

# Carefully to Carry

SEPTEMBER 2006

## Frozen fish on reefer vessels and in containers

*Factors which affect the condition of frozen fish cargoes during trans-shipment and transport and advice on how to spot signs that a fish cargo is running into problems.*

### Introduction

According to the UN's Food and Agricultural Organisation, there are more than 28 million people engaged in fishing operations worldwide. The annual world catch of fish exceeds 100 million tonnes, of which around 25 per cent is processed into frozen fishery products. Each year, a high proportion of these frozen products enters international trade and is carried by sea.

Sometimes cargoes of frozen products are found to be damaged when they are unloaded from ships and rejected, leading to claims against shipowners and agents alleging that the damage is due to negligence on the part of the masters and crews of the carrying vessels.

Clearly a vessel is not liable for damage that was sustained before loading, or during handling if due to the actions of third parties. Frequently it is difficult to establish the precise cause and chain of events leading up to the damage. Specialised knowledge is required to sample and inspect fishery products, and relate their condition to the events of the voyage. However, vessel operators also need adequate technical knowledge to minimise the risk of problems occurring, and to act in the event of a claim.

These guidelines are intended to advise ships' masters, officers and crew on good practices to be observed during the loading, storage, carriage and discharge of frozen fishery products carried as bulk cargoes. They also provide detailed guidance on how vessel operators can limit their liability for damage, by ensuring adequate pre-shipment inspection and by acting promptly to preserve evidence when a problem occurs. Other sections also provide background information on factors which affect the condition of frozen fish cargoes during trans-shipment and transport and advice on how to spot signs that a fish cargo is running into problems.



***"The carrier shall properly and carefully load, handle, stow, carry, keep, care for and discharge the goods carried."***

Hague Rules,  
Articles iii, Rule 2

### Carefully to Carry Advisory Committee

This report was produced by the Carefully to Carry Committee – the UK P&I Club's advisory committee on cargo matters. The aim of the Carefully to Carry Committee is to reduce claims through contemporaneous advice to the Club's Members through the most efficient means available.

The committee was established in 1961 and has produced many articles on cargoes that cause claims and other cargo related issues such as hold washing, cargo securing, and ventilation.

The quality of advice given has established Carefully to Carry as a key source of guidance for shipowners and ships' officers. In addition, the articles have frequently been the source of expertise in negotiations over the settlement of claims and have also been relied on in court hearings.

In 2002 all articles were revised and published in book form as well as on disk. All articles are also available to Members on the Club website. Visit the Carefully to Carry section in the Loss Prevention area of the Club website [www.ukpandi.com](http://www.ukpandi.com) for more information, or contact the Loss Prevention Department.

## Frozen fishery products

### Types of frozen fishery products

A variety of frozen fishery products are carried by sea in reefer vessels and reefer containers. The main types, in approximately descending order of frequency are as follows:

#### Whole, gutted<sup>1</sup>, or dressed<sup>2</sup> fish individually frozen

1. Gutted fish are whole apart from removal of the viscera.
2. Dressed fish have heads and guts, and perhaps tails and fins removed

Tuna intended for canning is a typical example.



Whole fish individually frozen

#### Whole, gutted, or dressed fish in blocks

This is a common form of presentation for small and medium-sized fish intended for further processing. Blocks are rarely more than 10cm thick or more than 50kg in weight. Common sizes are 25 and 50kg. Blocks are either unwrapped or wrapped in plastic film and are sometimes packed in strapped cartons.



Fillets of fish, frozen in a block, wrapped and packed in a carton

#### Fillets of fish frozen in blocks

Fillets of fish are often frozen into geometrically shaped blocks. Blocks are usually wrapped in plastic film and packed into inner display packs. The display packs are then commonly packed in outer cartons.

#### Fillets of fish, individually frozen

These are fillets frozen as separate pieces, and perhaps then coated with batter, or batter and breadcrumbs.

Fillets are either placed in packages for retail sale or loosely packed in plastic bags. Small display packs are packed in outer cartons while loosely packed fillets may be packed in bags within outer cartons.

#### Cephalopods, frozen in blocks or as packaged products

These include squid, cuttlefish and octopus. Both processed and unprocessed products are typically frozen in blocks weighing 10 or 25kg. Blocks are occasionally individually packaged, but more usually are overwrapped in plastic with several blocks being packed together in a single outer carton.



Cephalopods (squid) frozen in blocks

#### Crustacean shellfish, frozen in blocks or as packaged products

These include lobster, crayfish, shrimp and crab. Smaller crustaceans and crustacean meats are often frozen in blocks weighing up to 1kg. Blocks are packed individually in cartons or over-wrapped in plastic film and then packed into outer cartons.

#### Crustacean shellfish, individually frozen

Large crustacea, for example lobsters and crayfish are individually frozen, whole or as tails, wrapped and packed in cartons.

## Freezing and storage of fishery products

### Introduction

The master of a vessel carrying frozen fishery products does not generally need to be concerned with how the products have been frozen and stored before delivery to the vessel. Indeed, he has no means of knowing or verifying these conditions, except perhaps when fishery products have been prepared and frozen at sea and transhipped directly to the carrier vessel. However, the quality of the cargo discharged from the vessel is affected by freezing, storage and distribution practices before transfer to the vessel, as well as by the manner of loading, stowage and carriage on the vessel.

The following is intended to inform masters and crew about the technologies involved in freezing and storage of frozen fishery products, and the effects of freezing and storage on product quality.

## The freezing process

When a fish product is cooled in a freezer its temperature drops rapidly to about  $-1^{\circ}\text{C}$ , when ice begins to form. However, not all the water in the fish turns to ice at this point. As more heat is extracted, more ice forms, but the temperature of the product drops only slowly until about  $-3^{\circ}\text{C}$ . This period, when the product temperature changes very gradually, is known as the 'thermal arrest period'.

The product's temperature then begins to drop rapidly towards the operating temperature of the freezer. (Fig A)

When the product is allowed to thaw, the temperature will follow a curve similar to Figure A, but in the reverse direction.  $^{\circ}\text{C}$ , then slowly to about  $-1^{\circ}\text{C}$  as it passes through thermal arrest, then rapidly again until the product reaches the ambient temperature.

It is important for the quality of the frozen product that the thermal arrest period is as short as possible, preferably less than two hours. This rate of cooling can only be achieved in equipment designed for the purpose – merely placing fish in a cold store will not achieve a sufficiently high freezing rate. The refrigerated holds of reefer ships are designed as cold stores to maintain the temperature of already frozen products; they do not have the refrigeration capacity to freeze products at the required rate.

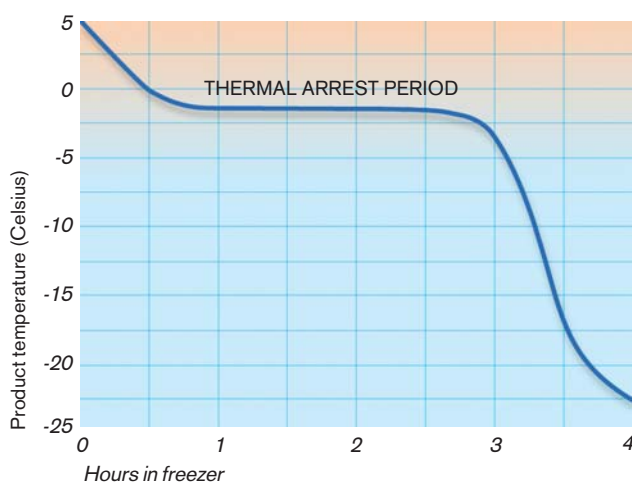


Fig A. Freezing curve of fish initially at  $5^{\circ}\text{C}$

## Examples of freezing methods

### Brine freezing of individual fish

Brine freezing is used for larger, whole fish like salmon and tuna. The technique is used almost exclusively onboard fishing vessels, particularly tuna-catchers. The

fishing vessel is fitted with one or more insulated tanks containing refrigeration coils. Before fishing starts, these tanks are filled with sea water, which is then cooled to around  $0^{\circ}\text{C}$ . As fish are caught, they are dropped into the tanks. When a tank is full, salt is added to lower the freezing point of the brine and the temperature is lowered so that the fish freeze. The temperature that can be achieved depends on the concentration of the brine – the minimum, when the brine is saturated, is about  $-21^{\circ}\text{C}$ . In practice, fishing vessels aim for a solution giving a temperature of around  $-12^{\circ}\text{C}$ . Once the fish are frozen, the brine is drained from the tank and the fish are held in dry condition with the refrigeration system on.

### Freezing of blocks

Small products, including small fish, fish fillets, squid, octopus and shrimps, are often frozen in blocks. The product is laid in trays and frozen, either in a tunnel through which cold air is passed or between pairs of hollow plates through which refrigerant is circulated. The frozen block is knocked out of the tray, protected by some form of over-wrapping and perhaps packed into cartons.

## The quality of frozen fishery products

### Quality of products

Complaints about defects in the quality of frozen fishery cargoes usually fall into one or both of two categories:

- Abnormal and offensive odours, flavours or texture, or any other defects that will influence the consumers' perception of quality.
- Physical damage affecting the processability or merchantability of the product (can occur during the freezing process, though more usually happens during handling of the frozen product).

Quality defects in both categories can arise during handling, processing and storage of the product before delivery to the vessel, during loading into the ship's holds, and while the product is stored on the reefer vessel.

Loss of quality can occur both before and after freezing. However, the nature of the defects differs in the two circumstances and an experienced assessor should be able to distinguish between them.

### Loss of quality before freezing

Fish of all kinds are notorious for the speed at which they spoil (even when chilled) and for the unpleasant nature of the spoiled product. Spoilage affects the appearance, odour and flavour of the product. Freezing halts the spoilage process and fixes the quality as it was at the time of freezing. When frozen products are thawed out, the quality can be no better than it was at

the time of freezing. If defects in the quality of frozen fishery products at time of delivery are shown to be a consequence of spoilage, then no blame can be attached to the carrier of the frozen goods unless the product had thawed out during the voyage.

### **Loss of quality during frozen storage**

Frozen fishery products are not completely stable in the frozen state and will deteriorate over time, resulting in changes in texture, odour and flavour of the product. Changes in texture are similar in character across most fishery products – the product becomes dry, stringy and tough. But changes in odour and flavour depend on the type of fishery product. Lean fish with low oil content (such as cod) develop the characteristic odours and flavours described as 'musty', 'cardboard', and 'wet dog', while fish with high oil content (like tuna, herring and mackerel) develop rancid odours and flavours reminiscent of new leather, linseed oil or old-fashioned oil paints. Odour and flavour changes in frozen crustacean shellfish and cephalopods are similar to those in lean fish. Oily fish deteriorate faster, and produce off-odours more quickly than lean fish during frozen storage.

The main factors influencing the rate at which fishery products deteriorate during frozen storage are temperature of storage and exposure to air. The lower the storage temperature the slower the product deteriorates. The storage life of fishery products carried at  $-18^{\circ}\text{C}$  ranges from 3 to 12 months. In general, storage life is halved for each  $5^{\circ}\text{C}$  rise in storage temperature. For example, a product with a storage life 8 months at  $-18^{\circ}\text{C}$  will have a storage life of 4 months at  $-13^{\circ}\text{C}$ . Since ship' refrigeration systems can maintain products at temperatures below  $-18^{\circ}\text{C}$ , and since voyages are generally less than a month long, there should be no significant loss of quality due to frozen storage-related defects during a voyage.

Rate of deterioration is also affected by exposure to air. Block-frozen products are usually protected by close wrapping with plastic film or by coating with a water glaze. To maintain quality, it is important that this cover, film or glaze is not damaged or lost.

Another defect arising during frozen storage is excessive loss of moisture from the product, which leads to general or localised dehydration known as a 'freezer burn'. The dehydration is signified by white patches which appear where glaze is lost or where there are tears or breaks in the protective wrapping. In unprotected material, dehydration occurs first in thin parts of the product such as the fins of the whole fish and the tail-ends of fillets, or at the corners of blocks. These dried areas do not re-hydrate when the product is thawed and are indicated by blemishes in the thawed product.

### **Physical damage to frozen products**

Physical damage takes a number of forms, but complaints about the quality of reefer cargoes are usually concerned with distortion or compression of the product. This kind of damage, which affects individually frozen fish or blocks of products, occurs when warm fishery products (i.e. warm relative to the recommended storage temperature) are subjected to pressure, for example in a stack of fish stored in the ship's hold.

When water is frozen, it changes from a liquid to a hard solid, ice, at  $0^{\circ}\text{C}$ . Although fish typically contain 70-80% of water – the exact percentage depends on the species – the situation is more complicated than freezing water alone. Water in the fish tissues starts to freeze at about  $-1^{\circ}\text{C}$  but at this point only a proportion of the water is converted to ice. Progressively, more water freezes as the temperature falls. At  $-18^{\circ}\text{C}$ , the maximum temperature usually specified for carriage of frozen fish in reefers, around 90% of the water has turned to ice. It is very hard to deform frozen fish at this temperature and below, except under extremely high pressure.

If the product warms at all, some of the ice melts. The fish tissue holds an increasing proportion of liquid water and a decreasing proportion of ice as its temperature rises.



*Indentations caused when warmed, soft tuna were pressed on to ridged floor plates by the weight of the stack of fish above them*

As the proportion of ice decreases, the fish tissue, though still partly frozen, becomes softer and can be deformed by moderate pressure. For example, it is possible to deform the surface of a product at  $-7^{\circ}\text{C}$  by pressing hard with the point of a pen, a temperature probe, or even a thumbnail. At  $-3^{\circ}\text{C}$ , 'frozen' fishery products are soft enough to deform and to sag under their own weight. If the cargo in the hold of a reefer is stacked to a height of 4 or 5 metres, as is often the case, there is sufficient pressure to distort fish to some extent at  $-7^{\circ}\text{C}$ , and to distort and compress fish considerably at  $-5^{\circ}\text{C}$  or higher.

Individually frozen fish can be severely indented where they lie across each other, and tend to take up the shapes of the surfaces they are pressed against – ridged floor plates or edges of structures in the hold. In an extreme case, a stack of fish can be compressed together into a solid mass, with almost no spaces between the fish. Blocks of products are squeezed, flattened and distorted and will extrude into gaps between cartons, they can also be indented by floor plates or pallet boards.

Frozen products at low temperatures are often brittle and prone to damage by rough handling. For example, tails are easily broken off whole fish and blocks can be shattered or chipped.

Products can also be damaged by contamination. If oil or chemicals are spilled, they may penetrate the wrappings and affect the contents. When cartons and wrappings are torn, the contents are more vulnerable to both contamination and dehydration.

## Pre-shipment inspection

### The need for inspection

Loss of quality in fishery products can be caused by damage both before and after freezing. Carriage of frozen fish by sea is just one stage in a long sequence of processing, handling, distribution and storage operations – products can be damaged or decline in quality at any stage. Receivers of damaged cargoes of frozen fishery products might allege that loss of quality occurred solely while the material was in the charge of the shipowner.

Pre-shipment inspection is therefore essential, to determine as far as possible the condition and quality of the product at the time of loading, and to note any circumstances that could lead to an exaggerated loss of quality during carriage in the vessel. Such information has an important bearing on any claim that loss of quality or damage occurred during carriage in the reefer. The inspection should take into account the nature of the material, its packaging and its presentation.

Pre-shipment inspection by the ship's officers is generally confined to visual inspection of the cargo and to measurement of physical properties such as temperature. Officers are not expected to carry out detailed evaluations of the quality of the material, which would require examination of material after thawing and perhaps also after cooking.

### Nature of the consignment

The deck officer should check that the materials to be loaded are consistent with the bill of lading. However,

information provided on a bill of lading is usually very brief – a cargo may be described as 'fishery products', which encompasses many different product types. Wherever possible, deck officers should record any additional information, for example, in the case of individually frozen fish, the species or variety, the presentation (whole or dressed) and the name of the fishing vessel.

It is also important to record the details of any labelling on wrapped or cartoned material, particularly production dates or batch codes. The absence of any labelling, particularly of batch or production codes, should also be noted.

Information on the nature of the consignment and all details of labelling should be recorded on the mate's receipt. If labels are detachable, one can be removed and attached to the receipt.

### Temperature of the consignment

It is essential to measure the temperature of frozen fish presented for loading. Since fishery products suffer damage if they are stowed at a high temperature, temperature records provide important evidence of the state of the product at the time of loading.

The terms of carriage normally stipulate the temperature, or at least the maximum temperature, at which the cargo should be carried. Holds of reefer vessels are intended for storage of frozen material loaded at the required temperature of carriage. Refrigeration systems have little spare capacity to lower the temperature of products which are put into the hold at above its operating temperature. Material that is above the operating temperature of the hold will take a long time to cool down and will lose quality as a result.

The terms of contract between the provider of the frozen products and the recipient sometimes specify the maximum temperature at which the products should be stored and delivered to the vessel – a maximum temperature of -10°C would be typical for frozen tuna delivered from a tuna fishing vessel. Even if there is no specific requirement for the cargo's temperature on delivery to the vessel, the master may refuse to accept a product if he considers the temperature too high and the product at risk of damage during stowage and carriage.

The deck officer should ensure that sufficient measurements are taken to provide an adequate summary of the temperature cargo, and that the measurements are accurately recorded. Guidelines for temperature measurement are given in the Appendix at the end of this article.

During loading, supervising officers should note any softening of the flesh of fish during transfer to the vessel – this can be gauged by pressing the surface of the fish with a thumb nail or the point of a temperature probe. Even when the temperature measured at the core of a fish is low, the flesh on the outside can be soft enough to be damaged by the pressure of a stack within the hold.


## Condition of the material

It is not easy to assess the intrinsic quality of frozen products by visual examination, but, with experience, one can get some indication of pre-freezing quality from the appearance of the eyes and skin in the case of whole fish, from the colour of the shell in the case of shell-on crustacean shellfish, and from the colour of the skin in the case of cephalopods. Of course, these indications of quality will not be visible in packaged products unless some of the cartons are opened. Whenever possible, photographs should be taken of any defects.

## Visual indication of spoilage in individually frozen fish

The inspecting officer should examine frozen fish individually for signs of spoilage before freezing. The table below summarises the difference in appearance between good quality and stale fish.

	Good quality fish	Stale fish
<b>Colours</b>	bright, demarcated	degraded and dull
<b>Eyes</b>	clear or slightly cloudy; flat to the head or even projecting slightly	yellowish or reddish; sunken or missing
<b>Skin</b>	clean – no discoloured slime or coating	abraded and covered with yellowish slime or blood-stained brine; head region of tuna takes on a diffuse pinkish hue



*Tuna spoiled prior to freezing – note sunken, discoloured eyes, dull colours, pinkish discolouration of head, loss of skin and dirty, bloodstained slime*

## Nature and integrity of packaging and wrapping

Packaging is intended to protect the product from physical damage. The inspecting officer should record any damage to outer wrappings, particularly if the damage has caused exposure of the contents. Sometimes the packaging includes strapping, particularly where a carton contains individually wrapped, heavy products like blocks of fillets. The

nature and integrity of any strapping should be noted.

Wrapping, which may or may not be supplemented by further packaging in a carton, is intended to prevent contamination and dehydration. Wrapping is only effective in protecting against dehydration if it is sealed or is closely applied to the product. The record should include details of the type and condition of any wrapping.

The officer should note any staining of cartons and outer wrappings, including the character and nature of the stain – lubricating oil, fuel oil, water, fish juices, for example. Oils tend to be dark in colour and leave the wrappings soft, even when frozen; fish-juice stains are yellowish or reddish. The officer should note if the staining is extensive, covering all or most of the container or wrappings, or localised. When stains are localised, note whether they are predominantly on corners or edges of packages or on the sides.



*Damage to outer carton, though wrapping and contents look unharmed*

## Blemishes, stains and contamination of the product

When the surface of the product is visible, it should be inspected for blemishes and contamination. Blemishes include surface damage to whole fish like abrasions and tears to the skin or splits in the flesh, and surface damage to blocks such as patches of freezer burn. An attempt should be made to assess the proportion of the consignment affected.

It is important to record an unusual discolouration or staining, and if possible the nature of the defect, for example, blood or bloody brine (particularly on brine-frozen tuna), oil, and chemicals. The product should also be examined for contamination by dust, organic matter such as fish offal or vegetable debris, and any other foreign matter.

In all cases of blemishes or contamination, the inspecting officer should note the extent of the damage and estimate the proportion of the consignment affected.

## Signs of thawing or partial thawing

Sometimes claims are made against shipowners on the basis that a cargo had thawed or partially thawed during the voyage, and had then frozen again to the stipulated carriage temperature. It is therefore important to check that a potential cargo does not show signs that it had thawed and refrozen *before* it had been presented for shipment. Such thawing or near thawing is often indicated by distortion of product shape and release of liquids from the product.



*Oil-stained cartons*

## Distortion

Distortion of whole or blocks of fish indicates that the material has thawed or partially thawed since freezing, or was distorted during the freezing process.

Individually frozen whole fish often have slight pressure marks formed during the freezing process. These minor distortions must be allowed for during examination of frozen products. The nature of the marks depends on the freezing process. For example, fish frozen in trays are slightly flattened or have indentations on one side where they have lain on the trays during freezing. Brine frozen fish tend to float in the brine tanks and are restrained below the level of the brine by a grating. As a result, the fish may have slightly flattened sides where they have been compressed, or shallow cylindrical-shaped depressions where fish lay across each other as they froze. Sometimes the pressure on tuna during brine freezing results in splitting of the skin and flesh,

usually on the dorsal surface at the base of the dorsal fin. Any other splitting should be noted by the officer.

Any distortions other than slight flattening or the presence of minor depressions suggest that the product has warmed up, softened, and refrozen in the distorted shape. The officer should note the nature and extent of any distortions.

Blocks of fish should reflect the sharp angles and regular, geometrical shape of the tray or former in which they were frozen. Blocks of fish which have thawed while stored on pallets or in stacks show signs of slumping, bending, or compression and material is often squeezed into spaces between blocks. Restraints such as strappings and the framing of pallets and shelf-supports cause indentations in the blocks of fish. Again, the inspecting officer should note the nature and extent of distortions.

## Release of liquid

Fish release liquid as they thaw. The cargo officers should check for pools of liquid collecting within wrappings, and for signs that liquid has been squeezed from the blocks and has refrozen on the sides of the stack or on shelves and pallets. Staining of cartons is sometimes an indication that the contents have thawed and released liquid.



*Carton has been stained by fish juices when the block partially thawed*

## Transfer, stowage and carriage Temperature control during loading

It is very important for maintaining quality that frozen fishery products be held at low temperatures at all times. Although it is inevitable that the product's temperature will rise during loading into the hold, the loading operations must be conducted so as to keep this rise to a minimum. The product's quality suffers not only due to the immediate rise in temperature as material is stowed in the hold, but also because of the time taken to bring the product back down to the required temperature after stowage.

As far as possible, the cargo should be loaded at, or below, the required temperature of carriage – typically around -18°C. Officers and crew should attempt to minimise warming of the cargo while it is being loaded and stowed in the holds, preferably so that the temperature of the cargo is not above -10°C by the time it is stowed. Although the ship's crew may have little control over loading operations, the master should co-operate with the ship's agent, and particularly with the stevedoring company, to ensure that good practices are adopted during loading and stowing.

### Good practices during loading

- Ensure that delivery to the ship's side is matched to loading onto the vessel to reduce the time that products are waiting on the quay.
- Products should be delivered in insulated containers or lorries, or at least in covered vehicles.
- If the material must be unloaded onto the quay or held on the deck of the reefer, it should be placed on pallets or on an insulating base, packed as tightly as possible and covered with a tarpaulin or similar protection against sun and wind.
- The cargo should be protected from exposure to wind, rain and sun until it is about to be transferred to the vessel.
- In tropical climates, avoid loading for two or three hours either side of noon and consider loading the vessel at night.

### Good practices during stowage

- Ensure that the hold is cooled to below the carriage temperature before loading begins.
- During breaks in loading, cover holds or decks with at least the hatchcovers, even if the thermal covers are not put in place.
- Refrigeration to the holds should be turned on during long breaks.
- Transfer cargo as rapidly as possible from the quay or discharging vessel to the hold.
- Once loaded, the cargo should be covered with tarpaulins.
- Where consistent with efficient loading, use only one hatch at a time to avoid through currents of air in the hold.

### Maintaining low temperatures during carriage

There is usually an explicit or implicit requirement to hold the cargo below -18°C during carriage. The ship's

refrigeration system must be capable of delivering air to the holds at a temperature a few degrees below the target temperature to allow for heat leaks through the ship's structures. Cargo spaces in reefers are usually cooled by re-circulating air systems, which are only effective if the air can circulate freely through and around the stow.

Most heat leaks into the cargo hold occur through the sides and bulkheads, and it is important to ensure that there is free circulation between the cargo and the structures to the hold. Sides and bulkheads should be fitted with vertical dunnage (without horizontal battens which could obstruct air flow) to keep the cargo away from the structures. There should be an even gap of at least 20cm between the top of the stowed cargo and the lowest part of the deckhead.

Cartons should be stacked with gaps between them while stows of individually frozen fish will inevitably have spaces between the fish unless the fish are deformable and have been compressed.

The ship's engineer should ensure that refrigeration equipment is well maintained and can achieve the design temperatures. Evaporator coils must be defrosted as required to maintain the cooling capacity. Frequent need for defrosting is a sign of high temperatures in the cargo and should be noted in the engine room log. In addition, the engine room log should record temperatures at critical and meaningful positions in the refrigeration system – for example, the outlet and return air streams in air cooling systems, and the outlet and return fluid temperatures in pipe-cooled systems.

It is vital to take and record temperature measurements in the hold. How meaningful these measurements are depends on the location of the temperature sensors. Material in the centre of the stow is the slowest to cool because the source of refrigeration is mainly around the sides of the stow. Refrigerated air percolates gaps between fish or between cartons and the cooling effect depends very much on the existence of uninterrupted spaces. Sensors attached to the sides or bulkheads of the hold are exposed to cold air circulating through the dunnage against the sides or bulkheads and therefore tend to indicate temperatures lower than the bulk of the cargo. Sensors should be attached to posts or other structural members running through the hold, where they are more likely to reflect the temperature of the bulk of the cargo accurately.

### Protecting the cargo from contamination

Every effort must be made to protect the cargo from contamination. Good shipboard practices will prevent

direct contamination by sea water, bilge water, fuel oil and the like, but it is important to be aware that fishery products are rapidly tainted by odours picked up from the ambient air. This is a vital consideration when using air-cooled refrigeration systems – the air must not become polluted by odiferous materials such as fuel oil, paints or chemicals used on the ship. A simple guideline is that if the air circulating through the hold has an odour, then that odour will be picked up by the fish products.

## Unloading

When a cargo is unloaded from the ship, similar precautions should be taken to those recommended during loading to minimise warming. Unloading should be completed as quickly as possible and the cargo should be protected from wind, rain and high temperatures.

## Documentation

### The importance of documents

Documents are fundamentally important in the investigation of any claim involving damage to cargo. They will be examined by the technical surveyors, and may be used as evidence in any subsequent legal proceedings. The following documents are likely to be important in the event of a claim.

- Ship's log.
- Bill of lading.
- Mate's receipts and attached record of the inspection of the cargo prior to and during loading.
- Deck log of loading and unloading.
- Stowage plan.
- Engine room log.
- Any documentation arising from disputes during unloading and/or receipt of cargo.

In addition, photographs and video recordings can provide important evidence in support of statements in the logs and inspection reports.

### Mate's receipts

The mate's receipts should include the record of the pre-shipment inspection (see previous section). This record should detail all observations on the cargo's condition at time of receipt, including results of at least a visual inspection of each part of the consignment. Records should also include temperature measurements, taken at sufficiently frequent intervals to provide a fair indication of the average temperature of the cargo.

Any observations which indicate that cargo temperature is high, or that cargo was delivered in a damaged or deteriorated condition, should be supported as far as possible by further evidence. This evidence might include photographs taken during pre-shipment inspection or results of reports by cargo surveyors.

The mate's receipt should include any information on the nature of the consignment supplementary to the bill of lading, as well as details of any labels.

## Deck log for loading

### Loading

Many charterparty agreements specify a minimum rate of transhipment or loading. To demonstrate compliance with this, and to provide evidence in case of claims concerning damage to the cargo during loading, the timing and sequence of events during loading should be noted in the deck log. At minimum, the log record should include the following:

- Time alongside.
- Where cargo was loaded from – quay, lighter, fishing vessel.
- Times of opening and closing of hatches.
- Arrival and departure of stevedores onboard.
- Times when the refrigeration system was turned on and off.
- Start and finish of cargo stowage.
- Any breaks in loading.
- Weather conditions (sun, wind, rain, ambient temperature).
- Any unusual or irregular events which might affect the condition of the cargo during stowage or subsequent carriage.

## Deck log for unloading

### Unloading

Normally, unloading may be the responsibility of the receiver, and the master of the vessel could consider that his responsibility for the cargo is over. However, the deck log should continue to record conditions during discharge, logging similar information as listed above for loading.

### Stowage plan

A stowage plan should be drawn up for all cargoes – an accurate plan is a central piece of evidence in any damage claims arising against the vessel. The stowage plan should indicate the location of each

consignment and part of consignment and should include the following information:

- Number of units (pallets, cartons or blocks) in each location.
- Gross and net weight.
- Origin of each part.
- The corresponding bill of lading.

## Engine room log

The engine room log is one of the most important documents, since it contributes evidence about the temperature of the ship's cargo during stowage and carriage. The log should document at least the following:

- The locations of temperature sensors in the holds.
- Temperatures at the sensors in the holds.
- Times when compressors were turned on and off.
- In air-cooled systems, the temperatures in the air streams entering and leaving the holds and compartments.
- In pipe cooled systems, the temperatures of refrigerant to and from the cooling pipes.

## Actions in case of dispute

### Action by the master of the vessel

The master must load the cargo in apparent good order and condition and act to maintain it in this state. This section describes actions to be taken when a potential problem is identified.

In the event of any concern or dispute over the condition of the cargo while loading or unloading, the master of the vessel should contact his owners or charterers or his P&I correspondent. Best practice would indicate that loading or unloading should cease until instructions have been received, although this may not always be possible.

As soon as any question is raised over the condition of the cargo, the ship's master should begin to document the events surrounding the discovery of defective material, and the nature and possible extent of the alleged defects.

If possible, loading or unloading of the vessel should be halted and the hatches closed until a cargo surveyor is present. Ideally, cargo should be inspected and sampled while still in the hold, or even during discharge, allowing the surveyor to determine if the nature and extent of the damage is in any way related to the position in the hold.

Once the cargo has been discharged into store, relating damage to location in the hold is obviously more difficult, or impossible, unless the cargo is adequately labelled. Therefore, if loading or unloading must continue, the master should ensure that each cargo unit is labelled with the hatch number and deck as well as location within the hatch and deck, as it leaves the hold. The deck log should also record the destination of the material and the agent responsible for handling it.

## Records

The master should ensure that all records and documents relevant to the dispute are secure, and that they are only made available to parties representing the ship's interests.

## Services of surveyors

When a problem is identified during loading or unloading – for example, if the temperature of the material is too high – loading or unloading should cease until the cargo has been inspected by a specialist surveyor.

If the dispute concerns the quality of the product, it will probably be necessary to call in at least one specialist surveyor to examine the cargo, establish its current quality and determine the nature and cause of any defects.

If it is suspected that defects result from maritime causes – for example, physical damage from movement of cargo, or from contamination with sea water, fuel oil or bilge water – an expert in ship operations should be called in. However, if the defects could be attributed to the initial quality of the material when loaded, or to the way the product was stowed and carried on the vessel, a specialist surveyor would be appropriate.

Many of the surveyors appointed by local shipping agents are general marine surveyors, often with a seagoing background; they are not necessarily skilled in the evaluation of the quality of fish cargoes. Masters and agents are therefore advised to check the expertise and qualifications of surveyors carefully to ensure that their technical background and experience are appropriate for the particular job.

As a general rule, a single surveyor should not be commissioned for both a cargo survey and a survey of vessel condition. Since the skills required for each type of assessment are very different, it is unlikely that one person would have experience in both areas at the levels of expertise required. A fish cargo surveyor should have a background in food science and the inspection of food products, and, ideally, some experience in assessing the quality of frozen fishery products.

## Official inspectors and sampling procedures

Where official inspectors – for example, port health officers or veterinarians – are involved, the master should document the authority under which the officers visited the vessel and the name and status of each officer.

The master is also advised to record the nature and amounts of any samples taken by representatives of the owners or by officials. Such records should include the location of the samples within the hatch or deck, the authority under which the samples were taken and the destination of the samples.

If part of the sample is given to the master, he should ensure that it is fully labelled, and, if possible, that it is sealed in a container under the impress of the person taking the sample. The master should store the sample in a secure place, under conditions such that the quality of the sample will not change.

If the cargo is in store, the surveyor should take into account the manner of discharge and delivery to the store, in case these operations could have affected the quality of the product or could in themselves be responsible for any damage.

## Appendix

### Measuring the temperature of frozen fishery products

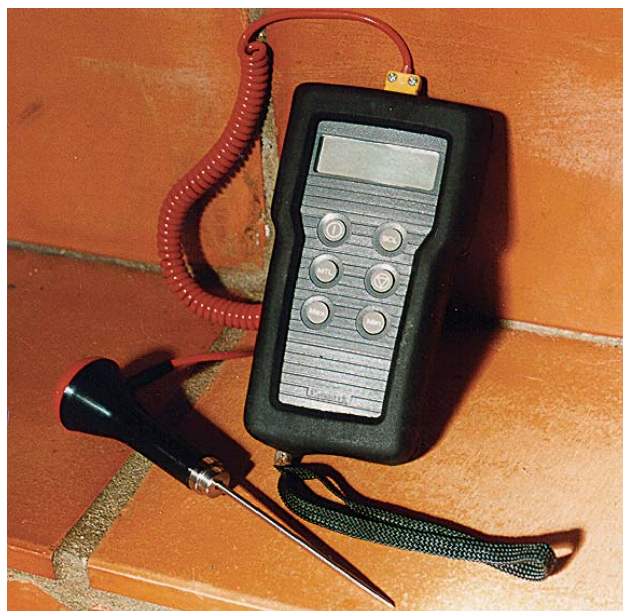
#### Equipment

The most convenient thermometer for measuring the temperature of frozen food products is a water resistant K-type thermometer with a digital display reading to 0.1°C. Typically, these thermometers have a measuring range down to minus 50°C and an accuracy of  $\pm 0.5^\circ\text{C}$  in the range required when measuring temperature of chilled or frozen foods. This accuracy is adequate for the purposes described in these guidelines.

There are several types of probe available for plugging into the instrument. The best all-round probe for measuring temperatures of fishery products is a 100mm long, 3-4mm diameter, stainless steel penetration probe on a 1m lead. There are also stouter, hammer-in probes on the market for forcing into frozen fish (provided the temperature is not too low), but these have long response times. It is usually preferable to drill holes and use a thinner probe.

#### Measuring the temperature of frozen fish

It is not usually possible to push a probe into frozen products. Normal practice is to drill a hole, with an ordinary engineer's hand or power drill, of such a diameter that the probe fits tightly. The bottom of the



Thermometer and probe

hole should be at the thermal centre of the object that is at the position that will cool down or warm up most slowly. The thermal centre is usually at the backbone in the thickest part of a fish, or at the centre line of a block of fillets. The hole should be around 100mm deep – that is, sufficiently long to take the whole length of the probe. This may mean that the hole must be drilled at an angle to the surface of a fish, or along the centre line of a block from one of the smaller side faces.

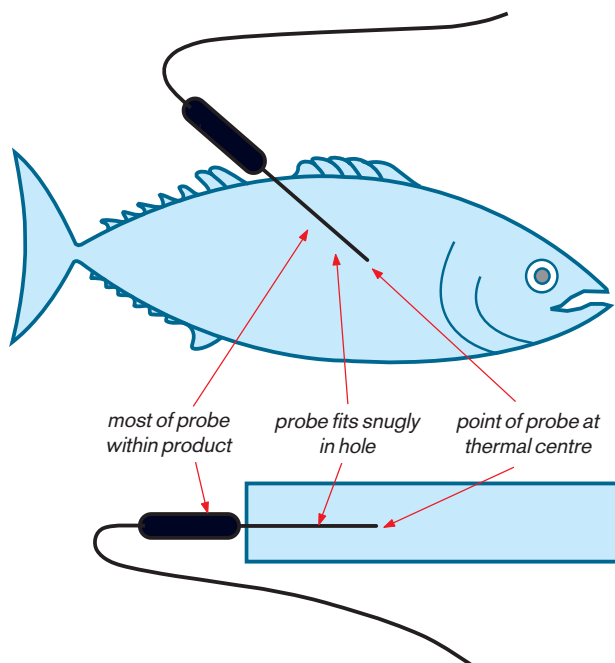


Fig B. Inserting temperature probe into frozen fish or block of fish

Once the probe has been inserted, note the lowest temperature reading given in the next 2-4 minutes. While the hole is drilled and the temperature measurement taken, the product warms up, so measurements should be taken as quickly as possible, and preferably while the product is still in the hold.

## Measuring the temperature of products in cartons

Products in cartons may be delivered in regular stacks or in random loads. In a regular stack of cartons – for example cartons on pallets – temperatures can be measured by inserting the probe between cartons. The warmest areas are the corner of the stack.



*Measuring temperature within a carton*

Temperature should be measured at diagonally opposed top and bottom corners and in the centre of a face. Insert the whole length of the probe between cartons, or between the flap and body of a carton, on the mid-line. Insert the probe between vertically stacked cartons rather than horizontally adjacent cartons as the weight of the cartons above ensures a good thermal contact with the probe. Record the minimum reading. Pushing the probe between cartons will result in some frictional heating, so five to ten minutes may be required to reach equilibrium. When measuring temperatures of cartons, it is useful to have several probes, cover the stack to avoid heat loss, and allow 5 to 10 minutes before connecting the probes in turn to the thermometer.

When cartons are loosely stowed, it is necessary to measure the temperature within cartons. If the contents are loose – IQF fillets, for example – the probe can be forced through the side of the carton into the product.

Thermal contact is poor in such cases – it may take 10 minutes, or more, to reach thermal equilibrium. If the cartons contain blocks, it should be possible to insert the probe between blocks to drill a hole in a block through the side of the carton. The carton usually has to be split to locate gaps between blocks and the centres of faces of blocks.

## Calibration of the thermometer and probes

Instruments are calibrated by their manufacturers, but it is possible to check thermometer/probe combinations at 0°C on the vessel.

Finely crush some ice made from fresh or distilled water, and pack it tightly in a vacuum flask or jar. Add cold water to fill the flask and insert the probe to its full length in the ice/water mixture in the centre of the flask and leave the flask and probe for a while in a cool place – perhaps a refrigerator or chill room – before taking a temperature reading. Since a mixture of ice and fresh water at thermal equilibrium has a temperature of 0°C, any deviation of the probe/thermometer combination from 0°C is the correction for that system.