors to identify fillets frozen under different conditions.

5.4.1.17 IF THERE IS ANY DELAY IN THE FREEZING OF FILLETS THEY SHOULD BE CHILLED BUT PRERIGOR FILLETS SHOULD NOT BE HELD IN FRESH WATER OR FRESH WATER ICE PRIOR TO FREEZING

Stowage should be by immersion in or spraying with refrigerated sea water, since contact with fresh water is known to increase shrinkage of fillets cut from fish in a prerigor condition.

5.4.1.18 ALL PIN BONES SHOULD BE REMOVED FROM THE FILLETS THAT ARE USED FOR MAKING BONELESS FROZEN BLOCKS WHICH ARE TO BE CUT INTO CONSUMER PORTIONS

Pin bones are objectionable in fillet blocks which are not to be further processed before cutting them into consumer portions or fish sticks (fish fingers). Their presence could make such products unacceptable to the consumer.

5.4.2 *Freezing of fish*

5.4.2.1 FIRST-CAUGHT FISH SHOULD BE FROZEN FIRST

The sequence of operations should ensure that fish caught earlier do not accumulate while later-caught fish are being frozen.

5.4.2.2 FISH WHICH ARE IN RIGOR AND STIFFENED IN A BEND POSITION SHOULD NOT BE STRAIGHTENED FORCIBLY WHEN LOADED INTO THE FREEZER

If fish, deformed because of rigor, are straightened forcibly, the muscle structure will be damaged, causing gaping in subsequent fillets. Fish in rigor should be put aside until the rigor is resolved, or should be frozen in special blocks and marked so that they can be recognized at a later stage.

5.4.2.3 THE FREEZING PLANT SHOULD BE ADEQUATE TO DEAL WITH THE NORMAL CATCHING RATES OF THE VESSEL, SO THAT FISH ARE NOT HELD FOR LONG PERIODS PRIOR TO FREEZING

Whole or gutted fish are best frozen soon after capture, allowing a bleeding time of at least 20 minutes for gutted white fish. Special care is required when preparing and freezing fillets in order to minimize damage caused by natural process of rigor mortise (see Appendix A.1). It is very important to maintain all raw material in a chilled condition prior to freezing. Delay in freezing may have serious effects on the quality and appearance of the thawed product.

5.4.2.4 PRECISE FREEZING TIMES FOR FISH PRODUCTS SHOULD BE CAREFULLY DETERMINED

The freezing time required for different products is influenced by many variables,such as product shape and size, the area exposed to the refrigerated surface or the refrigeration medium, and the temperature of the refrigerant. A calculated freezing time may serve as a rough guide when planning production, but whenever a new product is frozen in a freezer, the exact freezing time should be determined by direct measurements of the product temperatures during the freezing process. In many countries, practical advice on how to measure product temperature accurately can be obtained from fishery research organizations.

5.4.2.5 THE FREEZING PROCESS SHOULD BE RAPID AND THE TEMPERATURE REDUCTION ADEQUATE TO AVOID QUALITY LOSSES ASSOCIATED WITH BADLY FROZEN FISH

Slow freezing, incomplete freezing and freezing to inadequately low temperatures promote changes in the fish flesh which adversely affect its texture, flavour and keeping time. Since these changes are minimized by quick freezing and rapid reduction of temperature to freezer store level, an adequate freezing capacity of the freezers is necessary for the production of high quality frozen products and it will also avoid build-up of buffer stored fish.

5.4.2.6 FROZEN FISH BLOCKS SHOULD BE OF REGULAR SIZE AND SHAPE

Frozen blocks which are uniform in size and shape are easier to stow compactly with less likelihood of damage to the fish. They are also easier to discharge. Furthermore, control of temperature and speed of operation in industrial thawing of frozen blocks is more readily obtained if the units are of regular shape and uniform size. It is important that each fish within the block should be carefully arranged without bending, breaking or squashing so that it will retain its normal shape. This is particularly important when it is intended to saw the blocks into consumer portions.

5.4.2.7 IN VERTICAL PLATE FREEZERS, FISH SHOULD BE PACKED BETWEEN THE PLATES WITH AS FEW GAPS AS POSSIBLE. THE FREEZERS SHOULD NOT BE OVERLOADED WITH FISH

Voids in the block structure could slow down heat transfer and may cause weakness in the frozen blocks which will result in breakage. Fish should be loaded in a manner which will make solid blocks and should never be loaded above the top of the freezer plates. The fish may be gently compressed, but any undue pressure should not be used in an attempt to fit oversize into the freezer. Loading above the plates may prevent easy removal of the blocks and oversize blocks may be difficult to stow properly. Very large fish may be headed before freezing into blocks, or they may be frozen by other means, e.g. in a sharp freezer .

5.4.2.8 IN USING HORIZONTAL PLATE FREEZERS, FISH OR FILLETS SHOULD BE PACKED IN TRAYS OR OTHER FORMS TO PRODUCE UNIFORM COMPACT BLOCKS OR PACKAGES

It is important that there should be no voids in blocks and that surfaces should be uniform and flat. Overfilling trays will cause damage to the fish by excessive pressure while underfilling will result in bad contact with the plates and poor heat transfer conditions. Distorted or damaged trays or forms should not be used.

5.4.2.9 **THE DEFROSTING TIME FOR CONTACT PLATE FREEZERS SHOULD BE JUST LONG ENOUGH TO ALLOW EASY LOADING AND UNLOADING OF THE BLOCKS FROM SECTIONS**

Frozen fish block should be removed from vertical plate freezers immediately after adhesion to the plates is broken by defrosting: otherwise, the blocks will warm up and their surfaces will begin to thaw. Before reloading the freezers, both refrigeration and defrosting valves should be closed so that the plates are neither heated nor chilled during the operation.

If the refrigerant is allowed to circulate during loading, fish may stick to the plates, and it will be difficult to obtain compact blocks. Tearing of the skin and flesh may also result. If the defrosting operation is continued during loading, the temperature of the fish will rise considerably. After the freezer has been loaded, the refrigerant should be allowed to circulate immediately.

Horizontal plate freezers, in which fish are usually frozen in trays or packages, should be defrosted as often as necessary to prevent a build-up of ice and frost on the plates.

5.4.2.10 **BLAST FREEZERS SHOULD BE LOADED IN SUCH A WAY THAT THERE IS A SUFFICIENT FLOW OF COLD AIR AROUND THE PRODUCT**

In this process, heat is transferred from the fish to a cold air stream and carried to the cooling surfaces of the freezer. Adequate air circulation is essential and any obstruction to the flow of air around the product will result in poor freezing rates and variable product quality. If fish are placed too close together because of overloading the freezer, cold air circulation around the surfaces of individual fish will be obstructed and freezing times may be greatly increased. Wrapping fish or placing it in cartons will also slow down the rate of freezing.

5.4.2.11 **LARGE FISH SUCH AS TUNA, WHICH ARE TO BE CANNED, SHOULD PREFERABLY BE FROZEN BY IMMERSION IN REFRIGERATED BRINE**

In order to minimize salt penetration and because it is impracticable to work with brine temperatures lower than -18°C, fish frozen in this way should have their temperature at the centre lowered as rapidly as possible to between -12°C and -15°C. The temperature should then be lowered further to -18°C, or below in storage. During freezing there should be a rapid circulation of the cooling medium to ensure effective heat transfer. An upward circulation will assist in keeping the fish in suspension and all their surfaces in contact with the cooling medium. To avoid unnecessarily high salt penetration, the fish should be either removed from the brine or the brine pumped out as soon as freezing is completed.

5.4.2.12 ALL FREEZING PROCESSES SHOULD BE COMPLETED IN THE FREEZER BY ALLOWING THE FULL TIME FOR EACH CYCLE

The manufacturer of the refrigeration equipment should provide all necessary information for the correct operation of the plant, including the time required for each freezing cycle. If the plant is functioning properly, and loading and unloading is done according to instructions, fish coming out of the freezers should be properly frozen. There is always a temptation to reduce the freezing time or overfill freezers during periods of heavy catching. This should be avoided. If the freezing time is too short, the centre of the block will not be frozen, even though the surface may be hard. Blocks of fish which are not completely frozen are easily broken during unloading and storing. If many partly frozen blocks are stored, the freezer store temperature may rise, placing an extra load on the refrigeration equipment and also causing temperature fluctuations that will adversely affect the quality of all the fish in storage.

On the other hand, if fish are left in the freezers long after they are properly frozen, freezer capacity is wasted and unnecessary delays in the freezing of fish will occur. In the case of air blast or sharp freezers, there will also be quality losses due to dehydration of the fish surfaces.

5.4.2.13 FILLETS SHOULD BE FROZEN RAPIDLY TO ENSURE A HIGH QUALITY PRODUCT

Freezing of fillets should be carried out in contact or blast freezers. The use of brine is not recommended for the freezing of fillets because of salt penetration into the product.

5.4.2.14 FREQUENT CHECKS SHOULD BE MADE ON THE PRESSURES AND TEMPERATURES IN THE REFRIGERATION SYSTEM TO ENSURE CORRECT OPERATION

If frequent checks are made and records of these maintained, there will be little chance of the refrigerant's temperatures being too high or the equipment not functioning correctly. Any defects noted should be rectified quickly. It is important to watch the temperature gauges for superheating at the compressor's delivery side and subcooling of the liquid before the expansion valves. Sometimes, these two readings will indicate leaks of refrigerant before there is any serious loss of freezing capacity.

5.4.2.15 ACCURATE RECORDS OF ALL FREEZING OPERATIONS SHOULD BE KEPT

An accurate record of all loading and unloading times of the freezer and number of blocks frozen, including size and species, will greatly assist in efficient management and control of the operations.

5.4.2.16 A SYSTEM OF LABELS OR COLOUR CODES SHOULD BE USED WHEN LOADING FISH INTO A FREEZER TO ASSIST IN THE LATER IDENTIFICATION OF FROZEN PRODUCTS

Some system of identification is required to indicate the species, size, condition of fish and its suitability for further processing and handling.

The label should indicate location of catch, date of freezing, quality and state of raw material. Pre-rigor frozen fillets, for example, require careful thawing and are not suitable for smoking. If the shore processor could readily identify these fish, he would be able to overcome difficulties with appearance and texture and would also avoid using such a fish in processes for which it is unsuitable.

5.4.3 *Glazing and storing*

5.4.3.1 FROZEN PRODUCTS SHOULD BE GLAZED OR WRAPPED IMMEDIATELY AFTER FREEZING TO PROTECT THEM FROM DEHYDRATION AND OXIDATION IN THE FREEZER STORE

Present practices of protecting frozen fish during storage on board the fishing vessel vary widely and depend, among other things, on species, freezing method and storage temperature. Blocks of fish or single fish are usually glazed, and smaller blocks of fish or fillets may either be glazed or packed in wrappers or cartons of suitable material to protect them from dehydration and oxidation and also to safeguard their hygienic condition. Glaze and protective wrapping conserve the quality of frozen fish and should be used wherever practical.

Food additives cannot be used indiscriminately in ice glazing. Food laws differ from one country to another and it is essential to seek specialist advice before using a particular additive, whether the product is for domestic use or for export. Attention is also drawn to the Guide to the Safe Use of Food Additives (Second Series : CAC/FA1 5-1979) recommended by the Codex Alimentarius Commission.

5.4.3.2 FROZEN FISH OR BLOCKS SHOULD BE CONVEYED TO THE FREEZER STORE IMMEDIATELY AFTER GLAZING OR WRAPPING. THEY SHOULD BE HANDLED WITH CARE TO AVOID BREAKAGE OR DAMAGE TO THE GLAZE OR PROTECTIVE WRAPPER

Any delay at this stage will allow the surface of the product to warm up and will affect its quality. Frozen fish or fish blocks with soft surfaces are easily damaged if roughly handled. If much fish is allowed to warm up, this will put an extra load on the freezer store's refrigeration system. Wherever possible, frozen products should be transferred to the freezer store by conveyors rather than by rough manual methods.

5.4.3.3 FROZEN BLOCKS SHOULD BE STOWED IN THE FREEZER STORE IN SUCH A WAY THAT THEY WILL NOT BE BROKEN OR DAMAGED

Frozen fish products should be stowed carefully to avoid damage during the stowing and discharging or as a result of the vessel's motions. Broken blocks and loose frozen fish should be stowed separately from whole blocks.

5.4.3.4 FROZEN FISH AND FISH PRODUCTS SHOULD BE STORED ON BOARD THE VESSEL AT TEMPERATURES APPROPRIATE FOR THE SPECIES AND END PRODUCT

It should be borne in mind that although frozen fish may only be stored for relatively short periods aboard ship, the same frozen products may be stored for much longer periods ashore. Deterioration during the initial storage at sea cannot be corrected by later storage at a lower temperature. It is thus recommended that storage aboard fishing vessels be at the temperature needed to retain the intrinsic quality during the envisaged storage period but it should be at -18°C or lower.

However, in some cases, higher temperatures may be tolerable, as for example, in the storage of brine frozen tuna destined for canning. Whatever procedure followed it is of vital importance that the designated storage temperature be maintained at all times, as fluctuations in temperature can affect product quality.

5.4.3.5 A STOWAGE PLAN OF THE FREEZER STORE SHOULD BE KEPT TO FACILITATE LOCATING PRODUCTS OF DIFFERENT SPECIES, SIZE AND RAW MATERIAL CONDITION

A well prepared stowage plan will assist, during unloading, in separating blocks of different species and size of fish and blocks of different quality or intended for different purposes.

5.4.4 *Unloading the catch*

5.4.4.1 WHEN UNLOADING THE CATCH, CARE SHOULD BE TAKEN TO AVOID BREAKAGE OF FROZEN FISH OR FISH BLOCKS

Present methods of unloading often still require much manual handling of the product and this, apart from being less efficient, frequently results in breakage of blocks and damage to fish. The methods of unloading need to be reviewed periodically and mechanical equipment should be introduced wherever practical so that the catch may be unloaded more quickly and without damage.

5.4.4.2 FROZEN FISH SHOULD BE QUICKLY TRANSFERRED FROM THE SHIP'S FREEZER STORE TO THE SHORE BASED FREEZER STORE

There should be no delay after unloading: suitable transport should be available to transfer quickly the fish to frozen storage ashore. If there is any delay the temperature may rise considerably, and the surface of the frozen products may thaw. This can result in physical damage when blocks are being handled and also cause adverse changes in the texture and flavour of the fish.

Ideally, shore based freezer stores should be situated at the quayside near the unloading area to facilitate discharging directly from the vessel into the freezer store e.g. with conveyors.

5.5 Hygiene control programme

5.5.1 **EACH FISHING VESSEL SHOULD DEVELOP ITS OWN HYGIENE CONTROL PROGRAMME BY INVOLVING THE WHOLE CREW AND BY ASSIGNING TO EACH MEMBER A DEFINITE TASK IN CLEANING AND DISINFECTING THE BOAT**

A permanent cleaning and disinfection schedule should be drawn up to ensure that all parts of the boat and equipment thereon are cleaned appropriately and regularly.

The fishermen should be well trained in the use of special cleaning tools, methods of dismantling equipment for cleaning, and should be knowledgeable in the significance of contamination and the hazards involved.

6. FREEZING FISH ON SHORE - PLANT FACILITIES AND OPERATING REQUIREMENTS

6.1 Plant construction and layout

6.1.1 *General considerations*

6.1.1.1 **FISH FREEZING OPERATIONS INCLUDING THE STORAGE SHOULD BE DESIGNED TO PRODUCE SAFE AND WHOLESOME FROZEN PRODUCTS FOR EITHER FURTHER PROCESSING OR DIRECT MARKETING**

The decision to commence a fish freezing operation should be based on reasonable assurance that there will be sufficient fish supplied to sustain the operation, that the frozen product will be of good quality, remaining stable during the prolonged storage and that it could be easily and profitably marketed.

It is important that the costs of processing, freezing and freezer storage be carefully assessed to ensure that the whole operation will be economically practical.

The proposal to handle any non-fish food products together with the fish should also be carefully assessed before the decision is taken. Fish, as opposed to meats and vegetables, require a higher rate of freezing and considerably lower freezer storage temperatures to safeguard their quality. The handling and processing of fish should also be conducted in separate buildings or areas which are physically separated to prevent any contamination of fish or fishery products.

6.1.1.2 **FISH PROCESSING AND FREEZING OPERATIONS SHOULD BE PLANNED AND DESIGNED TO HAVE SUFFICIENT CAPACITY TO PROCESS, FREEZE AND STORE FROZEN FISH AND FISH PRODUCTS AT THE FORESEEABLE AVERAGE RATE OF DAILY DELIVERY AND SHOULD NOT BE OPERATED BEYOND THEIR FULL RATED CAPACITY FOR ANY EXTENDED PERIOD**

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 plant and freezer store should be.

If the operation 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 process quickly the expected peaks in a fluctuating fish supply without overtaxing the facilities of the plant for any extended period.

If a plant is operated above its designed capacity, its efficiency will decline and delays 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 necessitate a lengthy suspension of the freezing operation.

There should be sufficient standby replacement for all the processing and freezing equipment to allow for servicing and in case of an emergency. This requirement is of paramount importance in the operation of the freezer store where any malfunctioning or breakdown in refrigeration equipment could result in serious financial losses.

6.1.1.3 PLANTS FOR THE PROCESSING AND FREEZING OF FISH SHOULD BE DESIGNED AND EQUIPPED SO THAT ALL HANDLING, PROCESSING AND FREEZING OPERATIONS CAN BE CARRIED OUT EFFICIENTLY AND THE FISH CAN PASS FROM ONE STAGE OF PROCESSING TO THE NEXT IN AN ORDERLY MANNER AND WITH MINIMUM DELAY.

To conserve their quality, fish destined for freezing should be handled, processed and frozen as soon as possible after they have been brought in. A great deal of care should be taken in planning the layout and equipment of a plant to ensure that there is sufficient space and suitable facilities to carry out each operation efficiently and to move products through the various stages in an orderly manner.

The location of the freezer store should also be taken into account when arranging the equipment, positioning the freezers and elaborating the flow diagram for the whole operation.

In designing the freezer store and depending on the requirements of the operation, the following additions and modifications might be worthwhile considering:

(a) separate glazing room glazing operations:
(b) tempering room where fish blocks can be held at a slightly higher temperature for conditioning prior to cutting into sticks or portions; and
(c) buffer freezer store where small batches of the product can be held for a short period of time either before shipment or for further processing.

It is also often the case with the freezer store operation that a certain amount of frozen fish processing, such as steaking, portioning, trimming, consumer packaging and labelling, has to be done before distribution. A provision should be made therefore for a separate area or a room where these operations could be carried out without exposing the frozen fish to the high ambient temperature of the fresh fish processing plant.

Use should be made of conveyors and other mechanical moving devices wherever these are economically practicable.

Considerable elasticity of operation could be achieved by having adequate storage facilities for the incoming raw material. Fish which could not be immediately processed and frozen should be kept chilled and protected from contamination and damage.

6.1.2 *Construction*

6.1.2.1 FISH PROCESSING AND FREEZING PLANT SHOULD BE SPECIALLY DESIGNED FOR THE PURPOSE

Raw fish spoils considerably faster than raw meat of warm blooded animals. The keeping time of the fish delivered to the processing plant has been already reduced by time and conditions of handling and storage on the fishing vessel. Nothing can be done by the processing and freezing to improve the quality of fish delivered.

Because of this highly perishable nature of fish, the processing plant demands special facilities and materials which, as compared to other food processing establishments, are in some cases rather unique.

The technological and hygienic operating and production requirements also differ in being often more demanding and critical.

The processing and freezing plant therefore should meet the same requirements for construction and hygienic facilities as the fresh fish processing establishment detailed in the SLS 974 and repeated in this Code under 6.1.2 and 6.1.3 respectively.

6.1.2.2 THE PLANT AND SURROUNDING AREA SHOULD BE KEPT REASONABLY FREE FROM 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 fish processing and freezing plant, its design, layout, construction and equipment should be planned in detail with considerable emphasis on the hygienic aspect, sanitary facilities and quality control.

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

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

6.1.2.3 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 facilitate traction, any grooving of this nature should always run towards the drainage channel.

The junctions between the floors and walls should be impervious to water and should be covered 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.

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

Suitable and adequate drainage facilities are essential for removal of liquid or semi-liquid 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 100 mm and, if required, run to a catch basin for removal of 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.

6.1.2.5 INTERNAL WALLS SHOULD BE SMOOTH, WATERPROOF, RESISTANT TO FRACTURE, LIGHT COLOURED AND READILY CLEANABLE

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

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 and sealed to the wall or neatly boxed in and mounted at least 100 mm from the wall to allow for adequate cleaning and prevention of insect harbourage.

6.1.2.6 WINDOW SILLS SHOULD BE KEPT TO A MINIMUM SIZE, BE SLOPED INWARD AT LEAST 45^0 AND BE ATLEAST 1 METRE FROM THE FLOOR

Window sills and frames should be made of a smooth, water proof 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 filled 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.

6.1.2.7 ALL DOORS THROUGH WHICH FISH OR THEIR PRODUCTS ARE MOVED SHOULD BE SUFFICIENTLY WIDE, WELL CONSTRUCTED OF A SUITABLE MATERIAL AND SHOULD BE OF A SELF-CLOSING TYPE

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

Doors and the frames of the doorways should have 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.

6.1.2.8 CEILING SHOULD BE SO DESIGNED, CONSTRUCTED AND FINISHED AS TO PREVENT ACCUMULATION OF DIRT AND MINIMIZE CONDENSATION, MOULD DEVELOPMENT AND FLAKING AND SHOULD BE EASY TO CLEAN

Ceilings should preferably be 3 metres 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 finish products from falling debris or dust.

6.1.2.9 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 ones. 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 of suitable corrosion-resistant material.

6.1.2.10 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 ALTER CLOLOURS

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

It is highly desirable to have the light fixtures either recessed flush with the ceiling, or with the upper surface of the light fixtures fitting flush with the ceiling, in order to prevent the accumulation of dust on them.

6.1.2.11 THE FREEZER STORE SHOULD BE ADEQUATE FOR THE INTENDED PRODUCTION, TIME AND TEMPERATURE OF STORAGE, DESIGNED BY AN EXPERT AND CONSTRUCTED BY CRAFTSMEN COMPETENT AND EXPERIENCED IN THIS FIELD

The freezer store should be designed taking into account the size of intended production, the type of fish and fishery products, the intended time of storage and the optimal temperatures requirements.

It is also desirable that the location and the design of the freezer store should be integrated into the general layout of the whole establishment and its operation should be incorporated into the flow pattern of the overall operation. The freezer boats or the incoming trucks should be able to transfer their frozen fish into the on-shore freezer store with the minimal exposure to ambient temperature and with the least possible handling. The same requirements should also apply to the loading of refrigerated vehicles or railway cars.

6.1.2.12 A GOOD VAPOUR SEAL IS REQUIRED ON THE OUTSIDE SURFACES OF THE FREEZER STORE AND PRECAUTIONS SHOULD BE TAKEN TO AVOID DANGER OF FROST HEAVE FROM THE SUBSOIL

It is extremely important to have an effective water vapour barrier totally enveloping the warm face of the insulation layer in the freezer store walls, ceiling and floor. In the absence of such a barrier, the water vapour from the warm outside air will diffuse into the insulating material and freeze upon reaching the 0°C boundary. Freezing of this kind will bring about a gradual build-up of ice within the insulation layer, thus reducing its insulating efficiency and eventually could result in a serious structural deterioration of the whole building.

6.1.2.13 THE INFLOW OF OUTSIDE AIR INTO THE FREEZER STORE SHOULD BE MINIMIZED AS MUCH AS POSSIBLE. WHERE A FREEZER STORE DOOR MUST BE OPENED FREQUENTLY, THE FLOW OF AIR THROUGH THE DOOR SHOULD BE RESTRICTED BY THE USE OF AN AIR LOCK CHAMBER, A COLD AIR CURTAIN, SELF CLOSING SHUTTERS OR SOME OTHER SIMILAR DEVICE

When a freezer store door is opened to the outside atmosphere, a strong convection current will rapidly exchange the cold air in the store with warm air from outside. This in turn will raise the temperature of the store appreciably and put an additional load on the cooling equipment. The moisture brought in with the outside air will also freeze on the cooling surfaces and reduce their efficiency. If a freezer store has more than one entrance, only one door should be open at a time; otherwise, air current may greatly increase the inflow of warm outside air.

The proper installation and use of air lock chambers, cold air curtains, self closing shutters or similar devices will greatly reduce the flow of warm air into a freezer store during loading and unloading operations.

6.1.2.14 THE RELATIVE HUMIDITY IN THE FREEZER STORE SHOULD BE AS HIGH AS POSSIBLE AND EXCESSIVE AIR CIRCULATION SHOULD BE AVOIDED

The bigger the difference between the temperature of the store and the product, the faster dehydration will be. The drying of products in a freezer store is, however, a complex matter depending on many factors, such as movement of air, its humidity, incidental leakage of heat into the store (frequent opening of the doors), fluctuation in storage temperature and condition of the glaze or type of packaging material used for the products. Even with the best conditions of storage and packaging, frozen fish will dry slowly if held too long.

6.1.2.15 PROVISION SHOULD BE MADE FOR AN EFFECTIVE AND REGULAR DEFROSTING OF THE FREEZER STORE COOLING SURFACES

All freezer store cooling surfaces should be regularly defrosted in order to prevent an excessive build-up of ice or frost which could seriously affect the efficiency of the cooling system and may unnecessarily overload refrigeration equipment.

Defrosting in modern plants is done automatically while in some older installation it could be done either manually by scraping and brushing off, or by a hot defrost.

During the defrosting operation care should be taken to prevent any frost, ice or melt water falling on to the stored fish or fish products.

6.1.2.16 ALL FREEZER STORES SHOULD BE FITTED WITH AN ALARM DEVICE, OPERATED FROM INSIDE, SO THAT ANYONE TRAPPED INSIDE CAN OBTAIN ASSISTANCE QUICKLY

It should always be possible to open freezer store doors from within. An efficient system of signalling for aid is however necessary in case a person is trapped inside a freezer store. The alarm should sound in an area of the plant where there is always someone on duty. Workers should not enter freezer stores alone without advising someone else of their intention to do so.

Doors leading to the freezer store should preferably be of a sliding type and mechanically operated. A gasket heater should be present to facilitate the opening of the door.

6.1.3 *Hygiene facilities*

6.1.3.1 AREAS WHERE FRESH FISH ARE RECEIVED OR STORED SHOULD BE SO SEPARATED FROM AREAS IN WHICH PRODUCT PREPARATION OR PACKAGING IS CONDUCTED AS TO PREVENT CONTAMINATION OF THE FINISHED PRODUCT

Separate rooms, or well defined areas of adequate size, should be provided :

(i) for receiving and storing raw materials, and
(ii) for operations like heading and gutting fish, washing, filleting, steaking or other processing and packaging.

Manufacture or handling of products intended for human consumption should be entirely separate and distinct from the areas used for inedible materials.

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

6.1.3.2 A SEPARATE REFUSE ROOM OR OTHER EQUALLY ADEQUATE OFFAL 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, birds, insects and exposure to warm temperatures.

A separate refuse room for storing waste in elevated 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.

Refuse rooms or other offal storage facilities should be cleaned and disinfected regularly.

6.1.3.3 ANY BY-PRODUCT PLANT SHOULD BE ENTIRELY SEPARATE FROM THE PLANT WHICH IS PROCESSING FISH FOR HUMAN CONSUMPTION

The processing of by-products or non-fish products not fit for human consumption should be conducted in separate buildings or in areas which are physically separated in such a way that there is no possibility of contamination of fish or fish products.

6.1.3.4 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 AT ALL TIMES DURING THE WORKING HOURS

All water available for use in those parts of establishments where fish is received, held and processed 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/cm^2.

An adequate supply of hot water of potable quality should be available at all times during working hours.

Facilities should be provided so that at all times when required during working hours an adequate supply of hot water of potable quality at a minimum temperature of $65^{\circ}C$ should be available. Further provisions should be made to reduce the temperature of the water supply for other purposes such as hand washing.

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 the number of microorganisms and prevent the build-up of odours.

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

6.1.3.5 **WHEN INPLANT CHLORINATION OF WATER IS USED THE RESIDUAL CONTENT OF FREE CHLORINE SHOULD BE MAINTAINED AT NO MORE THAN THE MINIMUM EFFECTIVE LEVEL FOR THE USE INTENDED**

A chlorination system should not be relied upon to solve all hygiene problems. The indiscriminate use of chlorine cannot compensate for unhygienic conditions in a processing plant.

6.1.3.6 ICE SHOULD BE MADE FROM POTABLE WATER CONFORMING TO SLS 614 OR CLEAN SEA WATER AND SHOULD BE MANUFACTURED, HANDLED AND STORED SO AS TO PROTECT IT FROM CONTAMINATION

Ice used in the operation of the fish processing establishment should be made from potable water conforming to SLS 614 or clean sea water.

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 contaminants transferable by ice into the final product. Foot traffic should also be kept to a minimum.

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

6.1.3.7 **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 BACKSIPHONAGE WITH THE LINES CARRYING POTABLE WATER OR CLEAN SEA WATER**

Non-potable water may be used for such purposes as producing steam, cooling heat exchangers and fire protection.

It is very important that the systems of storage and distribution of potable and non-potable water are entirely separate and there is no possibility for cross-connection or for inadvertent usage of non-potable water in the fish processing areas. Only potable water should be used for the supply of hot water.

6.1.3.8 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 systm 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 or more often as needed.

Where waste systems are installed overhead in processing rooms to service floors above, the installation and location of these systems should be such as to preclude any chance of contaminating processing lines.

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

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

Facilities should be present in the fresh fish processing area for cleaning and disinfection of trays, removable cutting of filleting boards, containers and other similar equipment and working implements. Such facilities should be located in a separate room or in a dsignated area in the work rooms 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.

Containers and equipment used for offal or contaminated materials should be washed in a separate area then these used for products intended for human consumption.

6.1.3.10 ADEQUATE AND CONVENIENTLY LOCATED TOILET FACILITIES SHOULD BE PROVIDED

Adequate, suitable and conveniently located changing facilities and toilets should be provided in all establishemnts. Toilets should be so designed as to ensure hygienic removal of waste matter. These areas should be well lit, ventilated and where appropriate heated and should not open directly on to food handling areas. Hand washing facilities with warm or hot and cold potable water or clean sea water, a suitable hand-cleaning preparation, and more suitable hygienic means of drying hands, should be provided adjacent to toilets and in such a position that the employee must pass them when returning to the processing area. Where hot and cold water are available mixing taps should be provided. Where paper towels are used, a sufficient number of dispensers and receptacles should be provided near to each washing facility. Taps of a non-hand operable type are desirable. Notices should be posted directing personnel to wash their hands after using the toilet.

Toilet rooms should have walls and ceilings of a smooth washable light coloured surface and floors constructed of impervious and readily cleanable material. the doors leading to the facilities should be of a self-closing type and should not open directly into the fish processing areas.

The following formula could be used as a guideline 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

NOTE

Urinals may be substituted for toilets, but only to the extent of one-third of total toilets required.

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

Adequate and conveniently located facilities for hand washing and drying should be provided wherever the process demands. Where appropriate, facilities for hand disinfection should also be provided. Warm or hot and cold potable water or clean sea water and a suitable hand-cleaning preparation should be provided. Where hot and cold water are available mixing taps should be provided. There should be suitable hygienic means of drying hands. Where paper towels are used, a sufficient number of dispensers and receptacles should be provided adjacent to each washing facility. Taps of a non-hand operable type are desirable. The facilities should be furnished with properly trapped waste pipes leading to drains.

6.1.3.12 STAFF AMENITIES CONSISTING OF LUNCHROOMS AND 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 lunchrooms 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 employee without causing undue congestion. Clothing and footwear not worn during working hours must not be kept in any processing area.

6.1.3.13 STORAGE FACILITIES SHOULD BE AVAILABLE FOR THE PROPER DRY STORAGE OF PACKING MATERIALS

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

6.1.3.14 IF POISONOUS OR HARMFUL MATERIALS, INCLUDING CLEANING COMPOUNDS, DISINFECTANTS AND PESTICIDES, ARE STORED, THEY SHOULD BE KEPT IN A SEPARATE ROOM DESIGNED AND MARKED SPECIFICALLY FOR THIS PURPOSE

Extreme caution must be exercised to prevent poisonous or harmful materials from contaminating the fish. All such materials should 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.

6.2 Equipment, utensils and working surfaces

6.2.1 EQUIPMENT AND UTENSILS FOR THE HANDLING, STORING, FILLETING OR SIMILAR PROCESSING OF THE FRESH FISH PRIOR TO FREEZING SHOULD BE AS SPECIFIED IN THE SLS 974.

Equipment and utensils used for the handling, storing, filleting or similar processing of the fresh fish prior to freezing should meet the requirements detailed in 6.2 of the SLS 974.

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

Contamination of fish during processing can be caused by contact with unsatisfactory surfaces. All food contact surfaces should be smooth, free from pits, crevices and loose scale, 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 so designed that they can be easily dismantled to facilitate thorough cleaning and disinfection.

Containers used for holding fish should preferably be constructed of washable plastic or corrosion-resistant metal and, if of wood, they must 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. Any container the surface of which is pitted, corroded, scaled or has peeling paint, should not be used for holding fish. Wicker baskets should not be used.

Stationary equipment should be installed to permit easy access and thorough cleaning and disinfection.

Fish washing tanks should be designed to provide a constant change of water with good circulation, and 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 of fish and products intended for human consumption.

6.2.3 THE USE OF PROPERLY DESIGNED MACHINES FOR UNLOADING, GUTTING, WASHING, FILLETING, SKINNING, STEAKING AND SIMILAR OPERATIONS IS TO BE ENCOURAGED

Where large quantities of fish are processed, properly designed machines will simplify the production of fillets and similar products in quantity, with consistently low microbial counts. This is mainly because well designed machines have impervious and corrosion-resistant working surfaces, are easy to dismantle, clean disinfect and are capable of handling the fish with a minimum of delay.

It is essential that the installation of new machinery should be well researched and economically justified. The units should be rigorously tested before being put into commercial use, otherwise costly failures may arise.

6.2.4 THE FILLETING LINE SHOULD BE DESIGNED AS A CONTINUAL PROCESSING UNIT WITH ALL THE OPERATIONS ARRANGED SEQUENTIALLY IN SUCH A WAY THAT THE FISH COULD MOVE UNIFORMLY FAST THROUGH THE LINE WITHOUT ANY STOPPAGES OR SLOW-DOWNS

A properly designed filleting lines means saving in the cost of processing and will result in a better quality of the final product. When the fish or fillets are moved through the line by a conveyor, the conveyor should be provided with scrapers and spray-washers at least at its two terminal pulleys. If the fish are flumed, no recirculation of the fluming water should be allowed unless it is restored to a level of potable quality. Offal chutes should be located as close as possible to the filleters' stations but in such a way that there is no possibility of a splash-back. Each filleter's station should have a line of potable water or clean sea water with a tap to regulate the flow of water over the surface of the filleting board.

The filleting line should be easy to dismantle for cleaning purposes and should be constructed from a corrosion-resistant material such as stainless steel or marine grade aluminium. There should be an easy access to every part of the line.

6.2.5 FILLETING BOARDS AND OTHER SURFACES ON WHICH FISH ARE CUT SHOULD BE MADE OF IMPERVIOUS MATERIALS WHICH MEET THE PHYSICAL REQUIREMENTS FOR CUTTING SURFACES

Considerable microbial contamination of fillets and steaks is caused by contact with the filleting and cutting boards. Wooden cutting surfaces are porous and quickly become water-logged and are practically impossible to clean thoroughly. They are not recommended as suitable for this type of work.

If in the absence of other materials, wood has to be used, a single board of a well finished and smooth surface is recommended. Once the surface becomes badly worn then the board should be reconditioned or discarded.

The use of plywood or other boards of laminated structure should be discouraged.

6.2.6 EQUIPMENT USED FOR DIPPING OR SPRAYING FISH FILLETS OR STEAKS SHOULD BE MADE OF IMPERVIOUS CORROSION-RESISTANT MATERIAL AND SHOULD BE EASY TO CLEAN. DIP TANKS SHOULD BE EMPTIED, THOROUGHLY CLEANED AND DISINFECTED BETWEEN EACH CYCLE OF USE

Where it is desired and permissible to use such dips as anti-oxidants or polyphosphates, the dangers of contamination must be fully appreciated. Numbers of microbes will increase rapidly during use, and this requires that the tanks be frequently and thoroughly cleaned and refilled with new solutions. The use of sprays instead of dips has been found by many operators as a more efficient method of treatment of fillets or fish steaks. It eliminates an additional contamination with microorganisms, provides a continuously uniform solution strength and lends itself to a better temperature control. No recirculation of the solution should be permitted except if the solution is filtered, pasteurized and cooled.

6.2.7 MECHANICAL CONVEYORS SHOULD BE INSTALLED WHENEVER PRACTICABLE TO HANDLE THE FISH DURING PRE-FREEZING OPERATIONS

Manual methods of moving fish from one process to another, apart from being inefficient and costly in manpower, often result in damage to the skin and flesh, allowing the entry of microorganisms and thus hastening spoilage.

6.2.8 LIFTS OR OTHER CONVEYORS SHOULD BE INSTALLED FOR MOVING FROZEN FISH FROM FREEZERS TO FROZEN STORAGE

If rough handling methods are used, frozen blocks could be broken and the fish damaged.

Any fish conveying equipment, as for example fork lifts used in the fresh fish processing area or for the disposal of offal, should not be employed in the handling of frozen fish or fish products.

6.2.9 FREEZING EQUIPMENT SHOULD BE SUITABLE FOR THE PARTICULAR PRODUCT AND SHOULD HAVE AN ADEQUATE CAPACITY TO DEAL WITH THE EXPECTED PEAKS IN FLUCTUATING FISH DELIVERIES

It is most important that all freezing be carried out in an orderly manner, using equipment that is of sufficient capacity and is suitable for the product. The freezers should have proper defrosting facilities and be designed so that they are easy to clean. Refrigeration equipment needs to be reliable, capable of running for long periods with little attention and should have an automatic device for shutting it down in an emergency. An expert in this field should be consulted.

Large blocks of whole fish are usually frozen in vertical contact plate freezers. Horizontal contact plate freezers are generally used to freeze smaller fish, fillet blocks and packages of fish or fillets. Airblast freezing, sharp freezing and freezing in brine are also used. Some operations rely entirely on air blast freezers for freezing blocks of whole fish or fillets and individual whole fish. Sharp freezers may be installed to freeze large fish which cannot be accommodated by the contact plate freezers.

Freezing by immersion in refrigerated brine is most commonly used for the preservation of large fish such as tuna which are intended for reprocessing into canned foods. With this method it is important that the freezing medium should not impart any objectionable odours or flavours to the product or affect its quality in any other way. When using sodium chloride brine, care should be taken to minimize salt penetration of the product by removing it from the brine as soon as freezing is completed.

6.3 Hygienic operating requirements

6.3.1 HYGIENIC OPERATING REQUIREMENTS IN FISH FREEZING OPERATIONS SHOULD BE SIMILAR TO THOSE RECOMMENDED FOR FRESH FISH PROCESSING PLANTS

All fish and all surfaces, equipment and containers which come in contact with fish should be treated in a sanitary and hygienic manner as described in the SLS 974.

Fish, because of its highly perishable nature, requires strict adherence to specific hygiene requirements which should become a part of a daily operational routine of the plant.

All operations should be carried out in a manner and condition suitable for the handling of food for human consumption.

6.3.2 THE BUILDNG, 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 which come in contact with fish should be hosed down with cold or hot potable water or clean sea water as frequently as necessary to ensure cleanliness. 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. A preliminary rinse in potable cold water or clean sea water, followed by a wash in water of a sufficient temperature providing for effective cleaning, is recommended. An ample supply of potable water or clean sea water at adequate pressure is the first requirement and cleaning will be made easier if done immediately and the surfaces are allowed to dry.

The use of hot or cold 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.

Cleaning agents and disinfectants used should be appropriate for 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. The use of sponges and towels to wipe table or container surfaces which come in contact with fish should not be allowed.

6.3.3 FILLETING AND CUTTING BOARDS SHOULD BE FREQUENTLY AND THOROUGHLY SCRUBBED AND TREATED WITH DISINFECTANT. WHEREVER PRACTICABLE THE BOARDS SHOULD BE CONTINUOUSLY FLUSHED WITH CLEAN RUNNING POTABLE WATER CONFORMING TO SLS 614 OR CLEAN SEA WATER DURING USE. THE FLUSING WATER SHOULD CONTAIN 4 PPM MINIMUM OF RESIDUAL CHLORINE

It is recoginized that the amount of microbial contamination on fillets and similar products is related to the amount of microbial contamination of the working surfaces. Clean surfaces become contaminated as soon as they are used, and consequently each fish that is filleted, after the first one, increases the surface contamination. Filleting and cutting surfaces should therefore be cleaned during meal breaks and before resumption of production following other work stoppages.

Filleting and cutting surfaces should be cleaned frequently. If they are not thoroughly scrubbed and disinfected, at least at the end of each working day, there may be a serious day-to-day carry-over of microbial contamination.

It has been proved that this contamination of both fillets and boards can be considerably reduced by continuous flushing with cold potable water or cold clean sea water. A further reduction in contamination has been observed when using chlorinated water for flusing.

6.3.4 IF BARRELS OR OTHER CONTAINERS ARE USED ON THE FILLETING LINE FOR THE COLLECTION AND DISPOSAL OF OFFAL, THEY SHOULD BE LOCATED BELOW THE LEVEL AT WHICH THE FISH ARE PROCESSED AND IN SUCH A WAY THAT THERE IS NO SPLASH-BACK ON THE PROCESSING LINE

If individual offal containers are used close to a processing line instead of the flumes or chutes connected to a common line, they should be located in such a way that there is no possibility of splash-back. Placement of the filleting boards or the fillet containers on the rims of the offal barrels should not be practised.

If the containers are not being used then they should be lidded. In general, much could be gained in efficiency and cleanliness of an operation if flumes or other equally effective methods are employed for the disposal of the fish offal.

6.3.5 ALL MACHINES USED FOR GUTTING, WASHING, FILLETING, SKINNING, STEAKING OR SIMILAR OPERATIONS SHOULD BE THOROUGHLY CLEANED, DISINFECTED AND RINSED DURING REST OR MEAL BREAKS AND BEFORE RESUMPTION OF PRODUCTION FOLLOWING OTHER WORK STOPPAGES

The use of machinery reduces the risk of contamination from human sources. If, however, these machines are not properly maintained and regularly cleaned, they can become a serious source of contamination.

6.3.6 ALL MACHINERY AND EQUIPMENT SHOULD BE INSPECTED BEFORE PROCESSING BEGINS TO ENSURE THAT THEY HAVE BEEN PROPERLY CLEANED, DISINFECTED, RINSED AND REASSEMBLED

Dirty(soiled) surfaces and residues of the cleaning and disinfecting agents which have not been removed by rinsing will contaminate the product. It is better practice to start with a wet line rather than a dry surface.

Mechanized or automated equipment should be regularly checked to prevent breakdowns.

6.3.7 ALL PRODUCT TRAPPED OR ACCUMULATED IN MACHINERY AND EQUIPMENT SHOULD BE REMOVED PERIODICALLY THROUGHOUT THE WORKING DAY

Fish or pieces of fish trapped in equipment spoil rapidly and can contaminate the rest of the product. Fish fillets or similar products which drop on the floor should be discarded.

6.3.8 REMOVAL OF SOLID, SEMI-SOLID OR LIQUID WASTES FROM FISH UNLOADING, HOLDING AND PROCESSING AREAS SHOULD BE ON A CONTINUOUS OR NEAR 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 fish processing plant 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 or offer harbourage or breeding places for rodents, insects or other vermin.

Containers, flumes, conveyours, 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 or other suitable disinfectant.

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

Attangements for the frequent removal and the disposal of waste material should be approved by the appropriate official agency having jurisdiction.

6.3.9 FREEZER STORES SHOULD BE FREE FROM ODOURS AND SHOULD BE MAINTAINED IN A GOOD HYGIENIC CONDITION

The freezer store should be subject to the same hygienic requirements as any other food handling establishment. A regular clean-up procedure should be maintained to ensure a good hygienic environment. Frozen products of questionable quality should not be stored with products of good quality unless they are well separated and easily identified. Products which may have strong natural odours should be packaged to prevent these odours from contaminating other products. Any motorized transportation that is producing odours should not be used inside the freezer store.

6.3.10 ALL WHARVES, QUAYS, MARKETS AND SIMILAR AREAS WHERE FISH ARE UNLOADED OR DISPLAYED FOR SALE, SHOULD BE KEPT CLEAN AND DISINFECTED

Fish, as a food for human consumption, should be treated as such, in clean surroundings. Any dirty surfaces in the vicinity of the unloading area involve the risk that fish will be contaminated with filth and microorganisms of public health significance.

6.3.11 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

There should be an effective and continuous programme for the control of pests. Establishments and surrounding areas should be regularly examined for evidence of infestation.

Should pests gain entrance to the establishment, eradication measures should be instituted. Control measures involving treatment with chemical, physical or biological agents should only be undertaken by or under direct supervision of personnel who have a thorough understanding of the potential hazards to health resulting from the use of these agents, including those which may arise from residues retained in the product. Such measures should only be carried out in accordance with the recommendations of the official agency having jurisdiction.

The use of insecticides without any provision for collection of dead insects should be discouraged during the plant operation. Instead, the use of adhesive insect traps or very efficient "black light insecticutor" lamp 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 a type approved by the official agency having jurisdiction and should be stored in separate locked rooms or cabinets used only for that purpose and handled only by properly trained personnel.

6.3.12 DOGS, CATS AND OTHER ANIMALS SHOULD BE EXCLUDED FROM AREAS WHERE FISH IS 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 or areas where fish or their products are handled, prepared, processed or stored.

6.3.13 ALL PERSONS WORKING IN A FISH PROCESSING AND FREEZING PLANT SHOULD MAINTAIN A HIGH DEGREE OF PERSONAL CLEANLINESS WHILE ON DUTY AND SHOULD TAKE ALL NECESSARY PRECAUTIONS TO PREVENT THE CONTAMINATION OF THE FISH 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. Light colours are required to assess visually the cleanliness of the garment. It is desirable that, except for workers operating in freezers or cold rooms, the sleeves of clothing should not extend below the elbows unless waterproof protective sleevelets are used to cover the arms.

Gloves used in the handling of fish should be mainteined in a sound, clean and hygienic conditon, 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 another cleansing agent and warm potable water before commencing work, on every occasion after visiting a toilet, before resuming work and whenever otherwise necessary. 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.

6.3.14 NO PERSON WHO IS KNOWN OR SUSPECTED TO BE SUFFERING FROM, OR TO BE A CARRIER OF A DISEASE LIKELY TO BE TRANSMITTED THROUGH FOOD OR WHILE AFFLICTED WITH INFECTED WOUNDS, SKIN INFECTIONS, SORES OR WITH DIARRHOEA SHOULD BE ENGAGED IN THE PREPARATION, HANDLING OR TRANSPORTING OF FISH OR FISH PRODUCTS

The management should take care to ensure that no person, while known or suspected to be suffering from, or to be a carrier of a disease likely to be transmitted through food or while afflicted with infected wounds, skin infections, sores or with diarrhoea, is permitted to work in any area of a fish plant in any capacity in which there is any likelihood of such a person directly or indirectly contaminating food with pathogenic microorganisms. Any person so affected should immediately report to the management that he is ill.

6.3.15 MARKET CONTAINERS AND ALL RETURNABLE FISH BOXES SHOULD BE THOROUGHLY CLEANED AND TREATED WITH DISINFECTANT IMMEDIATELY AFTER EACH USE

The use of properly designed washing machines is recommended wherever practicable. Good washing by hand can be achieved by scrubbing with stiff brushes and by using high pressure water jets, with detergent added to the water.

6.3.16 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. Housing, scrubbing and cleaning with potable water or clean sea water to which suitable detergent and disinfectant have been added, is usually necessary.

Forklift trucks should not be used outside the plant unless they can be adequately cleaned upon re-entry.

6.4 Operating practices and production requirements

6.4.1 *Handling of fish before freezing*

6.4.1.1 ON SHORE HANDLING OF FRESH FISH INTENDED FOR FREEZING SHOULD BE IN ACCORDANCE WITH THE RECOMMENDATIONS GIVEN IN THE SLS 974 OR AS IN CLAUSE 4

The need for careful and rapid handling of fresh fish and the reasons for maintaining a chill temperature have already been fully explained. The following sections deal particularly with processes carried out in shore freezing establishments.

Since most of the fillets frozen on shore will be cut from post-rigor fish, problems concerning rigor are less likely to arise than when freezing at sea. Fillets taken from post-rigor fish should be of uniformly good quality, provided the whole fish have been properly handled and chilled prior to and during rigor. Any fish which are in rigor, however, should be dealt with in the manner already described.

6.4.1.2 FRESH FISH SHOULD ALWAYS BE TREATED IN A HYGIENIC MANNER

Evisceration, filleting and other operations in the handling of fish should be clean and hygienic. Precautions should be taken to protect fish from contamination by animals, insects, birds, chemical or microbiological contaminants or other objectionable substances during processing, handling and storage.

Preparatory operations leading to the finished product and the freezing operations should be so timed as to permit expeditious handling of consecutive batches in production within the time and temperature range that will prevent deterioration and spoilage and will allow for proper freezing.

6.4.1.3 NO FISH SHOULD BE USED FOR PROCESSING 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 fresh fish should be rejected if it is known to contain harmful, decomposed or extraneous substances which will not be removed to an acceptable level by normal procedures of sorting or preparation. Fish in a diseased condition should be discarded or the diseased portion removed. Only clean, sound fish should be used for further processing and freezing.

6.4.1.4 IT IS ADVISABLE TO MAKE THE CANDLING OF FILLETS OF CERTAIN SPECIES OF FISH ROUTINE PRACTICE

If the fish is known to be highly parasitized, it pays to fillet and candle a few which are picked at random in order to decide whether to proceed with the processing.

Although most types of parasites found in fish are harmless to humans, nevertheless the presence of parasites in fish or fish products is highly objectionable to the majority of the consuming public.

Proper and careful candling will not only remove the undesirable parasites but will also detect and remove the blood spots, pieces of skin on the skinless fillets and any other defects which otherwise might reduce the overall quality of the product.

6.4.1.5 FISH WHICH CANNOT BE PROCESSED IMMEDIATELY ON ARRIVAL AT THE PLANT SHOULD BE WELL ICED IN CLEAN CONTAINERS AND STORED IN SPECIALLY DESIGNATED AREAS WITHIN THE PLANT WHERE THEY WILL BE PROTECTED FROM HEAT AND WEATHER CONDITIONS AND WILL NOT BE CONTAMINATED BY DUST, INSECTS OR VERMIN. WHERE POSSIBLE, THE ICED FISH SHOULD BE STORED IN A CHILL ROOM, THE TEMPERATURE OF WHICH IS JUST ABOVE THAT OF MELTING ICE

In order to produce good quality frozen fillets or similar products, the quality of the fresh fish must be maintained by protecting it from heat, contamination from other sources and physical damage.

It must be stressed again that placing quantities of fish in a chill room does not remove the need for adequate icing. Chill rooms are designed to maintain a chill temperature and to keep already cool fish from warming up. The refrigeration machinery used in chill room operations is not adequate to lower the temperature of a mass of fish in a short time. The initial cooling must be done by the addition of ice.

It is poor practice, therefore, to load the chill room with large quantities of fresh fish that were not pre-chilled effectively to the temperature of melting ice.

The chill room should be equipped with a recording thermometer and an automatic temperature control and should be so designed that it can be kept in a clean hygienic condition at all times. The chill room should also be equipped with an automatic alarm system to alert proper personnel when the temperature drops below $0^{o}C$.

6.4.1.6 IF THE FISH ARE TO BE DIPPED OR SPRAYED WITH FOOD ADDITIVES, THE ADVICE OF AN EXPERIENCED FOOD TECHNOLOGIST OR THE OFFICIAL AGENCY HAVING JURISDICTION SHOULD BE SOUGHT

The use of additives or any additional treatment of fish during the processing increases its cost and, therefore, should be measured against the benefits gained. An additive permitted in one country might not be allowed in another.

6.4.1.7 WHERE PRODUCTS ARE PACKAGED BEFORE FREEZING THIS SHOULD BE DONE RAPIDLY TO AVOID UNDUE RISE IN TEMPERATURE

Fish temperatures may rise during packaging. Temperatures of 10°C and above are not unusual in processing factories and the spoilage rate will increase if the fish are held for long at these higher temperatures.

6.4.1.8 WHERE FISH FILLETS ARE TO BE FROZEN IN BLOCKS THEY SHOULD BE FITTED NEATLY INTO THE FORMING TRAYS OF ALUMINIUM OR SIMILAR MATERIAL

The frozen products will then be uniform in shape and size, allowing good overall contact in plate freezers. The product can easily be removed from the trays, after freezing, by quickly dipping in or spraying with potable water.

6.4.1.9 PLANT PRODUCTION SHOULD BE GEARED TO THE CAPACITY OF THE FREEZERS

The rate of packaging or sorting in trays should not exceed the rate of freezing to such an extent that processed fish are delayed more than a hour before entering the freezers.

6.4.2 *Freezing of fish*

6.4.2.1 ONLY GOOD QUALITY FRESH FISH AND FRESH FISH PRODUCTS SHOULD BE FROZEN

Freezing and frozen storage cannot improve the quality of fish. At best, the process maintains the fish in much the same condition as it was immediately before freezing. It is therefore essential that the raw material be as fresh as possible.

Ideally, fish should be frozen soon after capture, but this is hardly the case with shore-based freezing plants, unless the vessels operate only a few miles away and return to port at frequent intervals.

6.4.2.2 THE RECOMMENDATIONS FOR FREEZING FISH ON SHORE SHOULD BE THE SAME AS THOSE GIVEN IN THIS CODE FOR FREEZING FISH AT SEA

Good commercial practices and proper equipment are essential factors for producing good quality frozen fish and fish products irrespective of whether the fish are frozen at sea or on shore. All the recommendations given in 5 of this code, 5.4.2, should also apply to on-shore operations. Some of the most important things to remember when freezing the fish are the following :

(a) Freezing should be fast enough to prevent development of adverse quality changes in the product;

(b) In vertical plate freezers, fish should be carefully packed between the plates so that there are as few air spaces as possible;

(c) Defrost heating of vertical plate freezers should be just long enough to loosen the frozen blocks for unloading;

(d) In horizontal plate freezers, fish and fish products should be packed in trays or other forms to produce uniform and well compacted blocks;

(e) Air-blast freezers should be loaded in such a way that there is always a sufficient flow of cold air around the product;

(f) Sharp freezers should not be overloaded with fish;

(g) In brine freezing, there should be rapid circulation of the cooling medium and the ratio of fish to brine should be carefully controlled;

(h) Freezing process should be allowed to run their full allotted time to ensure their completion; and

(i) Frequent checks should be made of refrigerant pressures and temperatures and accurate records maintained.

6.4.2.3 WITH RAPID **FREEZING TECHNIQUES, WHERE THE PRODUCT IS IMMERSED IN OR SPRAYED WITH LIQUEFIED GASES, CARE MUST BE TAKEN THAT THE PRODUCT DOES NOT BECOME DEFORMED OR CRACKED**

Although cryogenic freezing methods (freezing with liquefied gases) have not, as yet, been very widely adopted in the fishing industry, they are used to some extent particularly in the production of fairly high-cost individually frozen sea foods. Cryogenic freezers freeze the product by spraying it with liquid nitrogen or refrigerant R-12 (freon). Care must be taken that the product is not cracked or deformed by freezing it too quickly and that the compounds used as freezing media meet the approval of the official agency having jurisdiction or the requirements of the importing country.

6.4.2.4 WHERE CONVEYORS **ARE USED TO FEED THE PRODUCT THROUGH THE FREEZERS, THE SPEED SHOULD BE ADJUSTED SO THAT THE PRODUCT IS PROPERLY FROZEN BY THE TIME IT REACHES THE END OF THE FREEZING CHAMBER**

Both the load on the conveyor and the speed at which it passes through the freezer must be taken into account so that the product remains in the freezer long enough to reduce its average temperature to the frozen storage level.

6.4.2.5 FREEZING SHOULD BE COMPLETED IN THE FREEZER AND SHOULD NEVER BE CARRIED OUT BY PLACING UNFROZEN OR PARTIALLY FROZEN PRODUCTS IN A FREEZER STORE

Fish will suffer serious quality losses, due to an extremely slow freezing rate, if frozen in a freezer store. Refrigeration equipment of freezer stores has not sufficient capacity to cope with the extra heat load. Warm products placed in freezer store will not only take a very long time to freeze but may also warm up other products already in the store.

6.4.2.3 DISTORTION OF BLOCKS OR PACKAGES DURING FREEZING SHOULD BE AVOIDED

Where uniformity of the dimensions of the final products is important, as for example with retail packages of fillets or fish blocks intended for further processing, freezing is best done in trays or moulds under pressure in a horizontal contact plate freezer.

6.4.3 *Glazing and packaging*

6.4.3.1 FROZEN FISH OR FISH PRODUCTS SHOULD BE GLAZED, WRAPPED OR PACKAGED TO PROTECT THEIR QUALITY DURING STORAGE AND DISTRIBUTION

The quality of frozen fish and fish products will decline rapidly during storage and distribution if they are not adequately protected against the effects of dehydration and oxidation as well as against physical damage and contamination by foreign matter. The surfaces of large whole fish or irregularly shaped portions are generally protected by glazing, or wrapping, or by glazing and wrapping, or by the use of wrapping material which can be shrunk against the surface. There are many kinds of materials available which have good protective properties and which are suitable for the packaging of frozen fish and fish products.

If food additives are used in ice glazing, it is essential to seek specialist advice, whether the product is for domestic use or for export, as food additive regulations differ from one country to another. Attention is also drawn to the Guide to the Safe Use of Food Additives (Second Series : CAC/FAL 5-1979), recommended by the Codex Alimentarius Commission.

In general, ice glazing is used on fish intended for further processing or for restaurant or institutional trade, rather than on consumer packaged fish or fishery products. Water derived from the melting of ice glaze has been often regarded unfavourably by the average consumer.

It is advisable to control glazing as much as possible so that the thickness of the glaze deposited on fish is uniform and the amount of glaze, expressed as a percentage of the total fish weight, is fairly constant and known by the buyer.

6.4.3.2 FISH PRODUCTS THAT ARE NOT PACKAGED OR WRAPPED SHOULD BE GLAZED AS SOON AS THEY ARE REMOVED FROM THE FREEZER

Glazing will prevent dehydration and will also decrease rancidity. In fatty fish, the reaction of oxygen from the air with various components of the fish flesh, mainly fat, will result in rancid odours and flavours . Such fish as herring, sardine, mackerel, salmon and tuna are particularly prone to oxidation. If they are properly glazed, oxidation is retarded because the oxygen must then diffuse through the layer of ice before it can act upon the fats in the flesh. In some areas a modified glazing procedure is adopted whereby these fish are frozen in a block of ice. Occasionally, blocks of fish wrapped in parchment paper before freezing are glazed immediately on removal from the freezer. Since ice glaze is brittle and may flake away during handling, agents such as sugar, starch, sodium alginate or carboxymethylcellulose are sometimes added to improve its durability.

When additives are used in the glazing solution, care should be taken that the resulting glaze will in no way detract from the appearance of the product. An opaque glaze would be more appropriate for fish like halibut or fish fillets where it might enhance the natural whiteness of the skin or of the flesh. On the other hand, the bright silvery appearance of salmon will benefit more by complete translucency of the glaze film.

6.4.3.3 THE TEMPERATURE OF GLAZING SOLUTIONS SHOULD NOT BE ABOVE 5 ^{0}C

Glaze should be applied to frozen fish or fish products by brushing quickly or spraying with potable water or a solution containing an approved glaze additive or by immersing them therein. The temperature rise should be kept to a minimum. Salmon, halibut and fresh water fish are often glazed in a refrigerated room.

It has been noted that only fish which have been properly frozen will take glaze readily and uniformly, in particular when they are dipped in the glazing medium several times in succession as is usually done to increase the thickness of the protective ice film.

6.4.3.4 FROZEN PRODUCTS SHOULD BE TRANSFERRED TO THE FREEZER STORE IMMEDIATELY AFTER REMOVAL FROM THE FREEZER OR AFTER GLAZING

Any warming effect may thaw the surface glaze and will also introduce unnecessary heat into the freezer store.

Transfer of frozen products to the freezer store should be done quickly with the minimum of damage to the product. Water glaze is brittle and therefore any rough handling of glazed fish in transfer or in stacking might break the protective film and thus nullify the benefit of glazing.

6.4.3.5 ON PROLONGED STORAGE, THE GLAZED FISH SHOULD BE CHECKED PERIODICALLY FOR THE DETERIORATION OF GLAZE

Glaze deteriorates with time as the water evaporates and condensates on the refrigerating surfaces of the freezer store. If this is noted and the fish is to remain in storage for an undetermined time, it is advisable to reglaze the fish as soon as possible to protect it from dehydration (freezer burn) and oxidative rancidity.

6.4.3.6 PACKAGING SHOULD BE DESIGNED AND MATERIALS CHOSEN TO CREATE AN ATTRACTIVE, CONVENIENT AND ECONOMICAL PACKAGE WHICH WILL PROTECT THE PRODUCT ADEQUATELY

There are many factors to consider in designing packages for frozen fish products. It is important that the product be presented in a package that is attractive to the buyer and which is convenient to handle. Labels should be clearly printed and must comply with the labelling laws of the country where the product is marketed.

In addition, the packages of frozen fishery products should bear clear indication as to how they should be kept from the time they were bought at the retailer to that of their use.

When selecting materials, it is necessary to consider the whole packaging plan to ensure that all the required protective qualities are adequately provided. For example, the materials used for inner wraps and the way they are applied will, to some extent, determine the properties that will be required for the carton.

Since packaging materials vary considerably in cost, they will usually be selected in a manner that meets the requirements most economically. In this regard, it is important to consider the labour entailed in packaging. In some instances, it may be advantageous to choose a more costly material if less labour is involved in its use.

The lack of standardization in naming and defining the properties of materials used in the packaging industry causes considerable confusion. It is often difficult to determine which are basic and which are composite materials or to recognize some of the more popular and widely used materials, because manufacturers frequently give special names to their own products. Lack of standardization in test methods can also make it difficult to compare properties of materials.

Since the problems involved in planning the packaging and marketing of frozen fish are often complex, it may be desirable to seek the advice of experts in the packaging and marketing fields.

6.4.3.7 WRAPPERS, BAGS AND POUCHES SHOULD BE OF MATERIALS THAT MEET THE REQUIREMENTS FOR THE PARTICULAR PRODUCT, THE PROCESSING AND PACKAGING METHODS, THE MARKET AND THOSE OF THE OFFICIAL AGENCY HAVING JURISDICTION

Many types of flexible wrapping and packaging materials are available, usually in several grades and thicknesses. These include various types of vegetable parchments and treated papers, aluminium foil and films of regenerated cellulose, polyethylene, polyvinyl chloride (PVC), vinylidene chloride, vinyl chloride-copolymer (PVAC-PVC), polyester, polyamide and polypropylene.

These materials differ considerably in their cost and in their ability to exclude water vapour and gases. Some can be sealed by heat while others require the use of adhesives. They also differ in their physical properties at low temperatures and in their suitability for mechanical wrapping.

Laminated wrappers are often used to take advantage of desirable properties of two or more materials. For example, regenerated cellulose film, which has low gas permeability, high shear strength, is completely transparent and takes print well, is frequently bonded with polyethylene film which has low water vapour permeability, is flexible and has good mechanical properties at low temperatures.

There are many factors to consider in choosing wrapping material for frozen fish products such as the protective properties required for the particular product, the cost of the material, labour and equipment involved and consumer preferences.

6.4.3.8 CONSUMER PACKAGES FOR FROZEN PRODUCTS SHOULD BE SUFFICIENTLY STRONG, WATERPROOF AND STAIN RESISTANT. THEY SHOULD HAVE WATER VAPOUR AND GAS BARRIER PROPERTIES TO MEET THE REQUIREMENTS FOR THE PARTICULAR PRODUCT AND SHOULD BE OF THE PROPER SIZE AND SHAPE

A large proportion of frozen fish products intended for retail sale are packed in paperboard cartons with or without an inner wrapping. To provide the required water and stain resistance and barrier properties, the paperboard is usually coated on one or both sides with wax, plastic or a wax and plastic combination, or it is varnished.

The packages should be sufficiently sturdy to protect the product from physical damage during handling, transport and retailing. They should be sufficiently water repellent to avoid staining or weakening when wet. Packages for fatty products should not be susceptible to grease stains. If there is no inner wrapper or if the wrapper is not a good water vapour and gas barrier, this protection should be provided by the package.

Packages should be of proper size and for the product to fit snugly so that the air space within the package will be as small as possible. Large air spaces within the package increase the risk of dehydration or rancidity. The contents of loosely filled packages are also more easily damaged during handling. Furthermore, a product which is to be frozen after packaging will freeze much quicker if there is no air space in the package.

Retail packages should be preserved intact up to the time of final sale.

6.4.3.9 PACKAGING MATERIALS SHOULD NOT CONTAMINATE THE PRODUCT IN ANY WAY

Since foreign odour and flavours will adversely affect the acceptability of the product, all wrappings, adhesives and printing material likely to come into contact with it should be odourless. The packaging should ensure that the original product flavour and odour are retained. Furthermore, there should be no risk that substances likely to be harmful to health will be transferred from the packaging material to the food.

6.4.3.10 PACKAGING MATERIALS SHOULD NOT UNDULY INCREASE THE TIME REQUIRED FOR FREEZING

In practice, it is often necessary to consider the type of packaging used in the light of its effect on the freezing time. The thicker and more elaborate the packaging material, the longer the freezing time required.

6.4.3.11 PACKAGES SHOULD HAVE LOW WATER VAPOUR PERMEABILITY

Packaging material with a low water vapour permeability is necessary to reduce product dehydration. The permeability of such material depends on both temperature and relative humidity. Water vapour permeability of fish packages should not exceed 0.2 $g/m^2/24$ h at -20 ^{0}C at a relative humidity of 80 per cent.

6.4.3.12 PACKAGES SHOULD HAVE LOW PERMEABILITY TO GASES AND ODOURS

Packaging materials should resist the penetration of oxygen and other gases and should be properly sealed in order to minimize rancidity and prevent the absorption of odours during storage. Films and foils used for packaging should not be easily pinholed during processing and handling. This is especially important if the packages are vacuum packed or flushed with inert gas. Outer paperboard containers may be necessary in some instances for additional protection.

6.4.3.13 PACKAGING MATERIALS SHOULD BE SUFFICIENTLY STRONG AND DURABLE TO WITHSTAND STRESSES DURING PROCESSING, HANDLING, STORAGE AND DISTRIBUTION

The package should be able to withstand stresses during assembly, filling machine-closing, freezing, storage, transport and thawing. Wet-strength and impermeability to moisture are necessary as products may be wet when packed. Low temperature flexibility of the packaging material will prevent it from rupturing or tearing during storage or transportation. Laminated materials should not separate when damp.

6.4.3.14 **PACKAGES SHOULD BE IMPERMEABLE TO FATS AND OILS**

The impermeability and resistance of the packaging material to fats and oils is an important property, especially where pre-cooked or fatty fish are packed. If the packaging material becomes impregnated with oil, rancidity will develop during storage and the appearance of the product will suffer.

6.4.3.15 PACKAGING MATERIALS SHOULD NOT STICK TO THE WET OR FROZEN SURFACE OF THE PRODUCT

Packaging materials which stick to wet or frozen products are a source of annoyance to the consumer.

6.4.3.16 SUITABLE MATERIAL SHOULD BE USED FOR PACKAGING BOIL-IN-THE-BAG PRODUCTS

Packaging material used in this type of product should be capable of withstanding long exposure to the temperature of 100 ^{o}C when immersed in boiling water. Leak and waterproof features are eseential for boil-in-the bag packs. In addition, the presence of air spaces or excessive voids in boil-in-the-bag products should be avoided as the package will float on the surface of the boiling water.

6.4.3.17 THE USE OF SHRINK WRAPPING IS RECOMMENDED WHERE GOOD SURFACE CONTACT WITH PRODUCTS SUCH AS WHOLE FROZEN FISH OR IRREGULARLY SHAPED FROZEN PORTIONS IS REQUIRED

A number of wrapping materials have the property of shrinking when heated. These are usually made up to form bags into which the frozen product is placed. The package is evacuated and sealed and then shrunk by a few seconds' exposure to hot air or hot water. After shrinking, the package fits tightly against the enclosed contents, thus greatly reducing the voids that are otherwise encountered in the packaging of irregularly shaped products. Precautions should be taken to avoid penetration of the wrapping film by sharp points of the contents.

6.4.3.18 MASTER CARTONS FOR WHOLESALE PACKAGING SHOULD BE LIGHT, STRONG AND SHOULD PROVIDE GOOD PROTECTION FOR THE FROZEN PRODUCTS

Fibreboard and corrugated paperboard have been found to be satisfactory materials for master cartons which usually enclose a number of consumer cartons or packages. To facilitate handling, these containers should not be too large. A good wet strength and bursting strength are required. Master containers may be strapped with wire or bands to provide additional strength.

6.4.3.19 CARTONS, WRAPPINGS AND OTHER PACKAGING MATERIALS SHOULD NOT BE STORED IN THE PROCESSING AREA

Delivery wrapping of packaging materials should be removed outside the processing area and only those packages required for immediate use at any given time should be introduced to the area.

6.4.4 *Storage and distribution*

6.4.4.1 DURING FREEZING, THE TEMPERATURE OF THE PRODUCT SHOULD BE LOWERED TO SUCH AN EXTENT THAT AFTER THERMAL EQUALIZATION, THE TEMPERATURE OF THE PRODUCT IS THAT OF THE FREEZER STORE OR BELOW

Products should not be placed in frozen storage until their temperature has been brought down to that of the freezer store.

The freezer store is designed to hold products at the proper frozen storage temperature and should not be used either for freezing fish or for reducing the temperature of a frozen product to the temperature level of the freezer store.

6.4.4.2 IF PARTIALLY THAWED PRODUCTS ARE RECEIVED FOR FROZEN STORAGE, THEY SHOULD BE RE-FROZEN IN PROPER FREEZING EQUIPMENT PRIOR TO THEIR STORAGE IN THE FREEZER STORE

In some cases, frozen products may become partially thawed during transfer or shipment. If these products are still considered to be of an acceptable quality for human consumption, they should be re-frozen rapidly in a proper freezing plant. Tuna, for example, may show signs of surface thaw after unloading from the fishing vessel, but may be re-frozen and stored ashore without any significant change in its suitability for canning.

6.4.4.3 FROZEN FISH PRODUCTS SHOULD BE STORED AT TEMPERATURES APPROPRIATE FOR THE SPECIES, TYPE OF PRODUCT AND INTENDED TIME OF STORAGE

Inevitably, some deterioration of frozen fish products will occur during frozen storage, but if proper temperature and conditions are maintained, these changes will be slight, even after a relatively long time of storage.

Temperature during storage is the most important factor affecting the quality of the product. Lower temperatures retard adverse quality changes; in other words the rate of quality loss is a function of temperature and time of storage. Temperature fluctuation during the storage should be kept to the minimum.

Another factor influencing the choice of storage temperature is the capacity of air to hold moisture. The higher the temperature, the more moisture air can carry without becoming saturated. At higher temperatures therefore there is a faster transfer of water vapour from the product to the cooling surfaces and thus a greater degree of product dehydration.

The table in Appendix B shows the approximate keeping time for some species of fish and fish products when stored at various temperatures.

6.4.4.4 THE TEMPERATURE OF THE FREEZER STORE SHOULD BE CONTROLLED CAREFULLY TO AVOID FLUCTUATIONS

Excessive product temperature fluctuations either in range or frequency are undesirable. Fluctuations of more than 2 ^{o}C in the freezer store temperature should be avoided. Moisture transfer from the product to the colder refrigeration surfaces is accelerated as the temperature difference is increased. Consequently, fluctuations of the freezer store temperature promote dehydration of the stored products. The air velocity in cold freezer stores should be moderate and no higher than necessary to achieve sufficiently uniform temperature within the store.

6.4.4.5 FREEZER STORE TEMPERATURES SHOULD BE CHECKED OFTEN, PREFERABLY BY THE USE OF TEMPERATURE RECORDING DEVICES, AND RECORDS SHOULD BE MAINTAINED

Frequent checks of store temperature allow prompt action to correct any malfunctioning. When deviations occur, the refrigeration equipment should have sufficient reserve capacity to regain quickly the correct temperature level.

Accurate temperature measurements by recording devices will quickly indicate whether proper conditions are being maintained. Care should be taken to place the sensitive element of the recording device in such a position that the reading obtained will be indicative of the actual store temperature. Usually it is necessary to fit a number of such elements and recording devices to obtain a more representative reading.

6.4.4.6 THE PRODUCTS SHOULD BE STACKED IN THE FREEZER STORE SO THAT THERE IS ALWAYS A SPACE FOR COLD AIR TO CIRCULATE ALONG THE WALLS AND FLOOR

Although distances of 5o mm to 100 mm from walls and floors are sometimes regarded as adequate, occasionally large gaps may be required. Where possible, pallet storage should be practised, allowing air spaces below and around the outside of the stacked products. If this is done, then heat which might leak into the room will be absorbed by the circulating cool air instead of being absorbed by the product.

6.4.4.7 WHEREVER POSSIBLE, FREEZER STORES SHOULD MOVE THE LONGEST STORED PRODUCTS INTO DISTRIBUTION FIRST

Products held in frozen storage should be clearly identified and records should be kept to prevent older stocks from being allowed to deteriorate in quality through lengthy storage while newer stocks are being passed into distribution channels. A first-in, first-out principle should be followed.

6.4.4.8 ALL VEHICLES USED IN THE TRANSPORT OF FROZEN FISH SHOULD BE CAPABLE OF MAINTAINING THE LOW TEMPERATURE REQUIRED TO PRESERVE THE QUALITY OF THE PRODUCT

Under ideal conditions the temperature of frozen fish during transport should be the same as the freezer storage temperature. It is recommended that vehicles transporting frozen fish should be capable of maintaining temperature at -18 °C or lower by means of mechanical refrigeration systems, dry ice, or liquefied gases.

Frozen products should not be stacked directly against the floor, walls or roof of the carrier unless the carrier has a body of the jacked type, but should be stacked in such a manner that cold air can circulate around the load to absorb heat which leaks into the vehicle. A minimum distance of 50 mm between the load and the vehicle's floor, roof and walls is suggested.

Local multiple-stop deliveries from distributing warehouses to shops or restaurants may present problems quite different to those encountered in long distance transport between coastal and inland freezer stores. In the absence of mechanical refrigeration, insulated containers with dry ice may be used to keep the temperature of the product from rising. Loading for multiple-stop deliveries should be planned in accordance with the delivery route. The opening of vehicle doors should be kept to a minimum to prevent loss of cold air. Such a loss may be further reduced by use of flexible self-closing inner doors.

Low temperature deliveries of small orders may also be made in individual insulated boxes which are packed in the freezer store prior to loading for distribution.

6.4.4.9 CARE SHOULD BE TAKEN THAT FROZEN FISH PRODUCTS ARE NOT EXPOSED TO HIGH TEMPERATURE DURING LOADING AND UNLOADING OF TRANSPORT VEHICLES

Frozen fish warm very quickly. The effects of any temperature fluctuations, even of short duration, are cumulative and detrimental.

The load should be assembled in the freezer store on pallets, and mechanical methods of loading should be used wherever possible. It is important that the products should not be allowed to stand in non-refrigerated areas. Vehicles should be pre-cooled to + 10 °C or lower prior to loading and should be equipped with devices to record temperatures during transport. Loading into and unloading from vehicles and into and from freezer stores should be as fast as practicable and the methods used should minimize the rise in product temperature.

Some recently constructed freezer stores provide low temperature loading bays, with flexible connecting loading tunnels that fasten directly to the doors of transport vehicles.

6.4.4.10 THE OPERATION OF THE REFRIGERATION UNITS ON TRANSPORT VEHICLES SHOULD BE CHECKED FREQUENTLY EN ROUTE

A temperature rise of the product during transport from one freezer store to another to - 15 °C due to unforeseen circumstances may be tolerated. Otherwise, any rise in temperature of the product higher than - 18 °C should be reduced to this temperature or lower without unnecessary delay.

Every frozen product transport vehicle should be fitted with a properly installed thermometer so that the temperature in the cargo space can be checked regularly without having to open doors and a record of these temperature readings should be kept for future reference. An insulation test should be carried out at regular intervals; tests every two years are recommended in some countries.

6.4.4.11 THE SUITABILITY OF REFRIGERATED TRANSPORT VEHICLES AND THE CARE WITH WHICH THEY ARE LOADED, OPERATED AND MAINTAINED SHOULD BE CHEKCED OCCASIONALLY BY MEASURING PRODUCT TEMPERATURES AT THE BEGINNING AND END OF A JOURNEY

Occasional checks should be made by measuring the temperature of the product at the bottom, sides and top of the load when the vehicle is being loaded and again when it is unloaded. If any excessive warming has occurred, the cause should be determined and the fault corrected.

Specially designed thermometers are used for this purpose. Such thermometers are described in "Recommended International Code of Practice for the Processing and Handling of Quick Frozen Foods -Appendix 1 : Method for Checking product Temperature (Addendum 1-1978 to CAC/RCP 8-1976)".

6.5 Thawing of Frozen Fish

6.5.1 ONLY VERY HIGH QUALITY FROZEN FISH SHOULD BE SELECTED FOR FURTHER PROCESSING WHICH INVOLVES THAWING AND REFREEZING

Substantial quantities of frozen fish products are now being manufactured from fish which has been frozen at sea or on shore, stored, thawed, processed and then refrozen. Even under the best of circumstances the quality of the final product will be affected by each of these operations and if they are not carefully performed the decline in quality may be quite serious. It follows then that in order to produce a good quality product out of fish which has been subjected to thawing and refreezing, it is necessary to use only high quality raw material and to carry out the handling, freezing, storing, thawing, processing and refreezing in accordance with the best of accepted practices.

6.5.2 EXPOSURE OF FISH TO ELEVATED TEMPERATURES DURING THAWING SHOULD BE CAREFULLY CONTROLLED

When frozen fish has been thawed, it is susceptible to spoilage in the same manner as fresh fish. The rate of spoilage increases as temperature is increased appreciably above that of melting ice. It is important therefore that the temperatures to which the fish are expoed during thawing should be no higher than is necessary to carry out the operation reasonably quickly and that the fish should be either processed or thoroughly chilled as soon as they are thawed. It is generally desirable to commence processing or return the fish to a chilled environment a little before thawing is complete, since the centres will continue to thaw until the temperatures within the fish have been equalized.

For some types of product it may be practical and desirable to carry out the processing operations such as cutting, breading, cooking or packaging, using fish which have been only partly thawed. Frozen blocks of fish or fish protions may, in some circumstances, require thawing only to the stage at which the individual pieces can be separated without damage.

It should be borne in mind that under similar conditions small fish will thaw much sooner than large fish or large fish blocks. Fish frozen in blocks can therefore by thawed more rapidly if the individual fish are separated as soon as thawing has proceeded far enough to do so. Where fish of various sizes thawed together care should be taken that the smaller fish are removed and chilled as soon as they are thawed.

6.5.3 THE THAWING METHOD CHOSEN SHOULD SUIT THE VOLUME AND TYPE OF PRODUCT THAT IS TO BE PROCESSED AND SHOULD BE ECONOMICALLY PRACTICABLE

The methods most commonly used by the industry to thaw fish for further processing have been described in Appendix A.3. It is difficult to make general recommendations as to which thawing method is most suitable for a particular product. The processor, in making his decision, should consider the capital, maintenance, operating and labour costs, as well as the volume and parcicular requirements of the product to be thawed. It is felt that a technologist who is familiar with the thawing practices should be consulted on such matters.

6.5.4 ALL THAWING OPERATIONS SHOULD BE CARRIED OUT UNDER HYGIENIC CONDITIONS

Since thawed fish are subject to the same risks of contamination and spoilage as fresh fish, it is essential that all areas, equipment, tanks and other facilities used in thawing, and all handling practices, should meet the same high standards for sanitation and hygiene as set out in the SLS 974.

6.5.5 FILLETS WHICH HAVE BEEN FROZEN PRE-RIGOR OR DURING RIGOR SHOULD BE THAWED CAREFULLY AT A LOW TEMPERATURE

Fish which have been frozen prior to or during rigor and thawed quickly after only a short time in frozen storage, may be subject to "thaw rigor". Under these circumstances fillets may become badly distored and drip excessively. The effects of "thaw rigor" on frozen fillets can be greatly reduced by thawing slowly at a low temperature.

6.5.6 WHERE FISH ARE THAWED IN STILL AIR, THE AMBIENT TEMPERATURE SHOULD NOT EXCEED 18 ^{o}C

When fish are thawed very slowly in still air, the surface of large fish might reach ambient temperature a long time before the centres are thawed. Since the rate of fish spoilage increases greatly at elevated temperatures, it is important that still air thawing should take place in a clean environment and that the air temperature should not exceed 18 ^{o}C. It should be said however that the thawing temperature to be chosen should depend on the size of the product, the species and the intended process. The fish should be either processed immediately, or thoroughly chilled, as soon as they have thawed sufficiently for the intended purpose.

6.5.7 WITH AIR BLAST THAWING. THE AIR SHOULD BE HUMIDIFIED AND ITS TEMPERATURE SHOULD NOT EXCEED 21 °C

Althoughly fish thaw much more quickly in rapidly moving air than in still air, thawing is still relatively slow. The surfaces of large fish will be thawed much sooner than the centres and to avoid loss of quality, the air temperature should not exceed 21 °C. It is also important that the circulated air should be humidified so that the surfaces of the fish do not dry out and thus spoil their appearance. Humid air will also assist in the thawing process by adding a little more heat to the fish when its water vapour condenses on their cool surfaces.

In batch thawing with air blast, care should be taken to ensure that the air is circulated uniformly around all the fish and that the fish are removed to chilled storage as soon as they are sufficiently thawed.

6.5.8 WHERE FISH ARE THAWED IN WATER, THE WATER USED SHOULD BE EITHER CLEAN SEA WATER OR FRESH WATER OF POTABLE QUALITY CONFORMING TO SLS 614 AND ITS TEMPERATURE SHOULD NOT EXCEED 21 °C

It is important that the fish should not be contaminated by the use of unhygienic water. Potable water is recommended for use in thawing although clean sea water might be used.

Since fish will thaw in well circulated water in about the same time as they would in an air blast, the maximum temperature recommended is the same, 21 °C. Care should also be taken to remove the fish from the water as soon as they are sufficiently thawed.

When water is circulated in the thawing tank, adequate precautions should be taken to avoid its becoming badly contaminated with blood, slime and microorganisms, The tanks should be drained and thoroughly cleaned at regular intervels.

6.5.9 WHERE DIELECTRIC THAWING OR ELECTRICAL RESISTANCE THAWING IS USED, PRECAUTIONS SHOULD BE TAKEN TO AVOID OVER-HEATING IN PARTS OF THE PRODUCT

Both these methods depend on the conversion of electrical energy into heat within the flesh of the fish. It is necessary that the absorption of energy should be uniform throughout in order to avoid damage by overheating and cooking in parts of the products. This is difficult to achieve in products which are not regular in shape and which have voids. At present, this limits the usefulness of these methods to certain types of products like regular shaped fillet blocks, in the case of electric resistance thawing and regular shaped fillets or whole fish blocks in the case of dielectric thawing. The latter method may also be used in thawing individual whole fish if damage to tail sections and fins is not important. Both of these thawing techniques are rapid and satisfactory if properly used. Nevertheless, it is recommended that the advice of an experienced technologist should be sought before either method is undertaken.

6.5.10 IMMEDIATELY AFTER THAWING THE FISH SHOULD BE EITHER PROCESSED AND REFROZEN OR THOROUGHLY CHILLED AND MAINTAINED IN A CHILLED CONDITION UNTIL IT IS PROCESSED OR DISTRIBUTED TO THE CONSUMER

As stated earlier, thawed fish will suffer quality loss and spoil in the same manner as fresh fish and should therefore be kept thoroughly chilled and otherwise handled and stored as described in SLS 974.

6.6 Sanitary control programme

6.6.1 IT IS DESIRABLE THAT EACH FISH PROCESSING AND FREEZING PLANT, 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 establishment are cleaned appropriately and that critical areas, equipment and material are designated for cleaning and/or disinfection daily or more frequently if required.

6.7 Laboratory control

6.7.1 IN ADDITION TO ANY CONTROL BY THE OFFICIAL AGENCY HAVING JURISDICTION, IT IS DESIRABLE THAT EACH FISH PROCESSING AND FREEZING PLANT, 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 procedures used should follow recognized methods in order that the results may be readily interpreted.

7. END PRODUCT SPECIFICATIONS

7.1 Appropriate methods should be used for sampling and examination to determine the compliance with the following specifications :

a) Fish and fish products should be free from microorganisms in amounts harmful to man, free from parasites harmful to man, and should not contain any substances originating from microorganisms in amounts which may represent a hazard to health;

b) Fish and fish products should be free from chemical contaminants in amounts which may represent a hazard to health;

c) Fish and fish products should be, to the extent possible in good manufacturing practice, free from any other objectionable matter and also parasites not harmful to man;

d) Fish and fish products should comply with any requirements set forth by the Codex Alimentarius Commission on pesticide residues and food additives as contained in Codex lists of maximum limits for pesticide residues of Codex commodity standards, or should comply with the requirements on pesticide residues and food additives of the country in which the product will be sold;

e) Specifications a), b), c) and d) should, to the extent possible, also apply to frozen fish and fish products.

8. RETAIL DISPLAY

8.1 FROZEN FOODS SHOULD BE OFFERED FOR SALE FROM REFRIGERATED CABINETS DESIGNED FOR THE PURPOSE

Display cabinets used for frozen fish and fish products in retail stores or other outlets should be capable of maintaining the low temperatures required to preserve the quality of the product.

Retail display cabinets are usually kept at a higher temperature than is recommended. The cabinets should be capable of maintaining a temperature of - 18 °C or lower, but during sale operations some fluctuation seems unavoidable and a slight rise of temperature may be tolerated for short periods but the product temperature should not be allowed to become higher than - 15 °C except for the top layer where a higher temperature may be tolerated. The temperature should be carefully controlled and all cabinets should be equipped with reliable thermometers where bulbs are in contact with the top layers of product so that temperatures can be readily checked several times daily.

In order to ensure constant temperature and for reasons of economy, cabinets should not be exposed to warm air currents, direct sunlight, heating or lighting equipment. The cabinets should be covered at night and over the weekend. The stocking of cabinets should be carried out quickly to minimize the time during which the product is exposed to ambient temperature.

It is advantageous to arrange storage space for new stock prior to its delivery. The temperature of products at the time they are delivered should be checked occasionally.

Although the air temperature in a cabinet can be readily checked, the actual temperature of the product should be measured occasionally. Advice on how to measure frozen product temperatures accurately may be obtained from a frozen product technologist or from various fishery research organizations. A special type of thermometer is required for this purpose.

8.2 THE CONTENTS OF THE CABINET SHOULD NEVER BE STACKED ABOVE THE DESIGNATED LOAD LINE MARK

The cabinet refrigeration system is not designed to maintain the temperature of products stacked higher than the load line marked on the cabinet. Packages should be stored close together but not too tightly packed. If displays are packed too tightly they take longer to stock, customers have difficulty in removing packages and damage often results. Simple dividers may be of assistance in stocking the cabinet and creating an orderly display. Stocks should not be removed from and returned to the cabinet except when absolutely necessary. Unpacked products are subject to risks of contamination and dehydration and should be stored and displayed in compartments separate from those used for packaged frozen foods.

8.3 FROZEN FISH SHOULD NOT BE STORED IN RETAIL CABINETS FOR LONG PERIODS

Refrigerated retail display cabinets are designed to hold frozen products for short periods only. Long term storage should be in low temperature freezer stores.

Merchants should avoid holding stock in retail display cabinets for much longer than one week and this should be borne in mind when ordering supplies. New suppliers should be placed under or behind the stock of that particular item, so that the packages which were delivered first will be sold first. Large stocks of frozen fish and fish products with a slow turn-over should be avoided.

8.4 DISPLAY CABINETS SHOULD BE DEFROSTED AT LEAST ONCE A WEEK

Defrosting cycles should be programmed in such a way that, as much as possible defrosting takes place outside the normal shopping hours.

If the cabinet is not defrosted regularly, the effectiveness of its refrigeration system will be seriously reduced by accumulation of frost and ice on the cooling surfaces. This can adversely affect running costs and operating temperature. For efficient operation, the inner walls and floor of the cabinet should be kept clean and free from thick frost. Unless it has an automatic defrost, the cabinet should be emptied for deforsting and during this time the product temperature should not be allowed to rise unduly. It is also advisable to have the cabinet checked from time to time by a competent refrigeration service man.

8.5 RETAIL DISPLAY CABINETS SHOULD BE USED TO STORE ALREADY FROZEN PRODUCTS AND NOT TO FREEZE THEM

Unfrozen or partially thawed fish or fish products should never be placed in a frozen cabinet for freezing or chill storage. These cabinets neither are designed nor do they have the refrigeration capacity for quick freezing.

8.6 FROZEN FISH WHICH HAS BEEN PARTLY OR COMPLETELY THAWED FOR RETAIL SALE SHOULD NEVER BE RETURNED TO A FROZEN FISH CABINET

Fish merchants occasionally might sell frozen fish in a partly or completely thawed condition. This fish may be delivered from the wholesale distributor under such conditions that it gradually defrosts during transport, to be ready for sale as thawed fish. The product may also be taken from the frozen fish display cabinet to be prepared for subsequent sale as a thawed product. The quantity removed should be limited to the immediate demand and under no circumstances should the thawed product be returned to the low temperature storage.

APPENDIX A
FACTORS AFFECTING QUALITY

A.1 Frozen fish

Only good quality fresh or thawed fish should be used for the preparation of quality frozen products. It has been stated in the SLS 974 that spoilage can be slowed down for a short period by maintaining the fish in a chilled condition at the temperature of melting ice, 0 ^{o}C.

The purpose of freezing is to lower the temperature of the fish to well below that of melting ice and inhibit microbial spoilage. If freezing is carried out correctly and the fish are stored in the proper freezer store at a constantly low temperature, deterioration can be arrested for long periods, resulting in a thawed product almost equal in quality to fresh fish.

However, undesirable changes will often occur if the raw material is not handled properly or is frozen too slowly or if the frozen product is not adequately protected against dehydration, oxidation and physical damage or is stored at too high a temperature or for too long a time.

The natural process of rigor mortis can adversely affect the quality of frozen products produced from some species of fish such as cod, if certain precautions in handling the fish prior to freezing are not observed.

If fish are cooled to about 0 °C soon after capture, kept chilled and not handled roughly, the effect of rigor on the final frozen product will not be too serious. At a higher temperature, the rigor process is much more intense and may have a serious effect on quality.

As fish go into rigor the muscle tissues contract, the carcass becomes stiff and the flesh rubbery. Intense rigor also results in changes in the flesh which will cause it to be much tougher after freezing and to drip excessively on thawing.

The time fish remain in the state of rigor mortis depends on a number of factors and may vary from a few hours to several days. In general, however, the lower the temperature at which the fish are held the slower the onset of rigor and the longer it will endure, but the less will be its intensity and consequently its effect on the quality of the final product. Freezing relieves the physical stresses of the rigor process but these may be resumed in what is known as "thaw rigor" if frozen storage is only of short duration and if thawing is done too rapidly.

As rigor mortis resolves, the tensions in the muscle tissue relax, the carcass becomes limp and the flesh soft.

When whole or gutted fish go into rigor the contractions of the muscle tissues are resisted by the skeleton and connective tissue. At temperature close to 0 °C the contractive strains are usually small and the flesh is held in place without damage. At higher temperatures, however, rigor is more intense and strong muscular contractions may cause tears and separations (gaping) in the flesh. Fillets cut from the fish where this occurs will be ragged and torn.

It also follows that rough handling of fish during rigor puts additional strains on the connective tissues which may then give way and cause gaping in the flesh. Attempts to straighten the fish that have gone into rigor in a bent position or have been bent by the uneven onset of rigor, will almost certainly damage the flesh.

Fillets removed from a fish in the pre-rigor state will themselves pass through the rigor process, but as the tissues are no longer supported by the skeleton, shrinkage will occur and the fillets may become distorted. The extent of shrinkage depends largely on the temperature at which the fillets are kept. Immediate freezing is the only safe way to avoid shrinkage, but if some delay in freezing is necessary, the fillets should be maintained at chill temperature.

The effect of rigor on the toughness and drip loss of frozen fillets is the same as for frozen whole or gutted fish. The warmer the fish when they go into rigor, the greater the drip loss and the tougher the final product.

If filleting is delayed until after the fish have gone into rigor at chill temperature, most of the problems of shrinkage are avoided, but there are some disadvantages. Mechanical filleting is often difficult when fish are in rigor and even hand filleting may give slightly lower yields compared with fish that are soft and flexible.

Frozen fillets cut from post-gutted fish are normally of uniform good quality provided the gutted fish have been handled carefully and kept chilled.

At present, the most reliable method of avoiding the undesirable effects of rigor is to keep the fish or fillets chilled at every stage before freezing. Provided they pass through rigor in a chilled condition, the effect on quality should not be serious.

The time which is taken to freeze fish and reduce its temperature to that of the freezer store may have an important bearing on the quality of the frozen product. It has been observed that, if fish are frozen very slowly, the ice crystals which form in the flesh will be relatively large. When such slowly frozen fish are thawed, there will be a large drip loss and the fish could have a poor appearance, texture and flavour.

If, on the other hand, good fish which have been properly handled are frozen very quickly, the ice crystals will be small and if it is not stored too long, the product will be almost undistinguishable from fresh fish.

At one time it was thought that the formation of large ice crystals was the principal reason for the loss of quality by slow freezing, but more recent studies have shown that the factors involved are much more complex.

It is difficult to give a specific rule as to how rapidly fish must be frozen to avoid this slow freezing effect. In some cases freezing times of several hours to as long as one day do not appear to have a significant effect. Indeed it may not be possible under the best of circumstances to freeze some large fish in less than 24 hours.

However, in some instances, freezing times in excess of 2 hours might have an advers effect on the appearance of a product and on the suitability of fish for subsequent filleting and smoking. There are studies which indicate that when the freezing is carried out without delay and rapidly and the temperatures to which the product is cooled and at which it is held are adequately low, the quality of the final product will be better.

For these reasons and to avoid backlogs of unfrozen fish, freezing should be done as rapidly as possible. Since there will be a substantial temperature gradient in a rapidly frozen product, it will generally be found that if the temperature of the warmest part (usually near the centre of the fish or fish block) is brought down to -21 °C in the freezer, the average temperature on removal from the freezer may approach close to the recommended freezer store temperature of - 29 °C.

There are many factors that affect freezing rates. Since the temperature gradient, the heat conductivity of the product and other parameters change as freezing progresses, the rate of freezing will also change. Specifications therefore, which state freezing times as so many centimetres of thickness per hour, may be unrealistic and misleading.

Freezing times of about 3 to 4 hours for 100 mm fish blocks are general on freezer vessels using vertical plate freezers while some horizontal plate freezers will freeze packages of fillets 22 mm thick in about one hour or 34 mm packages in about the same time.

There are a number of ways in which quality deterioration can occur in frozen fish that have not been properly protected and stored.

Dehydration will occur through the evaporation of moisture from products during frozen storage if they are not properly glazed or packaged, or if the freezer store is not properly designed or operated. This loss of moisture causes product surfaces to become dry and dull and sometimes discoloured. Since the evaporated water eventually condenses and freezes on the cooling surfaces of the freezer store, the transfer of moisture from the product will be continuous, unless adequate precautions are taken. Evaporation from the product can be greatly reduced, or even prevented, by proper glazing or packaging with a good water vapour barrier. Furthermore, the rate of moisture transfer to the cooling surfaces can be greatly decreased by preventing, as far as possible, fluctuations in the freezer store temperature or marked differences between the temperature of the product and that of the store's cooling surfaces.

Fatty fish which are improperly frozen or stored may also develop rancid odours and flavours. These result from the combination of oxygen from the air with the fat of the fish. Rancid fish sometimes have an odour similar to that of oil glazing or by sealing the product in a package which is impermeable to oxygen or by storage at low temperatures.

The temperatures at which frozen fish is stored has an important effect on the quality of the product. A temperature of - 23 °C has been recommended in some areas, - 26 °C in others, while in one particular fishery the standard temperature is - 29 °C especially for long periods of storage. Even at this latter temperature, changes in the flesh due to protein denaturation occur slowly and at higher frozen storage temperatures they take place much more rapidly.

Frequently, frozen fish, which are initially intended for short-term storage, remain in the freezer for much longer periods and therefore a temperature of storage such as-29 °C or lower is strongly recommended.

The length of time, according to one source, that some species of fish will remain acceptable in frozen storage at different temperatures is given in Appendix B.

Protein denaturation, as the name implies, is a slow irreversible change in the nature of the protein constituents of the flesh which alters the appearance, texture and flavour of frozen fish and increases the amount of thaw drip. Its effects are most notable in white fish which contain little fat. The flesh becomes dull and opaque and after cooking has a tough, dry texture. It may also develop the unpleasant flavours characteristic of badly stored fish and it often becomes unsuitable for smoking because it will not take on the glossy appearance desirable in such cures.

A.2 Some General Observations on Freezer Stores

The proper design and installation of freezer stores is a matter of great importance, requiring the services of trained and experienced engineers. It is difficult to deal comprehensively here with the complex problems that are involved, but some general points are offered for guidance.

It is important that insulation should be of a suitable material, adequate in thickness, and properly sealed against the entry of water vapour from the warm side. Inadequate insulation will allow too much heat to enter the store, placing an unnecessary load on the refrigeration system and probably resulting in large fluctuations in the store temperature during peak periods. Indeed it is possible that a badly constructed freezer store may never be able to attain the low temperature originally intended. The insulation of a freezer store will deteriorate rapidly if it is not made impermeable to the water vapour from the outside air. If moisture is allowed to permeate the insulation it will freeze as it reaches the colder side thus reducing insulating efficiency and ultimately causing the material to disintegrate.

The type and capacity of the refrigeration equipment to be used will be determined by many factors including the size of the store, its temperature of operation and whether the store is to be cooled by grids, by forced air circulation or by some other means.

The decision as to which method of cooling to use is a critical matter and should be taken only after careful consideration of many factors, such as captial, cost of operation and performance. Serious mistakes may be avoided at this stage by obtaining the advice of a competent engineer.

The cooling system should be designed so that temperature differences throughout the store are minimized without creating a low relative humidity which will cause stored products to dehydrate rapidly. If there is rapid circulation of air in the store, there should be some means of maintaining a high humidity. In general, it may be said that there should be adequate cooling surface, the difference in temperature between the cooling surface and the rest of the store should be small, and the storage temperature should be low.

A.3 Some general observations on thawing

Frequently frozen fish is thawed so that it can be processed into other fishery products. The thawing of fish requires considerable care, because thawed fish is subject to the same risks of contamination and spoilage as fresh fish.

Both the temperature at which the heat for thawing is provided and the length of time that the product is exposed to this temperature should be carefully controlled. If the thawed product is not to be processed immediately it should be held at the temperature of melting ice.

Frozen fish will thaw when the heat energy, which was extracted during freezing, is returned. There are two general ways of doing this; the heat may be allowed to flow into the product from a warmer surrounding medium such as air or water, or it may be provided as electrical energy which is converted into heat in the flesh itself.

Methods of thawing which involve the transfer of heat through the fish surfaces are relatively slow because the thawed outer layers of flesh, which is a relatively poor conductor of heat, restricts its flow to the frozen core. Therefore, a fairly high temperature gradient is required to thaw fish reasonably quickly and, in the case of large fish or fish blocks, this means that the outer layers may be exposed to temperature conducive to fairly rapid spoilage for some hours while the centre is still thawing.

Electrical methods of thawing are much faster than heat conduction methods and there is no need for part of the product to be exposed to temperatures much higher than that of melting ice. However, both dielectric and resistance thawing depend on the absorption of energy by matter which will conduct electricity. Since the electrical conductivity of fish flesh improves with increase of temperature, there is some risk, unless proper precautions are taken, that uneven absorption of energy will occur and "runaway heating" will cause cooking in some parts of the product.

The following is a brief description of the methods of thawing fish that are now in general use :

Still Air Thawing : The fish are allowed to thaw in a moderately cool ambient temperature. This method is very slow and requires considerable space, but it may be the most practical way of thawing if it is done infrequently and the volumes are small. In some instances it may be convenient to thaw fish overnight for processing the following day. Capital costs are low but the labour required in laying out fish and collecting them may be excessive.

Air Blast Thawing : The heat is supplied to the surfaces of the fish by means of circulating warm, moist air. Both batch and continuous air blast thawers are in use. Thawing time is, in some instances, less than half that of still air thawing. Capital and labour costs will depend very much on the type of equipment used.

Water Thawing : The fish are held in trays or baskets suspended in tanks and heat is supplied to their surfaces by circulated water. Water thawing is not generally considered suitable for frozen fillets because these tend to absorb moisture and lose flavour. It is suitable for whole fish, although lean fish may lose some skin pigments and perhaps some flavour. Thawing time is about the same as that of air blast thawing.

Contact Plate Thawing : This method requires special equipment and is only suitable for blocks that were frozen by a contact plate freezer. The blocks are sandwiched between plates which are in tiers and through which water is circulated to hold a temperature of about 20 °C. This equipment is said to thaw 100 mm cod blocks sufficiently in 5 hours for filleting after 3 1/2 additional hours in chilled storage.

Electrical Resistance Thawing : : This method is presently only recommended for frozen fillet blocks up to 50 mm in thickness. Heat is generated in the flesh by the resistance to a low voltage current which passes between two electrode plates in contact with the opposite large faces of the block. To ensure an even flow of electricity and thus avoid localized over-heating, the average temperature of the block should be not lower than -4 °C. Fillet block can raised to this temperature by immersion in water for a short time. Electric resistance thawing is two or three times faster than is possible with air blast or water thawing.

Dielectric Thawing : The product is conveyed without contact between electrode plates which are charged by a high voltage and a high frequency generator (about 5,000 volts and 40 megahertz). Heat is generated in the flesh by the effect of the rapidly changing electric field. Since warmer parts of the flesh will be more conductive and hence will absorb more energy, there is danger of runaway heating and consequent cooking in some parts of the product if proper precautions are not taken. This may also occur if a block is not solid throughout or is uneven in shape.

Runaway heating can generally be avoided in fish blocks if they are immersed in water to fill the voids before being placed in the dielectric thawer. Some economy in power may also be achieved by warming the water with the waste heat from the high frequency generator.

Dielectric thawing is the most rapid method of thawing fish in current use, but capital and power costs are generally considered to be too high unless substantial volumes of fish are thawed. The method is suitable for blocks of whole fish or of fillets. Individual fish may also be thawed by this method although there is some danger that small sections, such as fins or tails, will be damaged by runaway heating.

Microwave Thawing : Thin layers of fish may be thawed very rapidly by absorption of energy from a very high frequency electrical field (about 1,000 megahertz or more). However, the method is not considered to be commercially practical at the present time because of the high cost of the equipment and the serious limitation on the thickness of fish which can be thawed.

APPENDIX B
COLD STORAGE LIFE OF FROZEN FISH

Type of fish	Storage Temperature					
	* -9.5 °C		-20 °C		-29 °C	
	Good	Inedible	Good	Inedible	Good	Inedible
Gutted white fish	1 month	4 months	4 months	15 months	8 months	More than 4 years
Gutted fatty fish	1 month	3 months	3 months	6 months	6 months	1 1/2 years
Smoked white fish	1 month	3 months	3 1/2 months	10 months	7 months	1 year
Kippers	3 weeks	2 months	2 months	5 months	4 1/2 months	9 months

** This temperature is not recommended for the storage of frozen fish products; it is given here only for comparison purposes.*

The figures given in the above table are based upon the results of experiments carried out at Torry Research Station, Aberdeen, Scotland, over a number of years. All the samples were from very fresh fish, stored in ice for not more than 24 hours between catching and freezing. All but the smoked fish were well glazed, packed in wooden boxes lined with parchment paper and kept at temperature within 0.6 °C of those stated. Samples were tasted and compared with corresponding fresh fish at regular intervals.

Figures in the columns headed "Good" give the period in which the stored product is for all intents and purposes as good as fresh. The columns marked "Inedible" indicate the time when the product becomes so distasteful to a consumer accustomed to fresh fish as to be inedible.

The figures cannot be more than approximations of the limiting periods.

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