Summary Report on the Problems Faced by the Inshore Shrimp Industry in Complying with European Food Hygiene Legislation

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The Sea Fish Industry Authority

Seafish Technology

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Summary

Inshore shrimping is a small, traditional industry now largely dependant on a Dutch export market for brown shrimp but with some local trade in brown and pink shrimp remaining. Uniquely the industry produces a cooked at sea product and it does this in rudimentary conditions often on small, old and poorly equipped vessels. Despite this the industry does not have a history of damaging public health.

With increasing concern over food safety, particularly for pre-cooked foods, new hygiene legislation of European origin requires the upgrading of the majority of this industry, although those involved exclusively in small-scale trade within the UK direct to retailers or final consumers or only supplying raw material for further cooking are specifically exempted. Physical upgrading of equipment, rapid chilling after cooking and the use of clean water are required and a microbiological specification for the cooked product must be met.

Seafish has been investigating the problems faced by the industry in meeting these requirements, together with possible upgrading solutions. This work has been levy funded.

Microbiological survey of the industry has shown the counts of 'indicator organisms' (TVC's) on the cooked product increasing with handling on the vessel and ashore and during storage, and generally reaching 'unsatisfactory' levels according to the guidelines in the European specification. Contact with contaminated seawater and a general lack of hygiene and of temperature control are implicated. However, *Salmonella* was not found on the product and, in general, counts of *Staphylococcus aureus* are low and counts of *Escherichia coli* are thought to reach significant levels only after storage of the product or if produced in particularly contaminated conditions.

The provision of a supply of clean water is seen as a key to upgrading the traditional practice of cooking at sea. This water is required not only for cooling the product but also for the effective operation of shrimp handling machinery and for general cleaning purposes. UV sterilisation of the seawater has proven only partially effective because of the amount of solids suspended in these contaminated inshore waters. However, initial trials of a new technology for seawater sterilisation, ionisation, have shown considerable promise although the equipment is yet to be proven in commercial conditions.

Earlier work has shown that a satisfactory brown shrimp product can be produced by the fundamental change in handling practice of icing the raw shrimp at sea and transferring the critical cooking and post-cooking handling operations to more hygienic and controlled conditions ashore. This would enable continued operation of small vessels within the much less demanding hygiene requirements for handling wet fish. A delay in iced conditions of up to about 24 hrs prior to cooking still results in a brown shrimp product of good eating quality although with some loss in colour, but any delay is harmful to the quality of the pink shrimp product. However, the initial response of the trade to this fundamental change has not been encouraging.

Specific recommendations are made for upgrading the traditional cooking at sea operations. These include seawater sterilisation, tighter control of the cooking process, upgrading handling equipment and system design to avoid re-contamination, including the placing of the product in polythene bags, and the indirect icing of the bagged product. In total this would provide considerable improvement in hygiene but the TVC's achieveable for the product are not yet known.

Meeting the hygiene requirements presents considerable challenge, both financially and technically to this largely small-scale traditional industry. Clarification of the legal requirements and the allowance of a period of time for collaborative development of the upgrading solutions identified are recommended.

A programme based on the upgrading and trial of representative vessels is proposed. This would provide a model for the upgrading of the fleet and practical standards to be enforced by the Food Authorities.

Apart from this technical development there is much simple hygiene improvement that can be started immediately. It is proposed that a simple guide to good hygiene practice is drafted for the industry and it is recommended that all persons involved in the handling of cooked shrimp undergo training for a basic food hygiene certificate appropriate to their needs.

1. Introduction

Inshore shrimping is a traditional industry that is now relatively small and much declined from its levels earlier in the century. That decline probably stems from social, economic and competitive factors which have made these small and difficult to peel shrimp less attractive to the UK market. The industry is now largely dependent on a Dutch export market with only a small UK trade remaining.

The industry is unique in that it boils the raw material at sea to produce a cooked product with a longer storage life than the fresh raw shrimp. It does this in rudimentary conditions in comparison to the standards normally expected of food industry establishments ashore producing pre-cooked products. The hygiene standards of the vessels and their operators are typical of the inshore wet fish industry, where food safety risks are low, rather than of the mainstream food industry. Much of the fleet consists of small, old and poorly equipped vessels often in part-time operation, some supporting local 'cottage industry' outlets ashore, although newer and larger vessels have been introduced to support the Dutch trade. However, despite the rudimentary conditions there is no history of this traditional industry having damaged public health.

During recent years there has been increasing public and food industry concern about the upward trend in recorded cases of food poisoning, often related to the consumption of pre-cooked foods. These foods are of potentially high risk as they provide a suitable medium for the growth of pathogenic bacteria, and the usual safeguard of cooking immediately prior to consumption has been lost. The risk is controlled by hygienic raw material preparation, thorough initial cooking, particular attention to hygiene at all stages after cooking to avoid contamination, and by rapid chilling and distribution after cooking to minimise bacterial growth.

Food Safety Legislation reflects this increasing concern. Establishments ashore producing cooked products are already carefully monitored and controlled. Recently enacted legislation to facilitate hygiene controls within the Single European Market has extended control to the fishing industry and has laid down specific hygiene requirements for the cooking of shrimp, including a microbiological specification for the products. The UK industry will have difficulty in meeting these requirements.

For some time Seafish has been aware of these developing problems and since 1990 has had an increasing programme of levy funded work to address them.

The initial work concentrated on investigating the technical feasibility of rapidly chilling the raw shrimp at sea and transferring the cooking operation to more hygienic and controlled conditions ashore. The feasibility was demonstrated but the concept has met with considerable resistance from the industry.

Following the drafting of the European microbiological specification, the work has concentrated on a study of the bacteriological standards of the present industry cooking at sea, to determine the scale and causes of the problems and to investigate possible improvements to hygiene, including sterilisation of the water used at sea for shrimp cooling and handling. This work has been carried out largely in the industry based at Kings Lynn. The bacteriological study has been supplemented by further work carried out by the Food Authorities at Kings Lynn and Morecambe.

This report summarises the new hygiene legislation, outlines the nature of the industry, summarises the work done by Seafish and makes recommendations for improvements in hygiene. Strict enforcement of the legislation has been held in abeyance awaiting the results of this work.

2. The Legal Requirements For Producing Cooked Shrimp

These requirements have stemmed from Directive 91/493/EEC "Laying Down The Health Requirements For the Production And The Placing On The Market Of Fishery Products", and have been enacted in the UK by Regulations under the Food Safety Act 1990. A summary of the major requirements is given below and the relevant excerpts from the legislation associated with cooking on vessels are given verbatim in Appendix I.

Requirements	Legislation
• Details of vessels on which shrimp are cooked must be provided to the Food Authority and the vessels registered prior to operation.	Food Safety (Fishery Products) Regulations 1992
• Details of establishments in which shrimp are cooked ashore must be provided to the Food Authority and the establishments approved prior to operation.	Food Safety (Fishery Products) Regulations 1992.
• Basic hygiene requirements for fishing vessels.	Food Safety (Fishery Products on Fishing Vessels) Regulations 1992
• Further hygiene requirements for equipment on fishing vessels producing cooked shrimp.	Food Safety (Fishery Products) (Derogations) Regulations 1992
• Establishments ashore must satisfy more extensive hygiene requirements for premises, equipment and practices	Food Safety (Fishery Products) Regulations 1992 and Food Safety (Fishery Products) (Derogations) Regulations 1992
• There must be rapid cooling after cooking (with clean water if used) to a temperature approaching that of melting ice (unless another form of preservation is used)	Food Safety (Fishery Products) (Derogations) Regulations 1992
• Temperature and hygiene conditions must be maintained during storage and transport.	Food Safety (Fishery Products) Regulations 1992
• Manufacturers must carry out microbiological checks of the product	Food Safety (Fishery Products) (Derogations) Regulations 1992

• Microbiological specification for the cooked products	EC Commission Decision 93/51/EEC "The Microbiological Criteria Applicable To The Production Of Cooked Crustaceans And Molluscan Shellfish" (not yet enacted in UK legislation)
• There are exemptions to the above requirements for vessels where the shrimps are to be re-cooked ashore or where the fisherman sells small quantities on the local market (up to 25 tonnes per annum within the UK market) direct to retailers or final consumers (including caterers)	Food Safety (Fishery Products) Regulations 1992

If vessels land raw shrimp for processing ashore they are subject only to the less onerous Food Safety (Fishery Products on Fishing Vessels) Regulations 1992 and not to the further requirements above.

Of the requirements for producing cooked products, those concerning temperature control and the bacteriological standards present particular difficulties for vessels. The requirements for premises cooking ashore would present significant difficulty for some if they were involved in more than small/local trade.

In addition to the so-called 'vertical' EC hygiene Directives concerning fish, a 'horizontal' hygiene Directive concerning all foodstuffs has recently been agreed. Directive 93/43/EEC "On The Hygiene Of Foodstuffs" is to be enacted by 1996 and is likely to impose further hygiene requirements on the currently exempt small/local trade.

The microbiological requirements are somewhat complex but are crucial to the UK industry. *Salmonella sp* must be absent and other pathogens and their toxins must be at safe levels. For **peeled** products a specification is given for counts of *Staphylococcus aureus* and either thermotolerant coliforms or *Escherichia coli*. If the levels of the above organisms exceed the specifications the Food Authority must be notified and the necessary remedial action taken. If pathogens or *Staphylococcus* exceed the specifications the products must not be marketed. In addition, for both **peeled** and **unpeeled** products **guideline** specifications are given for 'indicator organisms' measured as total viable counts (TVC's) of mesophylic aerobic bacteria. The guidelines are to help manufacturers decide whether their plants are operating satisfactorily and to assist them in implementing the production monitoring procedures. Interpretation of the role of the guidelines is crucial as in practice the specified TVC's are difficult to achieve on vessels.

The microbiological sampling procedure for TVC's is based on taking a number of samples and applying a statistical analysis which yields a result in one of three categories depending upon the level of contamination: 'satisfactory'; 'acceptable'; and 'unsatisfactory'. It is a reasonable assumption that where levels are consistently 'unsatisfactory' the Food Authority may require that the manufacturer takes corrective action.

3. The Nature Of The Inshore Shrimp Industry

3.1 The Fishery

The fishery is for the small brown shrimp (*Crangon crangon*) and the small pink shrimp (*Pandalus montagui*). Best estimates of the UK landings for 1991 are 500 tonnes of brown shrimp and 150 tonnes of pink shrimp, valued at £1-1.5 million, although in earlier parts of this century when fishing effort was greater, landings have been up to 2000 tonnes per annum (from current trade sources and historic MAFF statistics).

These shrimp are widely distributed around our shores but current UK fisheries centre on The Wash and adjacent coast, particularly North to the Humber, and to a lesser extent on the English North West Coast from the Dee to the Solway Firth. It is estimated that about three quarters of the brown shrimp and nearly all the pink shrimp are landed to The Wash.

Our fishery is small compared to our Continental neighbours, particularly the Dutch who land about 5000 tonnes of brown shrimp per annum. There is thought to be scope for increasing our landings if the market were to justify increased fishing effort.

Brown shrimp are found in shallow waters within estuaries, on coastal shoals and along beaches. The pink shrimp are found in deeper coastal rather than estuarine areas. The life cycle of both species is about 3-4 years and initial growth is rapid. Periods of several years of relative scarcity followed by bursts of abundance tend to characterise the brown shrimp. The fishery is seasonal, peaking in the autumn. The pink shrimp are prolific but within more restricted grounds. Landings of pink shrimp are severely limited by market demand.

3.2 Products and Markets

These small shrimp spoil within hours of capture when held at ambient temperatures, so traditionally they have been cooked at sea or within a short period of capture if netted on the beach.

The bulk of the UK trade is in 'rough' (whole, cooked) brown shrimp exported to Holland. It is estimated that over 90% of East Coast brown shrimp landings follow this route.

There remains a small UK trade in rough shrimp for UK markets, and there is some peeling for local markets and to produce potted shrimp. The potted product is subjected to a secondary cooking process and is thought to be an intrinsically safer product.

The trade on the West Coast tends to be, but is not exclusively, small and local, whereas that on the East Coast is channelled largely through a couple of Dutch-linked merchants at Kings Lynn. Much of the West Coast trade is in potted shrimp. A large UK food company has recently developed a modern shrimp processing facility on Deeside. Surplus West Coast shrimp finds its way to Holland.

The brown shrimp in particular is difficult to peel mechanically and is normally hand peeled, which is a laborious and potentially contaminating process. Earlier in the century, under different economic conditions, much hand peeling was carried out in the UK. The Dutch export their shrimp to low labour cost areas, such as Morocco, for peeling.

The Dutch dominate European trade in brown shrimp and have strong financial links with the main UK commercial operators at Kings Lynn, although paradoxically the dominating Dutch businesses are subsidiaries of major companies in the UK food industry. The life of the typical Dutch peeled product from harvesting to eventual consumption is far longer than would be expected from the known storage life of fresh cooked shrimp, and so it is widely assumed that additional means of preservation are used. These products are marketed largely in the Benelux countries.

The Dutch are not interested in the small pink shrimp, and hence the depressed market for this species.

The trade in inshore shrimp is almost entirely separate from the greater and far more highly valued trade in the larger shrimp, mainly imported cold water prawns (*Pandalus borealis*) and tropical species. These larger shrimp are normally traded as frozen product, and the UK takes the lead in the trade in Europe. There may be theoretical scope for substitution here if the inshore product were to meet the exacting quality standards of this other trade.

3.3 The Equipment And Practices Of The Industry

This is a diverse industry ranging from small-scale harvesting on the West Coast for local consumption, some using tractor towed nets at low water, to relatively large and mechanised vessels of Dutch origin operating trips of up to three days out of Kings Lynn for the Dutch market. The great majority of the catch is landed by vessels.

The shrimp is caught by beam trawl with a mesh of about 20mm. Twin beams are used on the larger vessels. Towing times are typically 1-2 hours. Because of the fine mesh and the inshore nature of the fishery there is often a considerable by-catch of rubbish, small crabs and immature fish. This has to be separated from the shrimp.

A typical handling sequence on board, carried out on the open deck, consists of initial sorting of the raw material, cooking, cooling to ambient and further sorting of the cooked product, and then the placing of the product in single use plastic sacks (open mesh or close weave) or boxes (normally of open mesh construction). The product is discharged in those containers and taken to the merchants' premises. The product is not normally chilled before reaching the merchants' premises. When harvested by vehicles, cooking is normally carried out shortly after at the base of operation, which may be the fisherman's home, although some vehicles carry cooking facilities.

Sorting is by manual or mechanical means. The mechanical sorting equipment requires a supply of water for its operation. The water used for all purposes aboard is seawater pumped directly from under the boat. Because of the inshore/estuarine nature of the fisheries this water is often subject to bacterial contamination. With the practical mechanical equipment used it is impossible in the initial sort to separate small fish or other things of similar size to the shrimp. On mechanised vessels the separation of small fish is normally achieved by 'washing out' or 'mashing' in the secondary sort after they have been softened by cooking. A final manual sort is usually required.

Shrimp are cooked as soon as possible after bringing aboard but the delay can be up to about 1.5 hrs if fishing is heavy. Cooking is carried out as a batch process in a boiler, usually diesel fired. The shrimp are cooked in sea water, usually with added salt to improve the product. This salt may be omitted when the shrimp is destined for local peeling, as this makes peeling easier. Salt addition is by the scoop or handful and is not controlled. The cooking process itself is not controlled. Typically the water is brought to the boil, a batch of shrimp is dropped into the water which then comes off the boil, after a couple of minutes the water starts to boil again at the sides and the shrimp come to the surface, the mixture is then stirred and when it boils again the shrimp are considered cooked and are scooped out. Sometimes cold seawater is added finally to bring the mixture off the boil to aid removal of the shrimp. The time taken by the cooking process varies typically between 3 and 7 minutes.

Cooling after cooking is normally by water contact, largely in the sorting equipment but supplemented if necessary. In the past air cooling on open mesh racks over the side of the vessel was common. This takes up more space and is more laborious. Although nominally air cooling, this system remains open to the elements and to sea spray in rough weather. Storage of the cooked product is normally on the open deck of the vessel.

To describe in more detail the variations in equipment and practices employed, it is convenient to classify (arbitrarily) vessels into three types: I, II and III.

Table 1 - The Structure of the Wash Fleet

Type	Summary description of typical vessel	Approximate number in The Wash fishery
I	Modern 12-18 metre steel vessels, twin beam, mechanised and integrated stainless steel handling and cooking systems, fishroom, typically 2 crew	4
II	Older 12-18 metre vessels, mainly steel, twin beam, semi-mechanised 'rough and ready' handling and cooking equipment, few with fishrooms but rarely used, typically 1-2 crew	18
III	Typically traditional 9-14 metre wooden vessels, little mechanisation and only basic equipment, no fishroom, typically single-handed	28

The fishery on the West coast is prosecuted, largely by type III vessels and a significant number of tractor type units (there are about 27 such units fishing Morecambe Bay alone).

Photographs of typical vessels and their equipment are shown in Appendix II.

It is noticeable that because of economic pressures all these types of vessel now sail shorthanded.

Type I Vessels: These vessels remain at sea for 12-72 hrs and some have refrigerated fish holds. The shrimp handling and cooking equipment is of Dutch origin. The catch is dropped directly from the net into a hopper, from which it is conveyed into a multi-stage mechanical riddle (usually an oscillating device). The sorted shrimp is boxed awaiting cooking in the adjacent boiler. A tipping basket feed device may be used to transfer the shrimp from the boiler to the second mechanical riddle from which the sorted shrimp again fall into a box. The shrimp may be hosed in the box for further cooling and are picked over by hand as final sorting. The boxed shrimp are then stowed in the fishroom.

Type II Vessels: These are mainly ex-Continental beam trawlers of an earlier generation. Typically they remain of sea for 12-48 hrs. Equipment is likely to be mixed, with wooden and mild steel components, often 'home made' and with poorer integration between the handling stages with greater risk of contamination. The shrimp may be dropped from the net into deck pounds rather than a hopper. Some vessels may have only a single riddle used both before and after cooking. The shrimp is scooped from the boiler. Occasionally secondary air cooling on racks coupled with hand sorting is employed. The end product is usually stored on the deck in boxes or sacks.

Type III Vessels: Often these are ancient wooden vessels, some of which originally operated under sail. They usually work over a tide, about 12 hrs, often on a part-time basis. Equipment is usually limited to a boiler and possibly a small 'home-made' mechanical riddle. Sorting is usually by hand on the side deck or using a manual riddle held over the side of the boat. Because of the relatively small quantities of shrimp involved and by thorough initial hand sorting there may be no need for further sorting after cooking. The sorted raw shrimp may be placed in netting bags and cooked in those bags (normally with some agitation part-way through cooking), then cooled by dipping the bags over the side. Air cooling on racks, usually of wood and netting construction, is occasionally employed. The cooked shrimp are usually placed in sacks and stored on deck.

Modern Dutch Vessels: The Dutch fleet is more capital intensive, generally with larger, better equipped vessels than the British fleet. Their equipment and practices are a generation ahead. Their emphasis is on integrated, mechanised shrimp handling systems followed by chilled storage in holds. There has been much development of the integrated handling systems, the latest versions of which feature sophisticated rotary riddles which may also incorporate feed devices to and from a semi-continuous cooker. Seawater cooling remains an essential part of this mechanisation and it was this Dutch influence that led to its adoption in the UK.

Rapid refrigerated seawater cooling is employed in the latest systems. Refrigerated fishrooms are common and indirect icing of the cooked product is used in the summer if not refrigerated. The cooked product is stowed in shallow open sided boxes when refrigerated or in strong polythene bags under ice.

Handling Ashore (UK): Typically the larger vessels land at a quayside close to the merchant's premises and an open or non-refrigerated vehicle carries the boxes to the premises. Some of the type II vessels land at remoter locations in more difficult discharge situations, for which the use of bags is better suited for manhandling than boxes, and the shrimp are usually transported in multi-purpose pick-ups or vans, etc. Type III vessels land in a wide range of circumstances, which may involve mooring the vessel offshore and using a dinghy to bring crew and catch ashore, and often the product is transported in the back of the crew's pick-up, van or car.

At the premises of the large merchants at Kings Lynn the shrimp are tipped into a hopper, which may be in an exposed position outside of the building, from where they are conveyed inside to a grading machine which also doses the shrimp with chemical preservatives (benzoic acid, citric acid and salt powder). The shrimp are then boxed, weighed and placed in a powerful chill. The shrimp are transported to Holland in refrigerated vehicles.

The circumstances of the internal UK trade vary enormously from home-based operations to the modern food industry development on Deeside.

4. Microbiological Survey of the Industry

4.1 Purpose

This work was carried out to determine the extent and the causes of bacterial contamination in the industry producing a cooked at sea product, in the context of the European microbiological specification. The Wash fishery was surveyed to provide a profile of bacterial counts in the shrimp from its capture through to handling in the merchant's premises prior to export.

Complementary work has been carried out by the Food Authorities at Kings Lynn and Morecambe, providing further information on the product being handled ashore at Lynn and on the product landed by the West Coast fishery.

4.2 Methodology

The possible sources of contamination (the hazards), ranging from the sea in which the shrimp is caught onwards through each stage of handling at sea and ashore, were considered together with control measures such as cooking (a critical control point). From this a sampling programme was derived. Samples were taken at the following stages of the commercial operation:

(i) the raw material taken out of the net,

(ii) after the initial mechanical sorting of the raw material,

(iii) immediately after cooking,

(iv) after the second mechanical sorting combined with seawater cooling,

(v) after final hand sorting on racks,

(vi) immediately prior to landing after storage on deck,

(vii) on delivery to the merchant's premises,

(viii) after mechanical grading and benzoic acid, citric acid and salt treatment at the merchant's premises.

In general the same batches of shrimp were followed through stages (i) to (vi) to monitor changes following each operation, but this was lost at stages (vii) and (viii) because of the larger quantities of shrimp involved and its mixing in the merchant's premises.

Further samples were taken at the following stages, not necessarily part of the commercial sequence, to determine the effect of the post-cook cooling method:

(iii)(a) after cooling in seawater but with no machinery or hand contact,

(iii)(b) after air cooling on racks but with no machinery or hand contact.

In addition a number of samples were taken at intervals during the cooking process to determine the effect of cooking time, and a few swabs were taken from equipment surfaces to indicate general levels of cleanliness.

The work was carried out during the period March to July 1993, mainly on fully mechanised type II vessels but with some sampling on a variety of other vessels and in a major merchant's premises. The vessels were fishing on the inner and the outer Wash grounds, but all trips were restricted to one tide (about 12 hrs). Samples were taken on numerous occasions to increase confidence in the results.

The sampling procedure was to hygienically transfer a small quantity of shrimp to a sealable plastic bag, using disposable gloves and clean scoops for direct handling. The sealed bags were then placed directly in ice in an insulated container which ensured rapid chilling to near 0°C . Within a period of 24 hours the samples were taken to approved microbiological laboratories at Hull or Sheringham and analysis commenced. TVC's were obtained for all samples and, less frequently, counts were obtained for *Salmonella sp, Staphylococcus aureus* and *Eschericia coli*. Standard microbiological procedures were used in accordance with the European specification. All the samples were whole, unpeeled, shrimp.

To investigate further the extent of bacterial growth, samples from a number of stages were held at ambient temperatures for periods of up to 24 hours prior to analysis. These samples were from stages (iii), (iii)(a) and (iii)(b) and also from further stages labelled as (iii)(a) + and (iii)(b)+ which were (iii)(a) and (b) type shrimp that had been left on deck and then sampled immediately prior to the landing.

Samples of treated products from the merchant's premises were taken to the Public Analyst at Hull for analysis of residual levels of benzoic acid.

4.3 Results

The bacteriological profile is presented in terms of the European microbiological specification, although during the survey only one sample was taken on each occasion rather than the five required by the specification.

In none of the Wash samples was the pathogen *Salmonella* found and in only a few of the samples were there detectable levels (i.e. more than 10/g) of *Staphylococcus* and *E. coli*. In only one out of the 68 cooked whole shrimp samples analysed for these organisms did the count of *Staphylococcus* reach the 'unsatisfactory' level specified for peeled products (this was a water cooled sample held at ambient temperature) and in no case did the count of *'E. coli'* reach the equivalent 'unsatisfactory' level, although in several cases the counts of these organisms fell into the equivalent 'acceptable' category rather than the 'satisfactory' category. However, it should be noted that counts generally increase during the peeling process and so a greater proportion of these samples may ultimately have failed to meet the peeled product requirements.

The TVC's were generally high and largely 'unsatisfactory' for the whole shrimps as is shown in the summary Table 2. According to the guidelines, the levels are 'satisfactory' if all the samples have TVC's less than or equal to 30,000/g, are acceptable if levels are between 30,000/g and 100,000/g and the number of samples with TVC's between 10,000/g and 100,000/g is two out of five or less (i.e. 40%), and are 'unsatisfactory' in all cases where levels exceed 100,000/g or where the number of samples with TVC's between 10,000/g and 100,000/g is greater than two out of five.

Table 2 - Summary of TVC Profile For The Wash Fishery

Sampling Stage		No of Samples	% of samples with TVC's ≤30,000/g	% of samples with TVC's ≥10,000 and ≤100,000/g	% of samples with TVC's > 100,000/g
(i)	Out of the net	20	90	20	5
(ii)	After initial sorting	28	79	32	7
(iii)	Immediately after cooking	30	97	3	3
(iii) (a)	After water cooling	18	94	11	6
(iii) (b)	After air cooling	11	91	9	9
(iv)	After second sort/water cool	18	83	22	6
(v)	After final hand sort	12	58	58	0
(vi)	Immediately prior to landing	9	67	56	0
(vii)	On delivery to factory	21	62	14	33
(viii)	After grading/benzoic treatment	32	56	34	25

There is a clear trend of increasing TVC's at each handling stage, with the exception of the kill occurring during cooking. After final sorting at sea of the cooked product, and beyond, the counts are largely 'unsatisfactory'. Surprisingly little difference in counts was associated with fishing in the inner, more contaminated, areas of The Wash compared to the outer areas.

The results of the closer examination of the cooking process are summarised in Table 3.

Table 3 - Summary of Bacteriological Kill During The Cooking Process.

Time into Cooking Process (mins)	TVC/g for each sample			
	Trial 1	Trial 2	Trial 3	Trial 4
0	7,300	50,000	50,000	3,300
1	<1,000	28,000	29,000	450
2	1,000	14,000	2,000	220
3	1,000	40,000	42,000	800
4	<1,000	41,000	7,100	760
5	No data	3,600	7,700	110
6	No data	2,000	1,000	210
7	No data	No data	No data	40

The results are consistent in that they show an initial kill followed by an apparent increase in counts and then a final decline. This is thought to be a product of the sampling procedure as the initial boil breaks up the mass of shrimp and circulates cooler shrimp from the centre of the mass to the surface. A long cook, in excess of 6 minutes, is necessary to achieve a kill in excess of 90% when initial contamination levels are high.

The results of the storage at ambient trials are summarised overleaf in Table 4.

Table 4 - Bacterial Growth In The Cooked Product

Sampling Stage		No of Samples	Shrimp Temp. °C	% Of samples within TVC/gm ranges after delays in ambient conditions					
				0 hrs delay		12 hrs delay		24 hrs delay	
(iii)	Immediately after cooking	13	14-19	100	% ≤30,000	100	%≤30,000	100	% ≤30,000
				0	% ≥10,000 and ≤100,000	0	% ≥10,000 and ≤100,000	0	% ≥10,000 and ≤100,000
				0	%>100,000	0	%>100,000	0	%>100,000
(iii)(a)	After water cooling, no sorting	18	16-18	86	%≤30,000	80	%≤30,000	66	% ≤30,000
				0	%≥10,000 and ≤100,000	20	%≥10,000 and ≤100,000	50	% ≥10,000 and ≤100,000
				14	%>100,000	20	%>100,000	17	%>100,000
(iii)(b)	After air cooling, no sorting	17	16-18	100	%≤30,000	100	%≤30,000	85	% ≤30,000
				0	%≥10,000 and ≤100,000	0	%≥10,000 and ≤100,000	0	% ≥10,000 and ≤100,000
				0	%>100,000	0	%>100,000	15	%>100,000
(iii)(a)+	Water cooled, no sorting, immediately prior to landing after storage on deck	3	14-17	0	%≤30,000	0	%≤30,000	No Data	% ≤30,000
				100	%≥10,000 and ≤100,000	100	%≥10,000 and ≤100,000	No Data	% ≥10,000 and ≤100,000
				0	%>100,000	0	%>100,000	No Data	%>100,000
(iii)(b)+	Air cooled, no sorting, immediately prior to landing after storage on deck	4	14-17	100	%≤30,000	100	%≤30,000	100	% ≤30,000
				0	%≥10,000 and ≤100,000	0	%≥10,000 and ≤100,000	0	% ≥10,000 and ≤100,000
				0	%>100,000	0	%>100,000	0	%>100,000

Although TVC's were relatively low immediately after cooking and cooling, significant bacterial growth occurred on the water cooled samples during ambient storage. Detectable levels of *Staphylococcus* and *E.coli* also developed during storage.

The few surface swabs taken indicated that the surfaces of a shrimp box and an air cooling rack carried a high bacterial load, and that even after cleaning with chlorinated water the plastic mesh base of the air cooling rack remained contaminated.

The results of the work carried out by the Food Authority at Kings Lynn confirm the picture of high TVC's for the product ex-vessel increasing through the merchant's premises. In addition, high levels of *E.coli* (but not *Staphylococcus*) were found to have developed in subsequent storage at the merchant's premises and at a local shop where the product was sold.

The results of the work carried out by the Food Authority at Morecambe have shown some very high TVC's off these small inshore vessels plus high levels of *E.coli* which were associated with seawater cooled samples.

Residual amounts of benzoic acid were found to vary considerably but all were well below the proposed European standard of 8,000mg/kg. Closer examination of the residuals in conjunction with the TVC's for the samples concerned suggests a link in that high residuals tend to be associated with a reduction in TVC during the grading/treatment process whereas low residuals are associated with an increase, but the number of samples involved is relatively small.

4.4. Consideration of Results

Clearly there is a significant problem of high bacterial counts which is manifested largely by TVC's in excess of the European guideline requirements. The data suggests that this is a composite and cumulative result of the lack of hygiene at all stages - contamination coming from direct handling, surface contact and seawater contact - and growth occurring through lack of temperature control. The growth data, which is only for limited periods in relation to the total life of the product, suggests that contact with contaminated seawater inoculates the cooked shrimp with organisms that grow during subsequent storage. This is further manifest in the data from the Food Authorities where clearly unsatisfactory levels of *E.coli* are present after further storage and in the shrimp landed from highly contaminated waters. This suggests that there is **potential** risk as *E.coli* is a general indicator of faecal contamination which can include pathogens.

The control measures of cooking and benzoic acid, citric acid and salt treatment are somewhat variable in effect through lack of precision in operation.

5. Seawater Sterilisation Trials

5.1 Purpose

Initial water cooling of the cooked shrimp has significant practical advantages in comparison to air cooling on racks, particularly on the larger and mechanised vessels. For mechanised sorting an ample supply of water is, in any case, an essential part of the process. Water is also essential for general cleaning purposes. However, contact with untreated seawater from the inshore areas fished has been shown to be a source of microbiological contamination. The carriage of clean fresh water in tanks was not considered practicable for the quantities of water required by mechanised processing.

Therefore, it was considered that the development of a means of on-line sterilisation of sufficient quantities of seawater would be a key element in improving hygiene standards.

Trials were carried out to investigate ultra violet light (UV) sterilisation and a newer technology - ionisation. On-line chlorination was not considered suitable for small vessels. The trials also provided data on the level of contamination of the untreated seawater.

UV radiation is widely used for small-scale fresh and seawater sterilisation, and packaged units of standard design are readily available. However, for UV to be fully effective the water must be optically clear such that the radiation effectively penetrates the micro-organisms.

Ionisation is based on an electrical unit controlling the dispersion of silver and copper ions into the water which react with and kill micro-organisms. Potentially, ionisation can sterilise greater quantities of water per unit of cost and power required, and any residual ions have a continued effect similar to chlorination, but it is a developing technology and had not been tested in the UK for on-line seawater use.

5.2 Methodology

Trials were carried out on a Type II vessel from Kings Lynn between March and July 1993, firstly using the UV system for an extended period which covered operations in inner and outer areas of The Wash, and secondly using the ionisation system for a brief period of limited trials in an inner area after the equipment had become available. The sterilisation equipment was connected to the vessel's existing seawater supply system but was used only for water sterilisation trials and not for the shrimp processing operations (which would have required more powerful UV equipment). Seawater usage on the vessel was estimated at about 40L/min for the post-cook sorting and cooling machine and several times this for total water usage. Other vessels use more or less water, depending upon their size and degree of mechanisation.

The UV system consisted of a single tube 30 watt unit with the addition of two filters fitted upstream of the unit because of the expected problem of water clarity. These filters were a washable gauze filter of 50 microns followed by disposable cartridge filter of 5 microns. The nominal capacity of the UV unit for seawater was 15L/min and the total cost of UV and filters was about £500.

The ionisation system was an experimental unit consisting of a compact 10 watt electrode cell connected to a remote electronic control box with an ion emission indicator. The capacity of the unit for seawater was uncertain but expected to be about 110L/min for a cost of about £700.

During the trials, samples of untreated and treated seawater were taken at various flow rates through the sterilisers. The samples were collected in sterilised bottles, placed on ice in insulated boxes and taken within a period of 6-12 hrs to approved microbiological laboratories at Hull, Kings Lynn or Sheringham for analysis. Standard microbiological procedures were used to obtain TVC's, total coliforms, *E.coli* and occasionally *Salmonella* counts. Some samples of untreated seawater were taken also to the Public Analyst at Hull for measurement of UV transmittance (i.e. the effective clarity of the water).

During the UV trials, treated samples were taken with and without the filters in operation and in one case with the filters and not the UV in operation.

During the early trials when the UV equipment was in use, the treated and untreated samples were taken at the same water outlet point with the equipment in operation or not, and hence there was a short time delay between taking the samples. When the ionisation equipment was fitted, additional taps were provided to enable the simultaneous taking of treated and untreated samples.

The flow rates used during the UV trials were up to 15L/min, and for the ioniser trials were up to 40L/min. Lack of time curtailed the ioniser trials and investigation of higher flow rates.

5.3 Results

The results are summarised in Tables 5-7 overleaf. In these tables 'TC' refers to total coliforms, 'EC' to *Escherischia coli* and 'Sal' to *Salmonella sp.*

For the purpose of comparison, the European specification for drinking water requires an absence of pathogens such as *Salmonella*, and zero total coliforms in 100ml, and gives a guide level TVC (37°C incubation) of 10/ml (note TVC's are per ml whereas coliform counts are per 100ml). In reality the TVC's of drinking water can be somewhat higher than the guide level.

Table 5 - Results Of The UV Sterilisation Trials

Fishing Area	Flow Rate L/min	Filtration		Water Bacteriological Counts								% Kill		
				Pre Treatment				Post Treatment						
		With	Without	TVC/ ml	TC/ 100ml	EC/ 100ml	Sal	TVC/ ml	TC/ 100ml	EC/ 100ml	Sal	TVC/ ml	TC/ 100ml	EC/ 100ml
Outer	15	✓		1500	>200	0	Detected	680	130	28	None	55	>35	Increase
	15	✓		71	4	2	None	52	0	0	None	27	100	100
	15	✓		>2000	<50	<50	no data	30	<50	<50	no data	>98	no data	no data
	15	✓		91	20	3	no data	78	100	<1	no data	14	Increase	>66
	15		✓	530	120	52	no data	420	10	<1	no data	21	92	>98
	5	✓		500	<50	<50	no data	54	<50	<50	no data	89	no data	no data
	5	✓		26500	15	1	no data	580	7	4	no data	98	53	Increase
	5		✓	480	70	1	no data	120	20	<1	no data	74	71	no data
Inner	15	✓		412	24	24	None	224	24	12	None	48	0	50
	15	✓		10	1	0	None	18	1	0	None	Increase	0	no data
	15	✓		6240	0	0	None	92	0	0	None	99	no data	no data
	15	✓		540	6	5	None	133	0	0	None	75	100	100
	15	✓		200	100	<50	no data	125	<50	<50	no data	37	>50	no data
	15	✓		568	6500	6500	no data	43	200	200	no data	92	97	97
	15	✓		240	no data	no data	no data	78	no data	no data	no data	68	no data	no data
	15	✓		440	no data	no data	no data	280	no data	no data	no data	38	no data	no data
	15	✓		16300	9800	9800	no data	530	16900	2000	no data	97	Increase	79
	15		✓	180	170	51	no data	103	110	10	no data	43	35	80
	15		✓	73200	>20000	18000	no data	1030	>20000	16900	no data	99	no data	6
	5	✓		350	12500	5000	no data	11	<50	<50	no data	97	>99	>99
	5	✓		36400	24700	8200	no data	3700	7200	15800	no data	90	71	Increase
	5		✓	5000	7000	2500	no data	820	16000	4800	no data	84	Increase	Increase

Table 6 - Results of the Filtration Trial (No UV)

Fishing Area	Flow Rate L/min	Water Bacteriological Counts						% Kill		
		Pre filter			Post Filter					
		TVC/ml	TC/ 100ml	EC/ 100ml	TVC/ ml	TC/ 100ml	EC/ 100ml	TVC/ ml	TC/ 100ml	EC/ 100ml
Outer	10	26,000	30	2	310	24	<1	99	20	>50

Table 7 - Results Of the Ionisation Sterilisation Trials (Inner Fishing Area)

Flow Rate L/min	Water Bacteriological Counts						% Kill		
	Pre Treatment			Post Treatment					
	TVC/ml	TC/ 100ml	EC/ 100ml	TVC/ ml	TC/ 100ml	EC/ 100ml	TVC/ ml	TC/ 100ml	EC/ 100ml
40	2100	2300	266	88	31	<1	97	99	>99
	1380	3600	160	23	2	<1	98	>99	>99
	1200	1800	180	38	6	<1	97	>99	>99
	1100	1900	180	20	8	<1	98	>99	>99
	5500	3800	360	19	<1	<1	>99	>99	>99
	1760	900	200	128	1	<1	93	>99	>99
	880	600	120	86	1	<1	90	>99	>99
	770	500	40	40	<1	<1	95	>99	>99
	1020	520	70	78	<1	<1	92	>99	>99
	860	1300	100	78	<1	<1	91	>99	>99
28	530	2300	266	16	<1	<1	97	>99	>99
	1380	3600	160	13	<1	<1	99	>99	>99
	480	1800	180	11	<1	<1	98	>99	>99
	400	1900	180	10	<1	<1	98	>99	>99
	860	3800	360	31	<1	<1	96	>99	>99
20	1100	1460	80	37	<1	<1	97	>99	>99
	690	1200	120	25	<1	<1	96	>99	>99
	780	900	900	28	<1	<1	96	>99	>99
	680	300	300	43	<1	<1	94	>99	>99
	760	300	20	36	<1	<1	95	>99	>95

Extremely variable but often very high bacterial counts were found in the untreated seawater, particularly in samples from the inner areas where counts of total coliforms and *E.coli* were high in addition to the TVC's. *Salmonella* was detected in only one of 12 samples

The data on the effectiveness of the UV system is highly variable (even indicating increasing bacterial counts on some occasions). Part of that variability may result from considerable short-term variations in the cleanliness of the seawater being pumped aboard in these shallow areas, allied to the time delays in sampling pre and post treatment. Clearly the UV system caused a general reduction in contamination but on a number of occasions TVC's and counts of total coliforms and *E.coli* remained high after treatment, even at reduced flow rates. The variations tend to mask the effect of filtration but there is some indication that filtration contributed to the kill rate. The amount of material gathered by the filters confirmed this. On occasions the washable first filter required cleaning after only half an hour of use. The transmittance of the water varied between about 50 and 80% in the inner areas and about 75 and 90% in the outer areas.

The data on the ioniser system is far more consistent and shows low levels of contamination in all cases after treatment. The kill rate was from 91 to more than 99% for TVC's and typically was more than 99% for total coliforms and *E.coli*, and with no marked variation with flow rate over the relatively low flows (in relation to the expected capacity of the unit) investigated. Analysis of treated water samples by the suppliers of the ioniser equipment indicated residual levels of ions within normally accepted limits for potable water.

5.4 Consideration Of The Results

The high bacterial counts for the untreated seawater, particularly of the coliforms in the inner areas, make it unsuitable for contact with a cooked product. Because of the variability in contamination, even in outer areas, it would be wise to provide water treatment for operation in all areas.

These findings have implications for all businesses producing cooked at sea products, including mollusc products.

The performance of UV sterilisation cannot be considered satisfactory. The cause is most likely to be that contaminants are bound up with particulate matter suspended in these murky inshore waters and thus the UV is only partially effective. In practice the use of filters is likely to be problematic.

The less expensive, higher throughput ioniser technology appears, on the basis of this limited trial, to be far more effective and to provide treated water of a quality that is probably adequate. However, this is new technology and its performance at higher flow rates, over extended periods of time and in commercial circumstances is not yet proven.

6. Summary of Earlier Work on Icing at Sea and Cooking Ashore

6.1 Purpose

This work was initiated because of the fear that in the cramped and rudimentary conditions on much of the fleet, particularly on the older, smaller vessels, it would prove impractical to achieve the standards then being proposed for the hygiene legislation, particularly the microbiological specification. If it were to prove feasible to preserve the raw shrimp at sea by icing, and to transfer the critical cooking and post-cooking handling operations to more hygienic and controlled conditions ashore, then the fleet could continue working within the traditions of wet fish handling which, by and large would be acceptable within the new hygiene legislation. However, accepted belief was that these small shrimp spoilt too rapidly for this to be practicable.

The work also included some investigation of chilling the cooked product.

6.2 Methodology

The work was carried out largely in the Wash fishery but with some trials at Morecambe. Initial trials established a spoilage pattern and sensory assessment scoring systems for cooked brown and pink shrimp. Further trials investigated the effectiveness of direct and indirect icing and of fishroom refrigeration on the cooling of shrimp, and the quality and chilled storage life of shrimp cooked ashore after various delays in chilled conditions. Parallel trials carried out by MAFF, Torry Research Station (TRS), also investigated quality and storage life in association with bacterial counts. The trials were small-scale, handling only a few boxes of shrimp on commercial vessels.

The insulated boxes and covers previously developed by Seafish for iced stowage of finfish on small inshore vessels were used for holding the shrimp at sea.. For indirect icing the shrimp were placed in polythene bags of about 5kg capacity and surrounded by ice.

6.3 Results

The scope of this work was broad but the number and the scale of the trials were limited. Therefore the data given below should not be considered as absolute, but it is thought to give a valid representation of the relative merits of the various handling methods.

Separation of the significant by-catch of immature fish proved to be a problem during the trials. Thorough sorting at sea or adoption of the 'washing out' process after cooking ashore would be required.

Details of the sensory assessment systems developed are given in Appendix III. Based on experience with finfish, the cut-off point for consumer acceptability was taken to be when the score dropped below 3 and sour spoilage flavours developed.

Brown shrimp cooked at sea and then immediately iced was found to have a useful storage life, before the flavours became unacceptable, of about 8 days on ice. Typically during the trials, the useful iced storage life after landing was reduced by 2-3 days by the normal practice of ambient storage of the cooked product on the vessel.

Pink shrimp cooked at sea and then immediately iced was found to have a more variable useful storage life, from about 8 days on ice up to a maximum of 14 days in some cases. Typically the practice of ambient storage on the vessel reduced subsequent iced storage life by 1-2 days.

Direct icing resulted in chilling from typical ambients down to near 0°C within an hour. Depending upon the particular circumstances, indirect icing resulted in significantly longer cooling periods of 5-15 hours. However, direct icing would not be recommended for the cooked product, particularly pink shrimp, as it was found to harm its texture. Dependence on fishroom refrigeration alone, where the system is designed for maintenance of chill temperature rather than active chilling, resulted in cooling periods at least as long as indirect icing. Forced air chilling would, of course, be more rapid.

For brown shrimp, an iced delay of up to about 24 hours prior to cooking resulted in a cooked product of initial eating quality similar to that of the cooked at sea product, but with a useful iced storage life after cooking about 1-2 days longer than that cooked at sea. After a 48 hour iced delay prior to cooking the initial product eating quality was markedly inferior although the useful storage life remained comparable to that cooked at sea. For a 24 hour iced delay the tightness of curl of the product, taken by the trade as a measure of quality, was comparable to that cooked at sea but the colour of the product, also taken as a measure of quality, was somewhat faded.

For pink shrimp, any delay prior to cooking was found to result in a product of lower initial eating quality and reduced useful iced storage life. A 24 hour iced delay prior to cooking resulted in a reduction in useful iced storage life after cooking of about 4 days. The cooked product had also lost colour with delay prior to cooking.

TRS found that the salt content of the cooked at sea products varied considerably and that this affected their quality. They found also that the bacterial counts (TVC's) on the cooked at sea products were considerably higher and that significant bacterial growth occurred during storage.

6.4 Trade Reaction

Initial reaction to the work has not been positive. The findings for brown shrimp are counter to the long-held views of the fishermen. Significant change by much of the industry would be required to ice raw at sea and cook ashore. Current profit margins are low and ice may not be readily available and its use costs money. Approved facilities for cooking ashore are not widely available. Using the current commercial quality criteria for the Dutch trade the cooked ashore brown shrimp could be degraded because of the loss of colour, regardless of the product being of better keeping quality.

The yield of peeled meat from the cooked product is crucial to the trade. Very limited initial work suggests that yields from cooked ashore shrimp may be on a par to those from cooked at sea shrimp, but this remains a complex area to be investigated. There is a technical possibility that by controlling the cooking conditions ashore the mechanisation of peeling could be facilitated.

7. Discussion and Recommendations

7.1 The Legal Requirements

These requirements would not be considered excessive by those involved in the mainstream food industry producing cooked products ashore but they present a considerable challenge to much of the traditional inshore shrimp industry - both in terms of the physical changes in facilities, equipment and practices required and in the changes in the attitude and awareness of the people involved necessary to maintain the hygiene standards required of a cooked product.

The legal requirements for hygienic equipment for handling the cooked product, rapid chilling and clean water are relatively straightforward although they will necessitate significant investment in upgrading and, in the case of the water requirement, technical challenge.

The microbiological requirements for the cooked product are less straightforward and present greater difficulty. It is clear that *Salmonella* must be absent and that *Staphylococcus aureus,* thermotolerant coloiforms or *E.coli* must be within prescribed limits for peeled products, but clarification of the 'guideline' status of the requirements for indicator organisms (TVC's) and of the action to be taken if the guideline counts are exceeded is necessary as it is these counts that are generally exceeded by the producing industry. Common sense suggests that if TVC's are high on production of a chilled product there is an incipient problem of poor hygiene that needs to be rectified as it could manifest itself in more direct forms later in the life of that product following bacterial growth. The bacteriological data now available on the inshore shrimp industry tends to support that view. Because this is a relatively small-scale, traditional industry somewhat apart from the mainstream of food technology, clear guidance on these issues from the Food Authorities will be necessary to engender a coherent response on the part of the industry. The aforementioned investment in upgrading will go some way to satisfying the microbiological requirements but there remains a very considerable technical challenge for those cooking at sea.

The required bacteriological monitoring will also be a significant cost to be borne by the industry. For example, the cost of TVC's alone for the 5 samples to be taken on a single occasion is likely to be about £40 plus any collection or delivery charges. To enable errant producers to be identified and corrective action taken it would be necessary for the production of each vessel cooking at sea to be monitored, although it is assumed that the taking of samples could be based at the merchant's premises. Again it will be necessary for the Food Authorities to give guidance on the required frequency and methodology of sampling and, bearing in mind the lack of technical resource within the industry, possibly to carry out the necessary sampling and analysis on behalf of the industry. The latter is carried out in Holland and the producers are charged for the service. The frequency of sampling required there varies depending upon the Authorities' perception of the risk presented by each producer and particularly upon their 'track record' of the results of previous analysis. However, our Food Authorities may not have the resources to do this work and the industry may have to seek equivalent service from approved laboratories.

Theoretically the parts of the industry involved only in small-scale trade in the UK direct to retailers or the final consumer, or only supplying raw material for the potted product, need not comply with the legal requirements but it may be unwise to assume that small/local trade in a contaminated product would be permitted unhindered by the Food Authorities. Further legislation under the Hygiene of Foodstuffs Directive is likely to apply to that trade.

Where practical means of improvement to product safety and quality are identified, Seafish would recommend that it is in the interest of all industry to adopt such improvements regardless of the particular legal requirements.

7.2 The Microbiological Problem

Clearly there is a problem of bacterial counts generally exceeding the European guidelines for TVC's and in some cases reaching high levels for the faecal contamination indicator *E.coli.* The causes are seen to be a general lack of hygiene at all stages and particularly through contact with seawater in the contaminated inshore areas where the fleet operates.

The microbiological data from all sources is highly variable but has the same underlying features of TVC's increasing with handling, surface and seawater contact, followed by bacterial growth, particularly after seawater contact, and with indications that ultimately organisms such as *E.coli* which heavily contaminate the inner fishing areas, can manifest themselves on the product.

The primary control measure of cooking is imprecise but is seen to be largely effective although negated by the subsequent lack of hygiene and of the necessary secondary control by chilling. Possible further control by benzoic acid and similar chemical treatment is shown also to be imprecise but there are indications that potentially it could be microbiologically useful if heavily applied at the high residual levels permitted in the proposed European specification.

7.3 Improving Hygiene Standards For The Cooked At Sea Product

A comprehensive approach to improvement is required at all stages, including facilities and equipment, practices and the training of the people involved. Different approaches may be required for the different types of vessel and circumstances of operation, depending largely upon scale of operation and degree of mechanisation.

The provision of ample supplies of clean water is considered a pre-requisite for improvement, not only for product cooling but also it is essential for the mechanised handling operations and for the general maintenance of cleanliness. Based on the limited trials carried out, the ioniser sterilisation system would appear to be a practical means of providing that water, but this is new technology and its effectiveness is not proven in full-scale, arduous operation.

To comply with the legal requirements for equipment, the industry must upgrade much of its hardware for handling the cooked product from wood and rusty steel to hygienic designs in stainless steel and food grade plastics. It is not merely the construction materials that need to be considered but also the equipment and handling system design, such that it is easy to keep the facilities clean and that the cooked product does not come into contact with dirty surfaces. There should not be inaccessible places where shrimp and other materials can lodge and defy cleaning. Particular care needs to be taken over transfer of the cooked product between the stages of operation so that the product is not dropped on an unclean surface such as the deck or an unwashed box. Essential in this is the separation of clean, cooked product and the unclean raw material. The same facilities, e.g. boxes and sorting equipment, should not be used for both raw and cooked product if there is the possibility of cross-contamination.

Direct handling of the cooked product should be minimised. On small, un-mechanised vessels this can be achieved by thorough sorting prior to cooking so that a second sort of the cooked product is not necessary. The development of more selective fishing gear would also reduce the requirement for sorting.

There is scope for greater control over the cooking operation. The continuation of batch cooking, rather than the more controlled continuous cooking, is probably inevitable for the bulk of the fleet because of the small scale of operation, but the size of each batch of shrimp cooked needs to be controlled in relation to the capacity of the cooker and the cooking time in order that thorough cooking is guaranteed.

Water cooling of the cooked product has distinct practical advantages over air cooling, particularly on large, short-handed, mechanised vessels, and if given a supply of clean water may not present greater risk of contamination than air cooling on exposed racks. On small vessels with thorough initial sorting, air drying on hygienically designed and clean racks without further handling may remain viable.

To comply with the legal requirements for temperature control, the initial cooling to ambient must be followed, rapidly, by chilling. Indirect icing in insulated containers, with the product held in polythene bags, is the obvious solution for much of the fleet. Placing the product in polythene bags immediately after cooling also provides the necessary protection against contamination. Where vessels already have holds unused for shrimp stowage it may well be effective to line parts of those holds to provide hygienic, insulated conditions. For those few vessels with effective fishroom chilling it may suffice to hold the shrimp loose in shallow layers in perforated boxes or trays provided there is an adequate circulation of chilled air. However, if the cooked shrimp are held loose in re-usable containers then great care must be taken to ensure that those containers are clean when used, that they are thoroughly cleaned after use and are returned to the vessel and stored prior to use in protected, hygienic conditions. Similarly, disposable polythene bags have to be stored in hygienic conditions but this presents less of a problem.

Where small vessels are at sea for only a short period and the product is then rapidly chilled in premises ashore within a few hours of cooking at sea then this may prove adequate, although it is less desirable than immediate chilling at sea and could become a problem if there is any delay in landing or ashore.

The methods of chilling and containment used at sea have implications for subsequent landing and handling ashore. The necessary protection against contamination must be continued as must chilling during transport and storage. Shrimp held in sealed polythene bags, placed in boxes and covered in ice can be landed, transported and stored in less than ideal conditions and carry their protection and chilling with them. Whereas more care must be taken to prevent the contamination of loose shrimp in open boxes or trays, particularly during landing, and they must be transported and stored in fully protected and refrigerated conditions. The latter would appear suitable only for operation into hygienic port facilities, preferably when landing direct to a merchants premises. At no stage at sea, on landing or at the merchants premises should the cooked product be left lying around open and unprotected against contamination. The product should be delivered into, not outside of, the enclosed merchants premises.

Within the merchants premises there is scope for improved hygiene and greater control of benzoic acid type chemical treatment. The latter would require technical development but there may well be considerable bactericidal benefit if the market will accept high residual levels of preservatives. The Dutch market does appear to accept these residuals. However, this route is not recommended as a general solution for reducing the bacterial counts on poorly handled and hence poor quality products.

Whatever the facilities and methods used, there must be a general improvement in cleanliness throughout the industry and in the discipline of protecting this product from contamination. The current lack of hygiene stems largely from ignorance of the requirements for handling cooked products and of the risks if not carefully handled. The training of the workforce in basic food hygiene is considered essential. A change in attitude from the traditions of the wet fish industry is required.

7.4 The Way Forward

Clearly there is no quick and easy fix for this industry to comply in full with the legal requirements and with the hygiene standards normally expected for handling cooked products. On the other hand, despite the general levels of contamination resulting from lack of hygiene this traditional industry does not appear to have damaged public health and although not a large industry it remains a useful employer and earner of export income. Immediate measures can be taken by the industry to improve general hygiene but longer term development and investment in facilities is required also. The eating and keeping qualities of the product should improve as well as its safety as a direct result of these measures.

The collaborative participation of all sides (industry, Seafish, the Food Authorities and the Ministries) would facilitate improvement. The leading commercial elements of the industry recognise the need for improvement and have expressed willingness both to adopt immediate measures of a practical nature and to invest in the longer term requirements of upgrading. In these circumstances it would seem appropriate to allow the industry a period of time to develop and implement the types of upgrading now identified in this report.

Significant additional cost will be involved in the necessary upgrading, both initial investment and higher operating and monitoring costs. Bearing in mind the largely small-scale, low investment and traditional nature of the industry, and the economic pressures it is under, there is likely to be a loss from the industry of those who cannot or will choose not to bear such cost. This will particularly concern the marginal, part-time and other small-scale operators who are likely, therefore, to resist change.

To satisfy the microbiological requirements whilst continuing to cook at sea in exposed and often very harsh conditions on small vessels with limited facilities, remains a technical challenge. The improvements identified may well satisfy the requirements when they are applied in total but this remains to be proven, particularly in respect of the crucial supply of clean water, and it is not yet known what TVC's on the product are, in reality, achievable by good practice. Bearing in mind the nature of this challenge and the lack of food technology expertise in this industry, there is a need to guide the industry through this technical development and upgrading.

It is recommended that 2 or 3 vesels representative of different types are selected and are upgraded with water sterilisation and improved handling equipment and methods, and are monitored in commercial operation. The experience gained from this would provide a model for the longer term upgrading and the operation of the fleet, and a practical basis for standards which can then be enforced by the Food Authorities. Handling equipment suitable for this work may well be obtainable from Holland but an immediate problem to be faced by the industry is the provision of ice supplies.

To carry out such a development programme it is envisaged that industry would have to bear the cost of upgrading the trials vessels and that the Food Authorities would assist in the monitoring. Seafish has carried out the investigative work to date utilising the limited levy funds that can be allocated, but to provide the further technical input necessary for upgrading development and establishing standards will seek additional funds from the Ministries.

The low technology option for the fishing fleet of icing the raw product at sea for subsequent cooking ashore remains open. Despite the historic reservations of the trade this option can produce a brown shrimp product of good eating quality and better keeping quality than the current cooked at sea product. When the costs of upgrading for continuance of cooking at sea are considered, the option of icing raw at sea may become more attractive for small-scale and part-time operations and for those producing a peeled product. However, the provision of adequate cooking and handling facilities ashore is still required. The larger merchants or possibly cooperatives could provide such facilities (and ice supply). In the longer term there remains a possibility that research directed at combining shore based cooking and mechanised peeling could provide the technical breakthrough necessary to utilise our inshore shrimp resource for the higher valued frozen shrimp market.

Work carried out by others, with MAFF funding assistance, has been investigating the use of separator trawls in the shrimp fishery to reduce the by-catch. Should this be successful and be implemented by the Sea Fisheries Committees it could make a significant contribution to the hygiene issue by reducing the need for sorting the product.

Regardless of the final details of longer term technical development and upgrading, there is much simple hygiene improvement that can be started immediately by the industry. To facilitate this it is proposed that collaboratively with representations of the industry, the Food Authorities and the Ministries, Seafish drafts a brief initial guide to basic good hygiene practice that specifically addresses the needs of the inshore shrimp industry. This document should briefly summarise the fundamentals of good hygiene practice and make recommendations for practical measures that can be adopted in the short term. It is proposed that a working group is established forthwith to produce this document.

It is recommended also that all persons involved in the handling of cooked shrimp undergo training for an officially recognised basic food hygiene certificate (about a 6 hour course), preferably on a course designed to cater for the specific needs of the industry. It is recommended, and in the longer run it is likely, that this is made a legal requirement but in the meantime the Food Authorities can encourage the uptake of training and the leading shrimp merchants can require it of their suppliers (which would also help demonstrate the merchant's own requirement for 'due diligence' under the Food Safety Act). This hygiene training can be provided by local colleges, a Seafish Open Learning Module, Food Authorities and by other qualified persons. The Seafish Open Learning Module is designed for the needs of the fish industry. The local Group Training Associations, in this case the Eastern Sea Fish Industry Training Association and the North West Sea Fish Industry Training Association, and the Local Training and Enterprise Councils can assist in the delivery of this training.

In the longer run it is recommended that the results of the upgrading development programme are incorporated into guidance and training for the industry.

Appendices

Appendix I	Excerpts from the Food Safety Legislation associated with Producing Cooked Shrimp at Sea.
Appendix II	Photographs of typical vessels and their equipment.
Appendix III	Sensory Assessment Scoring Systems Developed for Cooked Shrimp.

Appendix I

Excerpts from the Food Safety Legislation Associated with Producing Cooked Shrimp at Sea

The Food Safety (Fishery Products) Regulations 1992

Registration of fishing vessels on which shrimps or molluscs are processed by cooking

12-(1) A person operating a fishing vessel on board which shrimps or molluscs are, for the purpose of a food business, processed by cooking shall, unless such processing is to be supplemented subsequently by cooking, comply with paragraphs (2) to (4).
(2) The person operating the fishing vessel shall-
(a) prior to engaging for the first time in the business of cooking, notifying in writing the food authority for the area in which the fishing vessel is based of his intention to do so, and shall at the same time supply the information specified in paragraph (3); and
(b) subsequently, similarly notify the food authority of any changes to the information originally supplied.
(3) The information referred to in paragraph (2)(a) is-
(a) the name of the vessel;
(b) the usual place of landing of the fishery products;
(c) the name and address of the owner of the vessel.
(4) Any cooking on board of either shrimps or molluscs, or both, shall be in accordance with the requirements of point 5 of section I of Chapter III of the Annex to, and point 7 of Chapter IV of the Annex to, the Council Directive, as set out in the Schedule to the Food Safety (Fishery Products) (Derogations) Regulations 1992.
(5) Each food authority shall maintain a register of all information supplied pursuant to paragraphs (2)(a) and (3).

Sales by fishermen of small quantities of fishery products

14.-(1) A fisherman may sell for human consumption in any year, within the United Kingdom, to retailers or final consumers a small quantity of fishery products which he has caught.
(2) For the purpose of this regulation a small quantity of fishery products means a total amount not exceeding 25 tonnes, comprising any species, but within such total the amount of any of the species listed in column (a) which are dead shall not exceed the amount for that species listed in the column (b)-

Column (a) Species	Column (b) Maximum amount
Oysters	5.0 tonnes
King Scallops	5.0 tonnes
Queen Scallops	10.0 tonnes
Mussels	20.0 tonnes
Marine Gastropods	20.0 tonnes
Other Bivalve Molluscs	10.0 tonnes

Schedule 4 - Storage Transport Requirements

1. Fishery products must, during storage and transport, be kept at the temperatures laid down in these Regulations, and in particular:-
(a) fresh or thawed fishery products and cooked and chilled crustacean and molluscan shellfish products must be kept at a temperature approaching that of melting ice;
3. Products may not be stored or transported with other products which may contaminate them or affect their hygiene, unless they are packaged in such a way as to provide satisfactory protection.
4. Vehicles used for the transport of fishery products must be constructed and equipped in such a way that the temperatures laid down in these Regulations can be maintained throughout the period of transport. If ice is used to chill the fishery products, adequate drainage must be provided in order to ensure that water from melted ice does not stay in contact with the products. The inside surfaces of the means of transport must be finished in such a way that they do not adversely affect the fishery products. They must be smooth and easy to clean and disinfect.
5. Means of transport used for fishery products may not be used for transporting other products likely to impair or contaminate fishery products, except where the fishery products can be safeguarded against contamination by such transport being thoroughly cleaned and disinfected immediately prior to each occasion it is used for fishery products.
6. Fishery products may not be transported in a vehicle or container which is not clean and or which should have been disinfected.

The Food Safety (Fishery Products) (Derogations) Regulations 1992

Schedule

Annex Chapter III - Section I

5. instruments and working equipment such as cutting tables, containers, conveyor belts and knives made of corrosion-resistant materials, easy to clean and disinfect;

Annex Chapter IV

7. Cooked crustacean and molluscan shellfish products

Crustaceans and molluscan shellfish must be cooked as follows:
(a) any cooking must be followed by rapid cooling. Water used for this purpose must be drinking water or clean seawater. If no other method of preservation is used, cooling must continue until the temperature approaching that of melting ice is reached;

(b) shelling or shucking must be carried out under hygienic conditions avoiding the contamination of the product. Where such operations are done by hand, workers must pay particular attention to the washing of their hands and all working surfaces must be cleaned thoroughly. If machines are used, they must be cleaned at frequent intervals and disinfected after each working day.
After shelling or shucking, cooked products must immediately be frozen or kept chilled at a temperature which will preclude the growth of pathogens, and be stored in appropriate premises;
(c) every manufacturer must carry out micro-biological checks on his production at regular intervals, complying with the standards to be fixed in accordance with Chapter V, Section 4 of the Annex.

Commission Decision (93/51/EEC). The Microbiological Criteria Applicable to the Production of Cooked Crustaceans and Molluscan Shellfish

Article 2
The microbiological standards shall be checked by the manufacturer during the manufacturing process and before the crustacean and molluscan shellfish products cooked in the processing plant approved in accordance with Article 7 of Directive 91/493/EEC are placed on the market.

Article 3
1. Sampling programmes shall be established by the managerial staff of the processing plant in relation to the nature of the products (whole, shelled or shucked), the temperature and time of cooking and the risk evaluation, and shall meet the requirements of Article 6 of Directive 91/493/EEC.
2. The programmes referred to in a paragraph 1 shall contain, in the event of failure to comply with the standards laid down under headings 1 and 2 of the Annex hereto, an undertaking:
- to notify the competent authorities of the findings made and the action taken with regard to unsatisfactory batches, as well as the measure provided for in the second indent below.
- to review the methods of supervising and checking the critical points so as to identify the contamination source, and to carry out analyses more frequently.
- not to market for human consumption batches found to be unsatisfactory on account of the discovery of pathogens or where the M value for *Staphylococcus* provided for under heading 2 of the Annex is exceeded.

ANNEX

1. Pathogens

Type of pathogen	Standard
Salmonella spp.	Absent in 25 g n = 5 c = 0

In addition, pathogens and toxins thereof which are to be sought according to the risk evaluation, must not be present in quantities such as to affect the health of consumers.

2. Organismus indicating poor hygiene (shelled or shucked products)

Type of organism	Standard (per g)
Staphylococcus aureus	m = 100 M = 1 000 n = 5 c = 2
either: Thermotolerant coliform (44 °C on solid medium)	m = 10 M = 100 n = 5 c = 2
or: *Escherichia coli* (on solid medium)	m = 10 M = 100 n = 5 c = 1

Where parameters n, m, M and c are defined as follows:

n = number of units comprising the sample,

m = limit below which all results are considered satisfactory,

M = acceptability limit beyond which the results are considered unsatisfactory,

c = number of sampling units giving bacterial counts of between m and M.

The quality of a batch is considered to be:

(a) satisfactory where all the values observed are 3m or less;

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The quality of a batch is considered to be unsatisfactory:

— in all cases where the values are above M,

— where c/n is greater than 2/5.

3. Indicator organisms (Guidelines)

Type of organism	Standard (per g)
Mesophilic aerobic bacteria (30 °C)	
(a) Whole products	m = 10 000 M = 100 000 n = 5 c = 2
(b) Shelled or shucked products with the exception of crabmeat	m = 50 000 M = 500 000 n = 5 c = 2
(c) Crabmeat	m = 100 000 M = 1 000 000 n = 5 c = 2

These guidelines are to help manufacturers decide whether their plants are operating satisfactorily and to assist them in implementing the production monitoring procedures.

Appendix II

Photographs of typical vessels and their equipment

Figure 1 - Class I type vessel

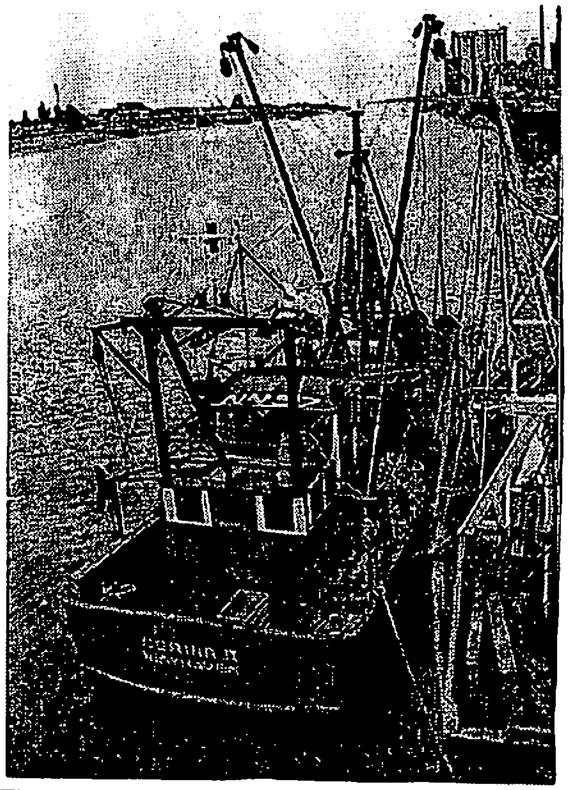


Figure 2 - Class II type vessel

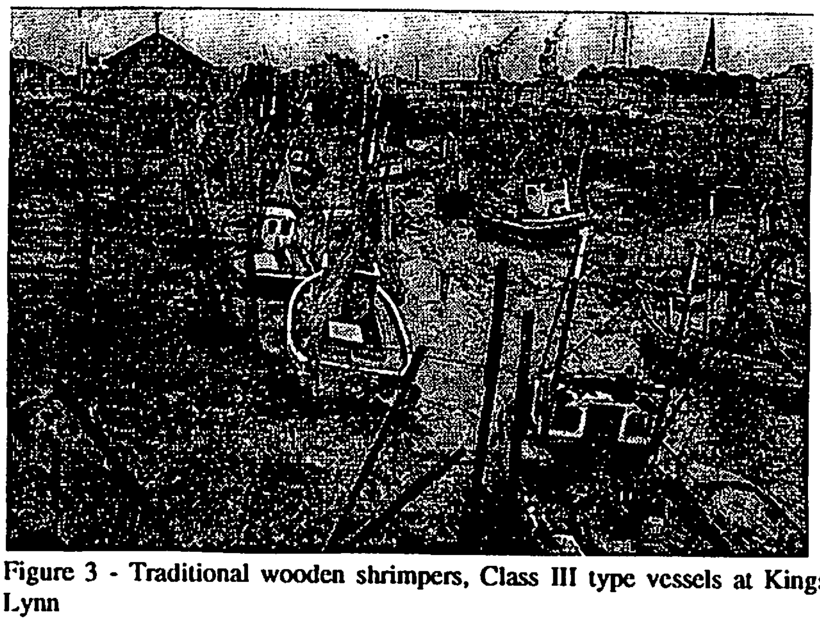


Figure 3 - Traditional wooden shrimpers, Class III type vessels at Kings Lynn

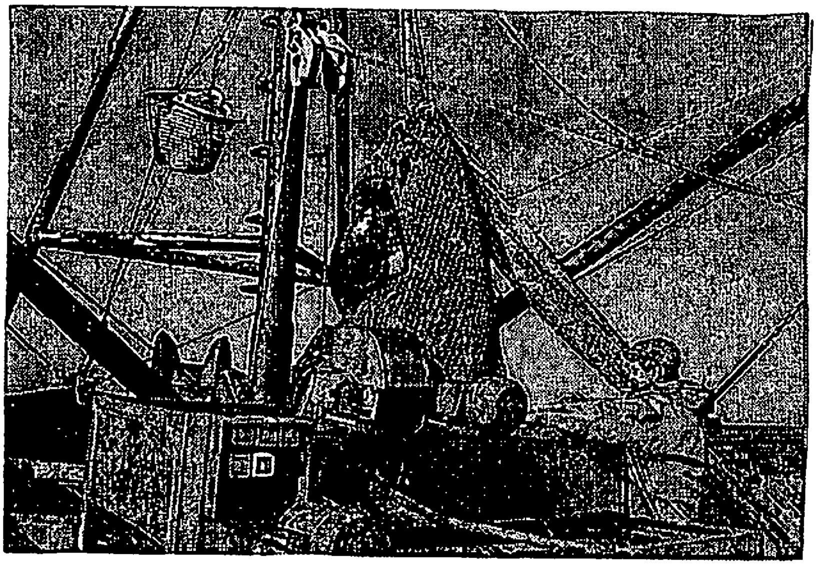


Figure 4 - Boarding the catch into a hopper on a Class II type vessel

Figure 5 -Boarding catch on a Class III type vessel

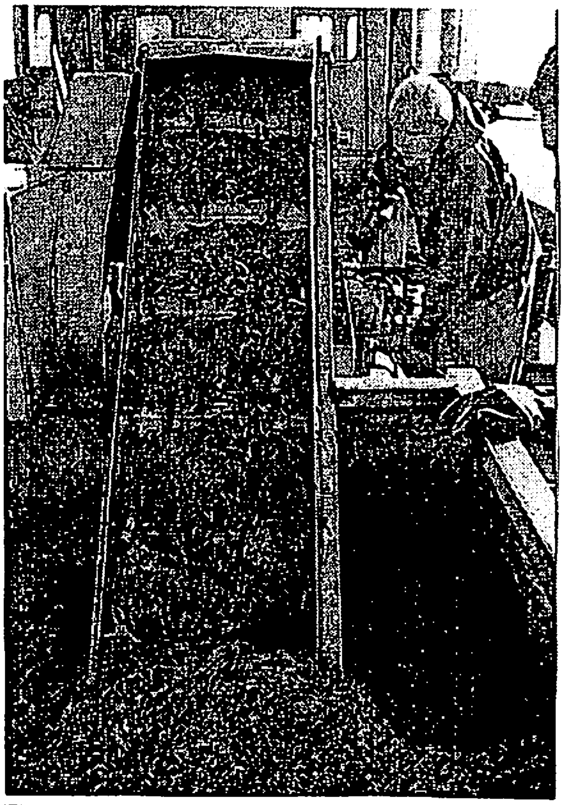


Figure 6 - Catch conveyed from hopper on a Class I type vessel

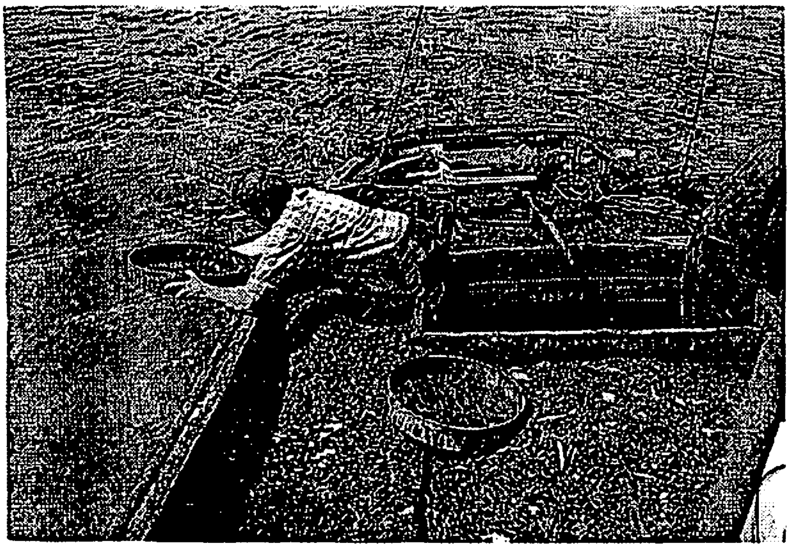


Figure 7 - Pre-cook sorting on Class III (above) and Class II (below) type vessels

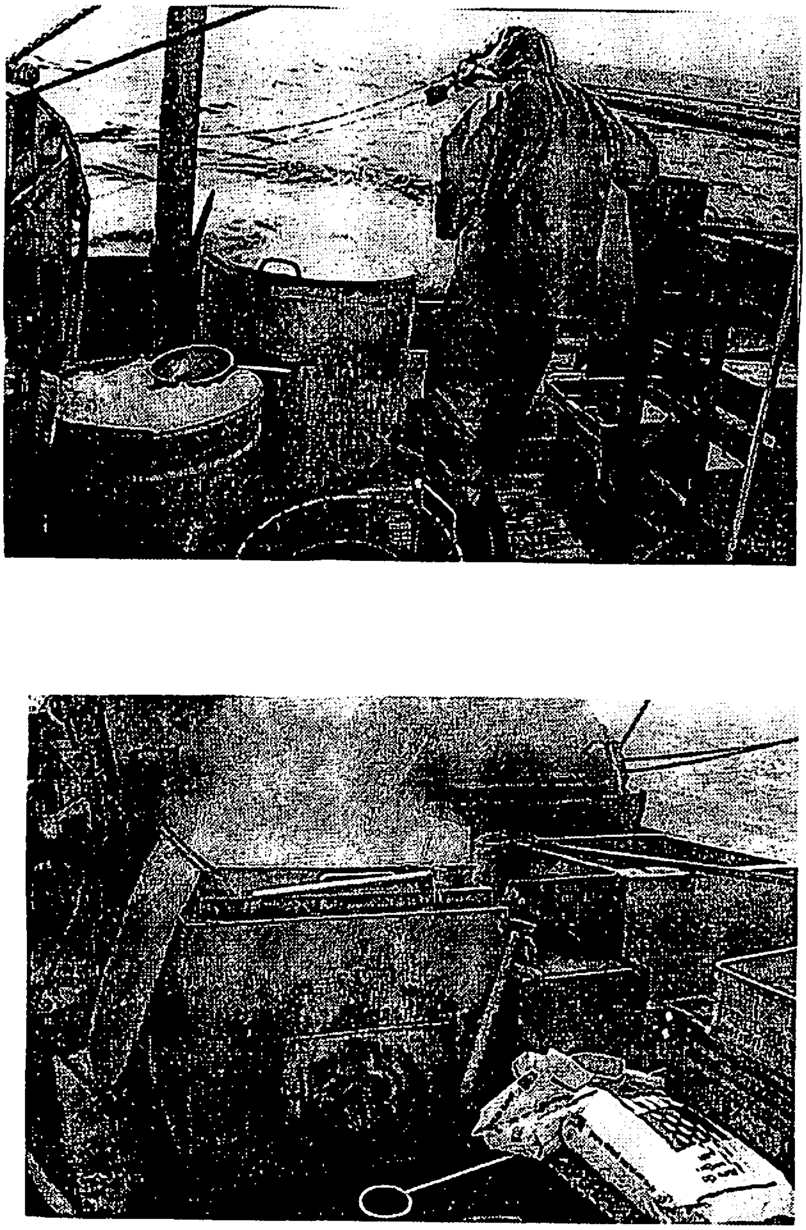


Figure 8 - Shrimp boilers on Class II type vessels

Figure 9 - Post Cook sorting by riddle on Class II type vessels

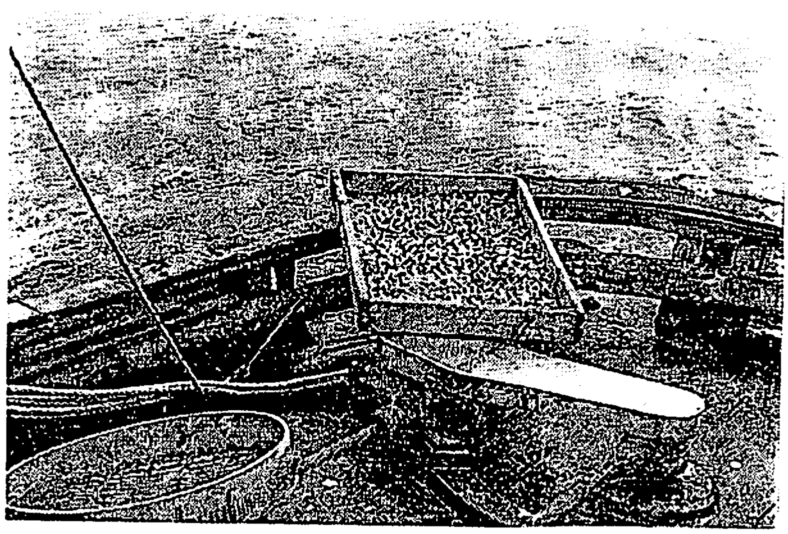
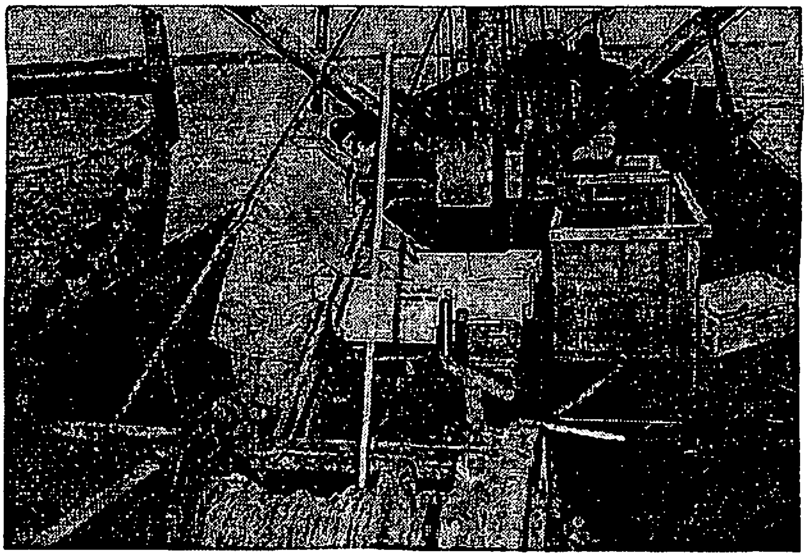


Figure 10 - Air cooling on racks on a Class III type vessel

Figure 11 - Final hand picking (after cooking) of fish particles, crabs etc from shrimps



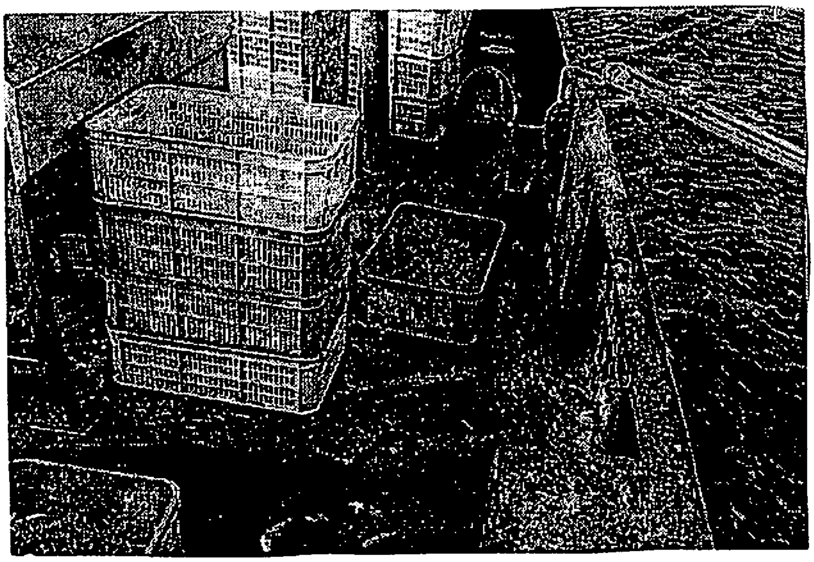


Figure 12 - Box and bag storage of shrimps on deck of Class II vessels

Appendix III

Sensory Assessment Scoring Systems Developed for Cooked Shrimp

System for brown shrimp (*Crangon crangon*) from the Wash cooked in brine then held in chilled storage:

Score	General Appearance	Odours	Flavours of Meat	Texture of Meat
5	Shiny and glossy with pink hues on shell body	Empty crabshells Marine Seaspray Creamy Cardboard Woody Boiled potatoes	Milky Sweet Characteristic shrimp	Chewy firm mouth feel
4	Loss of gloss but retaining pink hues	Seaweed faint ammonia sweaty		
3	Loss of pink hues Yellow colours appearing Yellow legs	Ammoniacal Sulphides Rotting vegetables Compost Rotten seaweed	No sweetness Slight sour Burnt milk Meat Fat Cottage cheese	Gritty feel to shell on peeling. Sticky meats. Very chewy Dry mouth feel
2	Dull loss of colours Slight slime			
1	Green and yellow colours	Faecal strong ammoniacal compost	Mature cheese Strong Sickly aftertaste	

System for pink shrimp (*Pandalus montagui*) from the Wash cooked in brine then held in chilled storage:

Score	General Appearance	Odours	Flavours of Meat	Texture of Meat
5	Distinct colours glossy Shiny pink bright	Milky Sweet Ice-cream Marine	Sweet milky Creamy Condensed milk Characteristic shrimp	Chewy Meaty mouth feel
4	Orange/red colours Pink colours Loss of gloss shine	Marine wet Pebbles Wet pastry	Loss of characteristics Little sweetness Raw pastry/lard	
3		Weak ammonia Dried old seaweed Wood shavings Fatty Meat Burnt milk	No sweetness Musty Muddy Cardboard Soap Spearmint Liquorice Aftertaste No characteristic shrimp	
2	Loss of bright colours Yellow colours	Compost Manure Mousey Burnt milk Ammonia Faecal Chlorine	Green vegetables, Soap Spearmint Liquorice Aftertaste	Gritty feel to shell on peeling Sticky feel to meats Very chewy Greasy mouthfeel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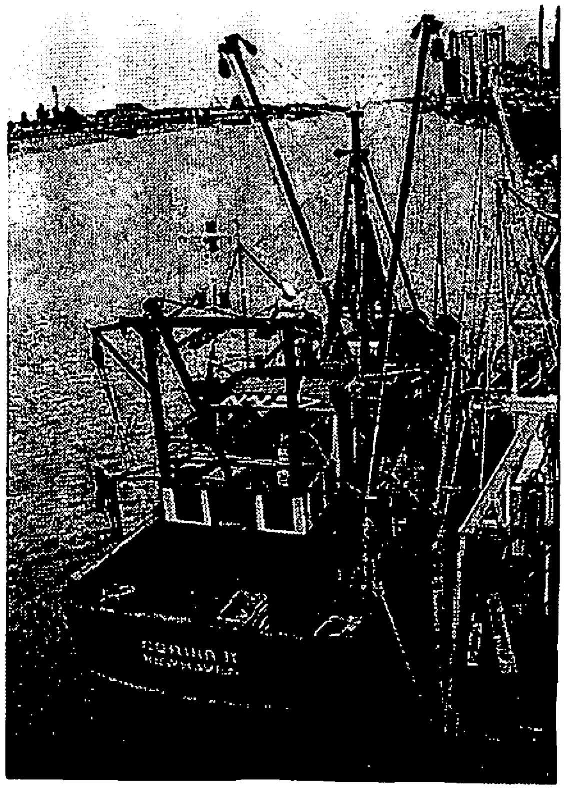
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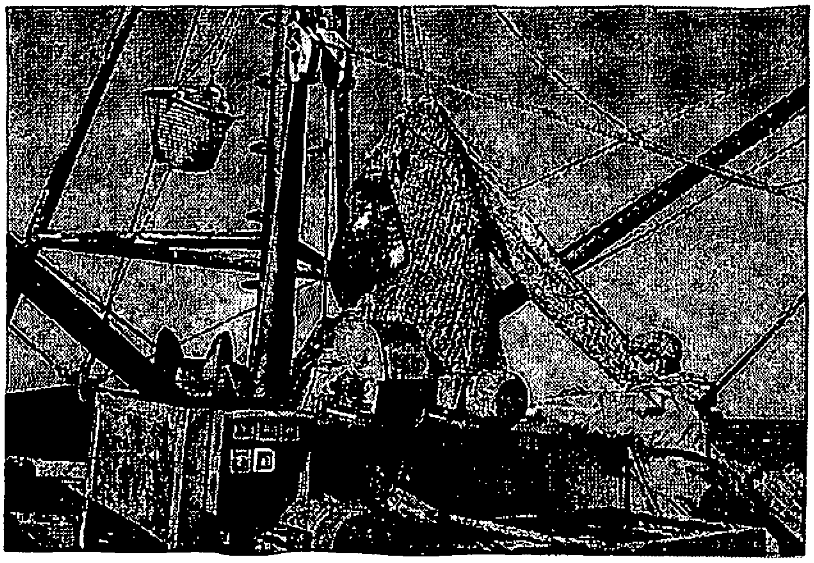

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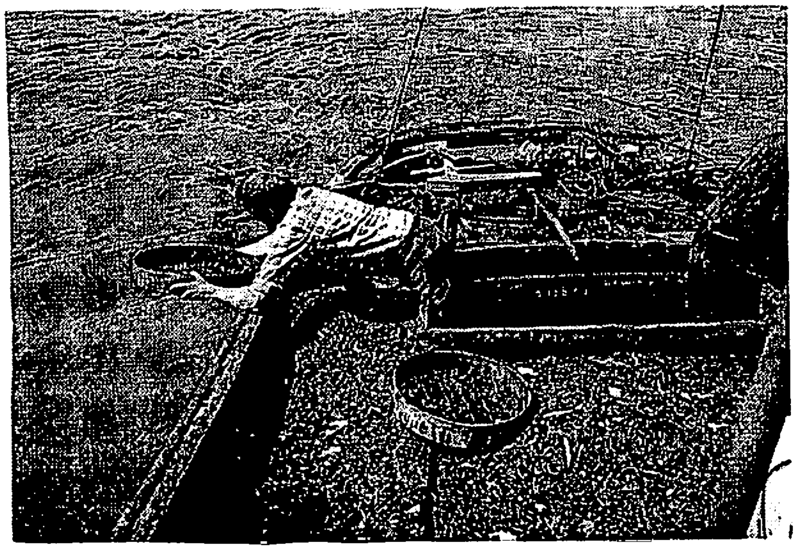

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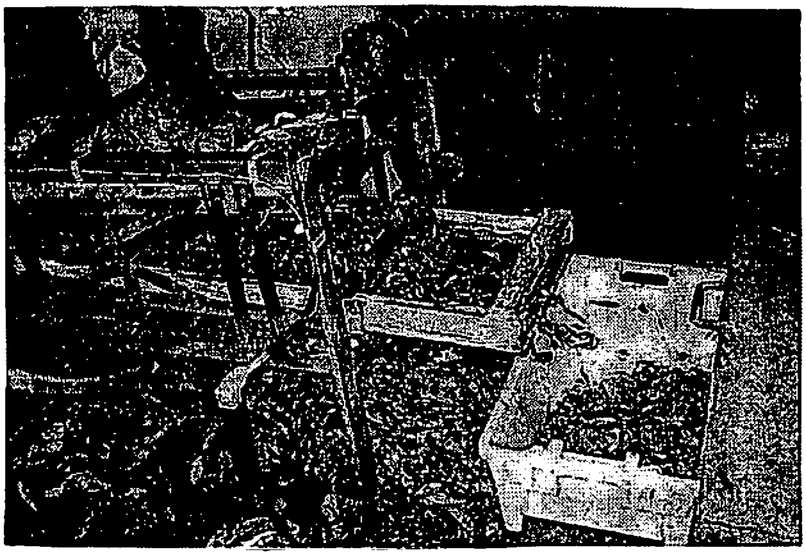

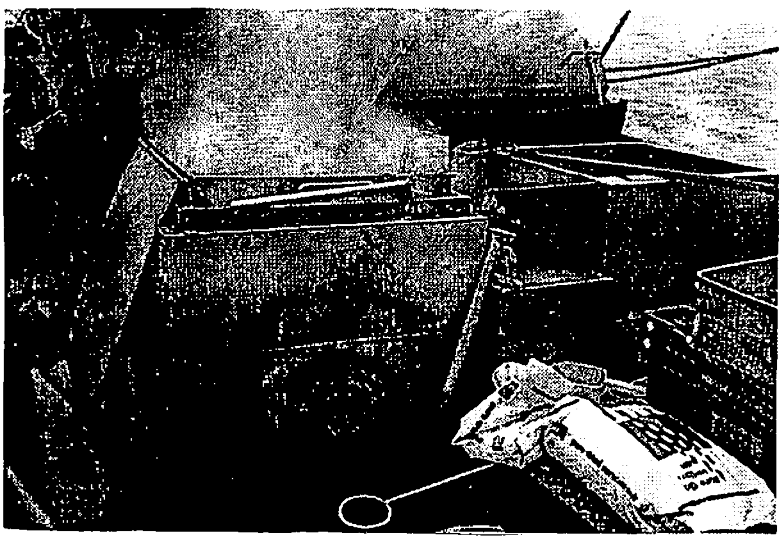

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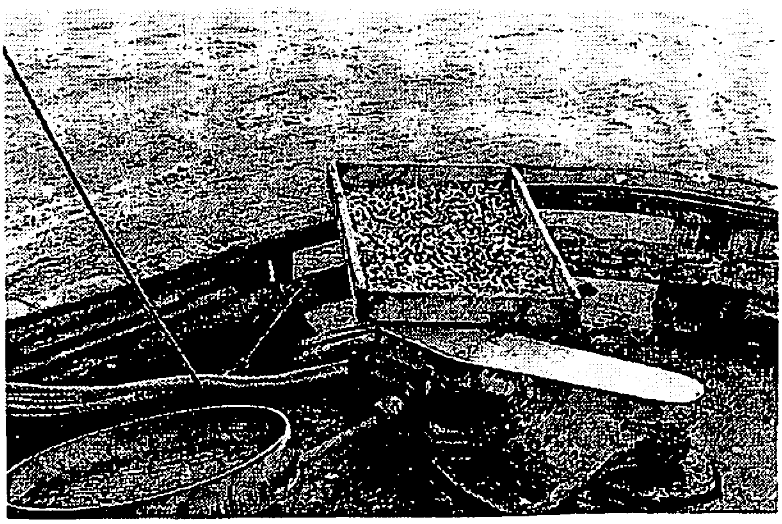

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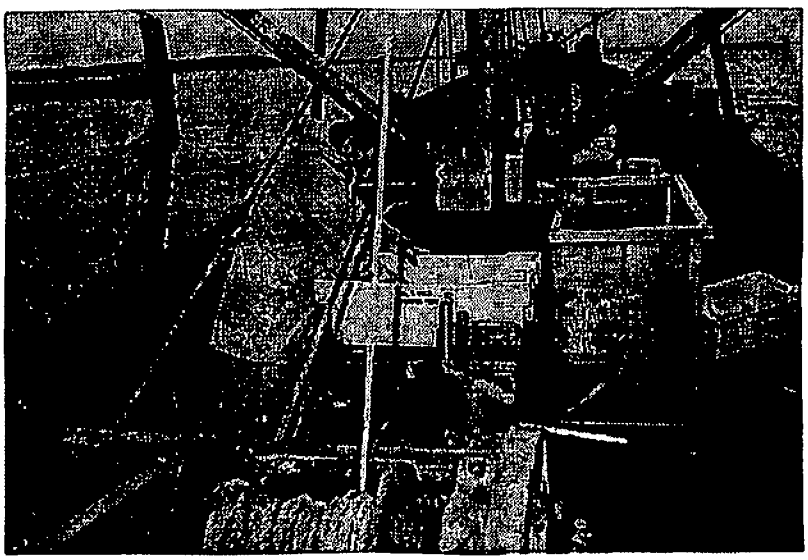

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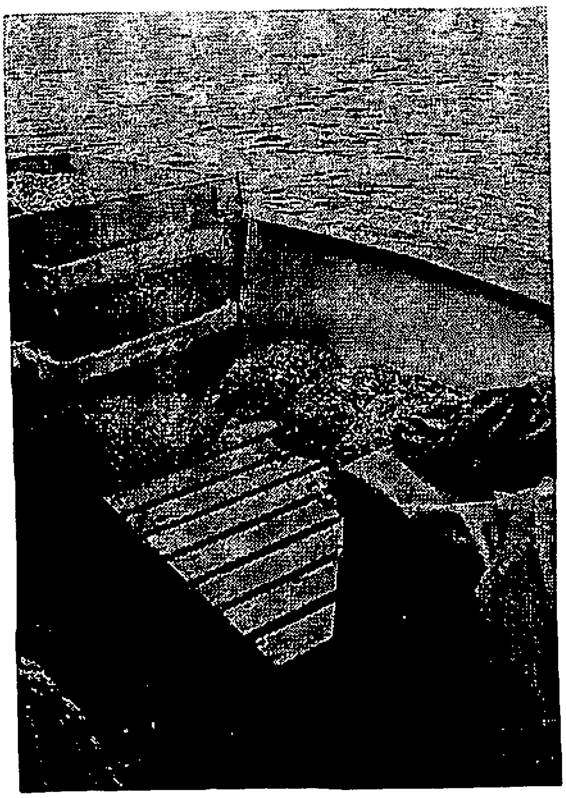

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