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MARITIME & COASTGUARD AGENCY

Research Project 530
Simplified Presentation of FV Stability Information – Phase 1

Final Report

EXECUTIVE SUMMARY

This report describes phase 1 of a research project, commissioned by the MCA, to advise them of methods of presenting simplified information to fishermen regarding their stability and safety. The remit of phase 1 was to recommend methods considered to be suitable for development in phase 2 of the project. The work was conducted by the Wolfson Unit between April and July 2004.

The work programme comprised a literature search, and consultation with various organisations and individuals associated with the fishing industry or engaged in stability research related to it.

Worldwide statistics reveal fishing vessels to be particularly vulnerable to stability incidents, and fatality rates to be high, so many national and international organisations have commissioned studies into the subject. Many of these have identified poor understanding of stability information by fishermen as a contributory factor in the low safety record. It is surprising, therefore, that very few examples were found of simplified methods of presentation of stability information.

Those that were found were considered in terms of their clarity and capacity to address the potential hazards. Methods of visual presentation of stability data were assessed and, additionally, methods of monitoring the vessel condition and fishing operation were considered.

It was concluded that stability guidance, in the form of a single page notice or poster, should be developed to bring the subject to the attention of the whole crew. It should be designed to emphasise the fact that stability is a variable characteristic of the vessel, and that it is within their control to maintain it at a satisfactory level. Similar notices have been developed in other countries and could be developed to address the hazards associated with the various types of vessel and fishing methods found in the UK fisheries.

The presentation should be used in conjunction with on board measurement systems to enable the fishermen to monitor their level of safety. Some monitoring systems have been developed in other countries and adopted by fishing fleets, and so it is anticipated that minimal further development would be required prior to implementation on appropriate vessels.

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1 INTRODUCTION

This report describes phase 1 of a research project to advise the MCA of methods that might be developed to present fishermen with simplified stability information. The contract, Ref. MSA 10/9/195, was issued on 2nd April 2004. The work programme followed that outlined in Wolfson Unit proposal ref. 2657/BD dated 5th February 2004. It was anticipated that phase 2 would entail further development of those methods as required.

2 BACKGROUND

The MCA has agreed with fishing industry representatives at the Fishing Industry Safety Review Group (FISG) Stability Review Group that the information contained within the MCA's recommended format for fishing vessel freeboard and stability information needs to be presented in a simplified format for ease of understanding and use.

The UK fishing fleet includes a wide range of vessel types and fishing methods. This research will be focussed on vessels over 12m registered length, for which stability booklets already exist.

3 OBJECTIVES

The following objectives were detailed in the MCA project specification.

To develop an easy to use format for the presentation of stability information contained in a vessel's existing stability book, to provide fishermen with information which will allow them to easily monitor the stability of their vessel in all modes of fishing applicable to the vessel, during a complete voyage cycle.

4 WORK PROGRAMME

4.1 Literature Search

A worldwide search was conducted through the Internet, the search facilities of the University of Southampton, and through personal contacts of the authors and the large international membership of the SNAME Ad Hoc Fishing Vessel Operations and Safety Panel.

4.2 Consultation with Other Authorities

Contact was made with the national administrations of many countries to obtain details of their current stability requirements and methods of presentation.

4.3 Consultation with Other Research Organisations

Contact was made with academic and industry researchers known to be active in the field, and with organisations that coordinate or monitor research, such as the Sea Fish Industry Authority and the Food and Agriculture Organisation. Requests were made for details of any relevant research, and for opinions and suggestions for methods that should be considered. The MAIB were also consulted regarding any recent information or opinions not published in their reports.

4.4 Consultation with Industry

Limitations of budget and timescale precluded consultation with all industry bodies. A selection was made of sample organisations that, it was hoped, would provide a representative view.

4.4.1 Designers, Builders and Consultants

Contact was made with representatives of the industry supplying vessels and calculating their stability. Opinions and suggestions were sought regarding the deficiencies of the conventional booklet and potential simplified methods of presentation.

4.4.2 Fishing Industry
Contact was made with representatives of fishermen's organisations to obtain a better understanding of the level of understanding of stability, the way in which the industry views and uses stability information, and to seek their opinions on appropriate methods of presentation.

4.4.3 Suppliers
Suppliers of equipment to the industry also provided valuable comments regarding the type of information and equipment that fishermen use to assist the operation of the vessel.

5 OBSERVATIONS ON THE STATE OF FISHING VESSEL STABILITY RESEARCH

5.1 Some Facts
The fishing industry is at or near the top of the list of the most hazardous occupations in most countries of the world. This statistic holds true for the full range of fisheries from subsistence level operations in small craft to highly developed industrial operations. The fatality rate, world wide, is about 24000 per annum.

In terms of accidents in the fishing industry, capsizing and foundering are relatively rare events. In terms of fatalities they represent the greatest danger.

The dangers of fishing have been well recognised and thoroughly researched for many years. A multitude of technical papers and government documents have been produced describing the hazards and the mechanisms behind them. Many of these documents address stability, are excellent works and, collectively, they provide a sound basis for an understanding of the issues.

With very few exceptions, the researchers that have studied fishing vessel stability conclude, in their technical papers, that considerable additional research is required to develop solutions to the problems they have addressed.

The causes of fishing vessel stability incidents are numerous but may be grouped into a few simple categories or, in some cases, combinations of them.

1. Reduction of stability or freeboard by modification or overloading of the vessel
2. Loss of stability or buoyancy due to ingress of water or water on deck
3. Loss of stability as a result of lifting from a high block
4. Excessive heeling moment, due to overloaded or fastened gear
5. Movement of gear or catch
6. Capsize by breaking wave

These categories are well understood by the researchers, the authorities and the fishermen, but there are fundamental differences between their understandings. Fishermen have an intuitive feel for stability but may not appreciate the margins of stability required to provide an appropriate level of safety. Few fishermen have academic backgrounds and so most do not understand conventional presentations of stability. Conventional presentations do not help them to assess when they have reduced their safety margin to an inappropriate level.

None of the causes of capsize retain any significant level of mystery and naval architects are well able to design boats that have good levels of safety with respect to all of them.

Solutions are well documented but typically will result in reduced profitability because of capital costs, increased running costs or reductions in catch.

Imposing the known solutions on a single fishery inevitably will render it uneconomic in a regional or global market.

There has been substantial resistance to the introduction of increased regulatory safety standards to the world's fisheries, regardless of the level of development of those industries.

5.2 Some Opinions

It is the opinion of the authors that the call of researchers for further work is in order to develop solutions, to the poor safety record, that are acceptable to the industry.

Attempts to provide safety from the known causes by developing methods that aim to measure the capsizing moments precisely and provide just sufficient buoyancy and stability will be inadequate for a number of reasons:

1. The vagaries of the environment make precise predictions of capsizing moments impossible
2. Catastrophic incidents usually result from a combination of adverse factors
3. Fishing operations result in highly variable vessel conditions, over a season or even a single voyage

In order to achieve a substantial increase in the safety record of a particular fishery, while enabling it to remain competitive, it will be necessary to apply adequate stability standards to the entire economic region. This will result in an increase in consumer prices. In the current global market this may require global standards. The sustainability of fisheries under the demands of the rapidly increasing world population adds a further dimension to the economic problem.

This study is aimed solely at UK fishing vessels, and the economic issues are beyond its remit, but it is hoped that any resulting developments might be applicable in other countries. For this reason the study has considered research, regulations and accident reports from other countries.

6 IDENTIFYING THE HAZARDS

6.1 Operational Hazards

Typical operational hazards are listed in Table 6.1, for four common methods of fishing. Some of these fishing methods are described in detail in Ref. 1. There are many other specialised fishing methods that involve other hazards not listed here and, whilst these are minority activities and not discussed here, they should be borne in mind when developing safety guidance. The list is not exclusive, but represents what the authors understand to be the serious hazards most likely to be encountered.

The hazards are described in the following sections. They are grouped in the table according to their frequency and duration. Hazards that occur regularly tend to be of short duration, so that the probability of a stability incident resulting from them is kept low. Hazards of longer duration tend to occur less frequently. Some, however, are of a permanent nature, at least in terms of the fishing operation, and may be progressive, perhaps due to an accumulation of small changes.

6.1.1 Handling the Gear

In most fishing methods, handling the gear under normal operation does not pose a threat to the vessel. The exception is for beam trawlers and dredgers. When recovering their gear at the end of the fishing trip they may be in a particularly vulnerable condition, low on fuel and with heavy gear suspended from high blocks on the derricks. This hazard is addressed in detail in Refs 2 & 3. Details of the capsizing of a twin beam trawler whilst conducting inspection and repair of the fishing gear, alongside in harbour, are given in Ref. 4. A similar incident is detailed in case 33 in Ref. 5.

6.1.2 Boarding the Catch

Again, as this is part of the normal operation, it is not a threat to the vessel in most methods. It may pose a threat to a trawler lifting the cod end with a particularly good catch, and where the lift is via a block located high on a gantry or derrick. It is also a hazard for dredgers where the gear needs to be recovered on board in order to empty the shellfish from the dredges.

Table 6.1 Operational hazards

		Pelagic Trawling	Demersal Trawling	Beam Trawling	Scallop Dredging
Regular, transient hazards	Handling the gear			Boarding the gear	Boarding the gear
	Boarding the catch	Lifting cod end from high block	Lifting cod end from high block		Boarding the gear. Blocking freeing ports
Occasional, prolonged hazards	Handling abnormal loads		Lifting cod end from block high & aft or offset	Lifting from derrick block high & outboard	Lifting from derrick block high or outboard
	Coming fast		Moment applied under way or in tideway	Moment applied under way or in tideway	Moment applied under way or in tideway
	Freeing fastened gear		Moment applied high & aft or offset	Lifting from derrick block high & outboard	Lifting from derrick block high & outboard
	Overloading the boat	Bulk fish. Reduced freeboard & cargo shift	Bulk fish. Reduced freeboard & cargo shift		
Progressive, permanent hazards	Modifying the gear	Larger nets, drums or doors	Larger nets, drums or doors	Longer or heavier beams or derricks	Longer or heavier beams or derricks
	Modifying the boat	Many possibilities	Many possibilities	Many possibilities	Many possibilities

6.1.3 Handling Abnormal Loads

Abnormal loads may find their way into any demersal trawl and may pose a threat to the vessel if recovery is attempted. The threat may be because of a local reduction in freeboard, because of lifting from a high block, because of a heeling moment applied by lifting from a block offset from the centreline, or a combination of them. For a beam trawler the lift may be from the outboard end of the derrick, and the applied moment extremely hazardous. Examples of capsize due to the presence of abnormal loads are given in Ref. 6, 7, 8 and case 35 of Ref. 5.

Apart from the reduction in freeboard and stability, and the applied moment, an additional hazard is the possibility of gear failure. The sudden removal of the load may cause capsize (see Ref. 9). Beam trawlers, for example, may use the weight of the gear on the opposite side to balance the lift. The heel angle of the vessel may not be alarming but the stability may be negligible in safety terms.

6.1.4 Coming Fast

A potential problem for all demersal trawlers is snagging the gear on a seabed obstruction. Trawlers may be subjected to a sudden increase in the warp tension but, because the warps typically are at a small angle to the horizontal, this does not pose a serious threat in most cases. In a tidal stream the vessel may be anchored by the gear and held at an unfavourable attitude to the waves, with a reduction in freeboard and a substantial heel angle, perhaps leading to catastrophic downflooding or capsize.

6.1.5 Freeing Fastened Gear

Attempts to free the gear may include hauling on the winch and applying unsafe loads on the vessel and gear as when recovering abnormal loads.

It is common practice to attempt to free gear by breaking it out with the vessel under power. This is particularly hazardous if the vessel is positioned over the obstruction, as a small propeller thrust will generate a very high tension in a vertical warp. This may lead to swamping or capsize. See Ref. 10, 11 and cases 32 and 21 of Ref. 5 and 12, respectively.

6.1.6 Overloading the Boat

When the fishing is good it is human nature to load the vessel to, or beyond, it's known capacity. In all cases this may result in an unsafe freeboard, with a reduction in stability and vulnerability to downflooding. Ref. 13, 14, 15 and cases 30 and 19 of Ref. 5 and 12, respectively, all detail accidents where overloading caused a reduction in stability and freeboard, and was a contributory factor to the loss of the vessel.

In addition to simply loading excessive weight, this category also includes inappropriate loading of the boat in terms of raising the centre of gravity above the safe limit. Fish may be held on deck or in a hopper rather than stowed in the hold, for example.

Trawlers loading bulk fish, or bagged shellfish, have the added problem of the potential for cargo shift if the catch is not adequately secured by pound boards, or is held on deck.

6.1.7 Modifying the Gear

Fishing methods are continually developing and some vessels conduct different methods, sometimes within a single season. Alterations to the gear carried therefore are commonplace. There is a further tendency to increase the size of the gear to increase the potential catch. On a trawler, larger nets require larger drums and larger trawl doors. On a beam trawler or dredger longer beams require longer derricks to handle them. The effects on freeboard and stability therefore are compounded with increased weight of gear handling equipment. Cases 32 and 19 of Ref. 5 and 12, respectively, detail accidents where a change of fishing method was seen to contribute to the loss of the vessel. Case 33 of Ref. 5 details the capsizing of a twin beam trawler, following modifications to her gear.

6.1.8 Modifying the Boat

As with fishing gear, the boats tend to be in a continual state of development. Modifications range from minor adjustments to major structural alterations. Fishermen operating the smaller vessels tend to be self-sufficient, or operate in small groups, with the practical skills to carry out the work. Surveyors and naval architects may not be involved and so the effects of the modifications on the stability rarely are assessed. Ref. 6, 16 and 14 and cases 30 and 32 of Ref. 5 and case 19 of Ref. 12, all detail accidents where vessels have capsized due to the reduction of stability or freeboard following modifications or refits.

6.2 Environmental Hazards

6.2.1 Wind Heeling

Wind heeling alone is unlikely to be the main cause of capsize, but might contribute. High sided vessels, such as those with shelter decks, and those with a large outfit of masts and rigging are the most vulnerable.

6.2.2 Shipping Water

Vessels are vulnerable to shipping water if the freeboard is low because of overloading, extreme heel or trim, or if they are out in severe sea conditions. See Ref. 17.

The watertight integrity of the vessel is jeopardised if doors and hatches are not properly secured, or if vents are in a vulnerable location. Adequate and efficient freeing ports are required to shed the water from deck, and these may be fully or partially blocked, perhaps to facilitate the handling of catch on deck.

Vessels with shelter decks should be less vulnerable to shipping water by wave action provided the shelter is closed fore and aft, but they may be less able to shed water from the enclosed space. They too rely on freeing ports and the securing of all closures.

6.2.3 Loss of Stability on a Wave

When located on a wave crest, the stability of a vessel may be reduced significantly. If the vessel is operating in following seas the duration of the event may be many seconds, increasing the possibility for a capsize to occur. This mechanism of capsize has been studied by many researchers through model tests and is well documented. It is unlikely to be the sole cause of capsize for a vessel with good stability characteristics, but might be a contributory factor for a vessel whose stability has been reduced to a marginal level by operational factors.

6.2.4 Breaking Waves

These are a hazard to all small vessels because the vulnerability to capsize is dependent on the wave height relative to the size of the boat. Experimental evidence from model tests on a variety of forms and vessel types has shown that a breaking wave height equal to the beam of the boat is sufficient to result in capsize. This is unlikely to be a hazard for the larger vessels under consideration here, but breaking crests may result in shipping water, high lateral accelerations or heeling to large angles, and the latter two of these may lead to shifting of the gear or catch.

6.2.5 Icing

A hazard for all vessels operating in very cold conditions. As for wind heeling, high sided vessels, such as those with shelter decks, and those with a large outfit of masts and rigging are the most vulnerable. Shelter decked vessels also may be more likely to operate in cold conditions.

6.3 Flooding

Flooding is recognised as a factor frequently contributing to capsizing and foundering incidents. It may occur by downflooding through an opening and therefore be the result of one of the factors described in Sections 6.1 and 6.2. Although the flooding may be viewed as the reason for an incident concluding with capsize or sinking, downflooding is the result of a loading or stability deficiency rather than the initial cause. Accident investigations have demonstrated that some fishermen fail to maintain secure closures on potential downflooding openings. This is a serious problem, particularly as most openings lead to spaces that are required to remain watertight for adequate stability. It has been common practice to modify older vessels with poor stability, adding enclosed shelters to enable them to comply with minimum criteria. Frequently these were fitted with doors that were left open for operational convenience, and when the additional stability was required, it was not available. An example is described in detail in Ref. 8. With hindsight, perhaps such allowances should not be permitted. If they are, it is clear that simple warnings that doors should be kept closed are insufficient to ensure safety.

Two other types of flooding are common. Flooding on deck, or in a shelter, may occur as a result of inadequate drainage of processing water, most commonly because of blocked freeing ports or scuppers. Flooding may also result from a leak to the hull or its fittings, as a result of collision, grounding or mechanical failure. This is a common problem, with absent or faulty bilge alarms frequently highlighted in accident reports. These initial causes of flooding include accidental collisions with floating objects, navigational errors or poor maintenance.

Whilst fishermen must be made aware of all potential flooding hazards, they are considered to be outside the remit of this study.

6.4 Requirements of a Method of Simplified Presentation

Any method of presentation, if it is to be successful in improving safety, must address the issues raised in Section 6. Consideration must be given to the operational hazards, their duration, frequency of occurrence, and the potential for encounters with the environmental hazards.

Operational hazards are under the direct control of the crew and can be avoided. The crew must be provided with the information to enable them to achieve that.

In contrast, the crew have only indirect control over the environmental hazards. They can, for example, maintain secure closures to prevent downflooding from shipped water, and keep the vessel head to severe seas to reduce the possibility of loss of stability on a wave, or being heeled to a large angle by a breaking wave. The crew can be provided with warnings and advice on ways to minimise the dangers but they cannot necessarily avoid the hazards.

7 METHODS CONSIDERED

7.1 Stability Poster, Norway & Iceland

A method of simplified presentation used by both the Norwegian Maritime Directorate and the Icelandic Maritime Administration. It is a requirement in Norway for vessels of 10.7 to 15 metres, but in Iceland it is recommended guidance, not a requirement. It is an attempt to convey, on a single A4 sheet, the level of stability relative to the minimum requirements and some operational advice on maintaining stability. An example, translated into English, is presented in Appendix 1.

It is not known what margins are used to determine the transition from one colour, or level of safety, and the next, but the fact that the loading conditions are described in approximate terms, rather than by exact values, suggests that precise prediction is not the intention here.

The poster includes general advice on good practice, addressing some of the operational and environmental factors described in section 6.

7.2 Safe Loading Matrix, USA

A method of simplified presentation conceived by John Womack, a naval architect in the USA. The matrix combines details of the loading condition of the vessel in terms of the tank contents and quantity of catch on board, and assigns a colour code to indicate the level of safety for each combination. A basic example is presented in Appendix 2. The method is under development and has not been adopted as a requirement by the authorities.

The presentation is similar in principle to that used in Norway, but provides much greater detail in terms of combinations of deadweight loadings. This detail enables the method to offer greater precision in comparing the relative levels of safety for the various combinations of parameters.

For vessels with a large number of tanks or other variable contributions to the loading, the number of variables may make the matrix rather complicated. Womack suggests two alternatives. A series of loading matrices may be developed, for different ranges of one of the variables, or a worst case may be used. For example, the vessel referred to in Appendix 2 is equipped with RSW tanks. Dividing each section of the matrix into two columns increases the complexity. Alternative matrices may be presented for RSW tanks pressed full or empty, the crew referring to the one relevant at the time, whilst the simpler alternative, as presented here, uses the worst case.

John Womack has also proposed a further development of the matrix, incorporating guidance on the level of safety in a range of environmental conditions. A basic example is presented in Appendix 3, and a more complex example in Appendix 4.

Womack advised that, when selecting boundaries for the colour scheme on the matrix, he takes account of a wide range of factors, including the following:

Potential for downflooding of the vessel
Type of fishing
Typical voyage cycle
Operational area
Distance from safe refuges
Likely direction of approach of storm relative to the refuges
Frequency of operation in that area & hence extent of local knowledge
Stability of the fishery in terms of economy & crew turnover
Local forecast availability and reliability
Availability of real time weather data
Likely nature of wind and seastate in storms

Some of these factors must be judged on a subjective basis, and implementation of the system by a number of consultants or surveyors would require the development of an objective set of criteria or guidelines. Further information on the development of the method is given in Ref. 18 and 19.

7.3 Safe Loading Matrix with Motion Monitoring, Canada

A system developed by Sea-Image Corporation in Canada, combining motion monitoring with the safe loading matrix developed by Womack, presented on a computer display on board the vessel.

The safe loading table is developed by the consultant and installed on the computer. Roll and pitch are measured continuously to monitor the amplitude of the motions and to derive mean values of heel and trim. All of these measurements are presented visually on the display. Limiting values of these parameters are defined for the vessel, and warnings given when the measured values approach or exceed the limits.

The cost of this system is understood to be about £5000.

7.4 Motion Monitoring with Environmental Monitoring, Iceland

In Iceland, efforts have been directed towards providing the fishermen with good environmental data, and continuous monitoring of their vessel's stability. The researchers there believe the greatest capsize risk to be from steep or breaking waves and that, with access to reliable forecasts, fishermen can avoid operation in areas of dangerous waves. Draught and roll period measurements enable them to monitor the effects of loading on their stability, and a method has been developed with which they can estimate the height of wave required to cause capsize. Both of these systems provide additional information that fishermen can use in planning their voyage.

Measured environmental data derived from land based weather stations, and wave buoys located in the fishing grounds, are made available via Internet or mobile telephone. These are supplemented by weather and wave forecasts, and areas where severe waves might occur are highlighted on wave height contour plots. The Icelandic Maritime Administration advised that the system receives up to 5000 calls per month by telephone and up to 8000 per month via the Internet. With a fleet of 1400 open boats and 1000 decked vessels, that represents at least one call per week, per boat in the fleet, and is an indication that it is a well used and respected service.

Model tests conducted on a number of fishing vessels indicated that the critical wave height to cause capsize was related to the area under the righting moment curve, the righting energy. The energy available in the steep wave was compared with the righting energy in this relationship. Thus, if the displacement and GZ curve are known then the critical wave height can be estimated. The stability characteristics of the vessel must be calculated, and the relationship between GM and critical wave height determined by the consultant and presented in tabular or graphical form for reference on board. The roll period monitor enables the GM to be estimated and, while it does not provide a measure of GZ at large angles, it is closely related for a particular vessel. This is combined with the crew's knowledge of their displacement, from calculation or from a draught monitor, to enable them to look up the critical wave height for the vessel in its current condition.

The stability monitoring system incorporates draught and roll period measurements. The system has been under development for some time, and was described in 1997 in Ref. 20, where recommendations were made for it to be tested on a number of Icelandic fishing vessels. The work was described at a conference in London in 2001, Ref. 21, but does not appear to have been adopted elsewhere.

7.5 Warp Tension Monitoring, Netherlands

It is understood that, although the fitting of warp tension monitoring is not compulsory in the Netherlands, it is recommended, and almost all beam trawlers over 24 metres are equipped with it. Owners have found that the capital cost is recovered by reduced wear on the fishing gear and that is understood to be a powerful incentive which, unfortunately, has not influenced owners of the UK fleet.

Monitoring systems range from a simple load cell fitted to the lifting block with a digital display in the wheelhouse, to a highly developed system integrated with the winch and engine controls. At a cost of about £10,000, the latter provides the benefits of automated pay out of the winch and reduction of engine revolutions or propeller pitch in the event of a sudden increase in warp tension, above a pre-set limit, as would occur when coming fast. Such systems enable monitoring of the mean and peak warp loads to indicate the quality of the seabed and content of the trawls, and incorporate instrumented rollers to monitor the length of warp outboard. Because they give early warnings of increasing load on the warps, the trawls tend to be recovered before they contain an excessive quantity of sand, stones or other debris, and so heavy lifts are not undertaken.

Whilst peak loads on rocky ground may be high, the signals are filtered and the mean towing loads are lower than the maximum safe lift for the vessel. Audible and visual alarms that are pre-set to the maximum safe load for lifting are not therefore triggered during normal fishing operations.

The manufacturer of these integrated systems advised that, while about 200 systems have been supplied to Dutch and Belgian vessels, only 12 have been supplied to UK flag vessels, and they are believed to be Dutch owned. Many French and Spanish vessels have been equipped, and other countries supplied include: Russia, Iceland, Norway, Denmark, Germany, Portugal, S. Africa, Namibia, Congo, Canada, Argentina, Peru, Chile, Australia, Indonesia and Tahiti.

The principal supplier stated that no fishing vessels fitted with the equipment have capsized or gone missing, except for one Dutch vessel, which capsized during an attempt at an excessive lift when one load cell had broken and was under repair. The safety record of the Dutch fleet has improved in recent years and the effects of the equipment appear extremely beneficial. A range of actions have been implemented simultaneously, however, so their individual effects cannot be isolated.

8 DISCUSSION OF THE METHODS

8.1 Categorisation of the Methods

The methods described above may be summarised as approaching the problems of stability in three ways.

1. Presenting guidance on the level of safety in various loading cases
2. Instrumented, continuous stability or load monitoring
3. Monitoring the warp tension and, enabling monitoring of the heeling moment applied by the gear.

Each of these categories is discussed separately in the following sections.

The additional feature of the Icelandic approach that facilitates the provision of efficient and reliable weather and wave forecasts is an excellent service. It enables the fisherman to consider in advance whether he is venturing into an area that might be hazardous to his vessel, bearing in mind its level of safety at that time as determined by motion monitoring. In order to assess the level of safety in the forecast environment the fisherman must have clear guidance on the level of safety of his vessel, and it is that aspect of the Icelandic method that is addressed here. The provision of environmental forecasts is outside the remit of this study.

8.2 Loading Guidance

This approach addresses the weight and distribution of deadweight items and relates them to the stability characteristics. In that sense it serves the same function as the conventional maximum allowable KG diagram, or the alternative maximum allowable deadweight moment diagram. It is recognised that most fishermen do not refer to their stability booklets and are not familiar with the implications of the conventional diagrams. More importantly, they do not have the time, inclination or adequate understanding, to determine how their vessel compares with the limiting curves presented on those diagrams.

The conventional stability booklet contains presentations of a standard series of loading cases, designed to represent the range of conditions likely to be experienced during the anticipated voyage cycles. A naval architect will understand the implications of the stability data presented for those conditions, and will appreciate that in some cases the stability offers a greater level of safety than in others. The fisherman, however, is likely to take the safety of the vessel in trust. He is likely to feel secure in the knowledge that a competent consultant and the administration have assessed the stability in the full range of operating conditions and found it to be adequate in all cases. He will concentrate on the business of catching fish and may never have any reason to doubt the safety of his vessel in terms of stability, or concern himself with the fact that the margins of safety are variable through the voyage cycle. In the light of all of the evidence it should be accepted by administrations worldwide that fishermen will not calculate their loading condition or their stability during the voyage. In order to use the conventional booklet presentations, therefore, they would need to understand, familiarise themselves with, and memorise, the stability characteristics during their typical voyage cycles, and understand the implications of the levels of safety provided.

The visual impact of the Stability Notice used in Iceland and Norway, and of the Safe Loading Matrix developed by John Womack, convey instantly that the level of safety is not constant. If these presentations are posted in the wheelhouse, this important message is unlikely to be overlooked by the crew.

If the notice is sufficiently simple in terms of the loading cases, the fishermen quickly may become so familiar with them that reference to them is no longer necessary.

In some cases suggested by John Womack the Safe Loading Matrices require a number of pages to present all of the information. It is less likely that the fishermen would familiarise themselves with such a large amount of information. It might be impractical to post them all visibly and, if they were kept in booklet form, reference to them would be less likely. Their impact may be reduced to such an extent that they become ineffective.

While the stability booklet is unlikely to be opened by any of the crew other than the master of the vessel, all of the crew will see these presentations if they are posted prominently. The Stability Notices are simple enough for crew members without any training in stability to understand them, and so they should be aware of any tendency of the master to operate the vessel in unsafe conditions.

Apart from the obvious hazard of loading the boat so as to and adversely affect its freeboard and stability, neither of the methods studied here addresses the other operational or environmental hazards directly. The Stability Notice includes operational advice on methods for maintaining stability, whilst Womack’s philosophy is to incorporate consideration of the likely hazards into the colour coding system.

8.3 Stability and Draught Monitoring

The term ‘Stability Monitor’ is used by a number of suppliers to describe instrumentation that monitors the roll motion, and in some cases the pitch motion, of the vessel. Typically these systems measure the roll period and relate that to the GM of the vessel. An increase in the roll period indicates a reduction in GM. In some cases, such as that being developed in Canada, amplitudes are also monitored to warn of extreme motion or a pronounced list or trim.

To use roll period measurement to determine the GM is problematic because it relies on knowledge of the roll inertia of the vessel and the added inertia due to entrained water and damping effects. There is a wealth of literature on this subject as a result of numerous attempts to use roll tests to assess vessels for which lines or stability data are not available. Various factors and coefficients have been proposed, some of them validated by model or full scale correlation, for use in relating roll period to GM. The relationship depends on the hull form, appendages, and weight distribution within the vessel. The method provides only an approximate estimate of the GM unless an accurate coefficient has been derived for a very similar vessel. The value of such systems therefore is to monitor the roll period and warn of any deviation from its normal value. Inappropriate loading, or perhaps flooding, might cause an increase in the roll period that could be detected by the monitoring system.

The difference between the roll motion of a vessel in port and its behaviour in a seaway must be clearly understood in order to assess the application of these systems.

In calm water, when a vessel is rolled by a transient moment, its motion decays over a few cycles at the natural roll period. This characteristic motion is as used in the conventional roll test. An efficient roll period measurement system will be able to determine the natural period from a record of the roll response to random excitation that always occurs in port, for example due to wind gusts or movement of crew.

In a seaway, the motion of the vessel will be a combination of responses to the same random excitation, and responses to forcing by waves. In waves, a vessel will be forced to roll at the period of the waves, regardless of its natural roll period. The importance of the natural period is in amplifying the motion induced by waves of corresponding period. Two vessels of different natural roll period, operating in the same seastate, will roll at the same period but with different amplitudes. If they move to an area where the waves have a different period, the vessel that previously rolled less may now roll to greater angles. The system that could interpret the roll motion in port may not be able to identify the natural roll period of the vessel within the complex roll time history that is measured at sea. In quartering seas, for example, the encounter period of the waves may be very low and the corresponding roll period significantly greater than the natural period.

Some researchers have addressed this problem and claim success in analysing measurements in a seaway to an acceptable level of accuracy. A review of work in this field is given in Ref. 22, and the same author describes his work in greater depth in Ref. 23, together with details of the complex mathematics that are involved in this analysis of the random roll decrement. Various academic institutions have researched such work for some time, and the referenced example was well advanced at least 12 years ago at the Memorial University of Newfoundland. Despite this, there does not appear to have been a commercial system developed to use the technique.

The roll motion is complicated further when fishing gear is deployed. The change to the vessel's inertia may be significant, particularly for a beam trawler where the added inertia of water entrained around the gear is applied at the outboard ends of the derricks. The fishing gear also adds to the damping, and this has a secondary effect on the roll period. These factors will both tend to increase the roll period.

A roll period monitoring system might include warnings pre-set by a consultant or administration, based on knowledge of the GM required for that particular vessel to comply with the criteria, and the roll period corresponding to that GM. A potential problem with such systems is that the fishermen may become used to warnings of slow roll period, for example when the gear is deployed and there is no danger, and may be complacent when an equally slow roll period occurs as a result of poor loading.

Fishermen are very aware of the roll period of their vessels. Their personal senses and familiarity with their vessel enable them to detect small changes in the characteristics of the motion. The complications of wave induced motion and the effects of deployed gear apply equally to their judgement as they do to instrumented monitoring systems, but fishermen have the advantage of additional information regarding the influencing factors. The deficiency in the 'human system' is in its application rather than its measurement accuracy. The fisherman cannot relate his perception of the motion to the level of safety of the vessel, because he does not have the information required to do so. Even if a maximum safe roll period were derived for the vessel, the fisherman would be unlikely to be aware of when it was exceeded. It is very difficult to estimate roll periods with any degree of accuracy without instrumentation so, while he might be aware that the period was longer than usual, the fisherman would be unlikely to be able to state the period in seconds or relate it to some limit.

Fishermen are equally aware of significant changes in list or trim but, again, they are unable to relate a developing list to their level of safety and quantify the reduction that it represents.

Some systems, for example that developed in Iceland, include monitoring of the vessel draught. This is an entirely independent measurement, typically using a pressure transducer mounted in the bottom of the vessel. The technology is used commonly on cargo vessels and is the same in principle as a depth gauge incorporated into tanks to monitor their contents. It would seem to be of particular benefit to fishing vessels, which load cargo at sea. To be effective, the system would need to be capable of deriving the mean draught with the vessel heaving, rolling and pitching in a seaway, but such analysis should be straightforward with records acquired over relatively long periods.

8.4 Moment monitoring

If a fishing vessel is performing a relatively heavy lift, a naval architect or deck officer with sufficient training should be able to determine the residual stability during the lift, and make some interpretation of the reduction in reserve stability and level of safety. To do so he would require details of the location of the lifting block and the load applied.

Most fishermen would be unfamiliar with the calculation required, and would not know the magnitude of the load. During the project on beam trawlers, described in Refs. 2 and 3, quoted weights of gear were found to be highly variable. Other consultants have expressed the view that weights of gear quoted by fishermen are often unreliable, and well outside the level of accuracy required for stability assessment.

Even on a specific vessel, gear weight is variable for two reasons. Fishing gear weights are highly dependent on the condition of the gear, particularly for demersal trawls, which suffer a high rate of wear, and gear is frequently changed or modified.

When fishing, the crew have some feel for the load being lifted through their familiarity with the heel or trim of the vessel, engine instruments or winch responses, but these are qualitative perceptions. On a beam trawler, when both sets of gear are raised simultaneously, the loads may be unacceptably high but the vessel will remain upright so that heel cannot be included as an indicator.

Regardless of the level of detail and accuracy of the stability data, even the best-educated fisherman cannot evaluate his level of safety without information on the load being lifted.

8.5 Success of the Methods in Addressing the Potential Hazards

As stated in section 6.4, a successful method of simplified guidance needs to address the potential hazards to the vessel. Table 8.1 is an attempt to present a simple summary of which hazards are addressed by each of the methods described in section 7. It is difficult to be precise in this simple format because some methods might address a potential hazard indirectly, for example, the minimum freeboard stated on the stability notice indirectly helps to minimise shipping of water. Another example is wind heeling, which is not addressed directly by any of the methods, but the safe loading matrices may take potential wind heeling into account when assigning the colour coding, and a motion monitoring system might detect heel due to wind. A further difficulty is that the wide variety of vessel types and fishing methods preclude effective generalisation. The aim of the table is to highlight the differences between the approaches in terms of the issues at which they are directed.

It is apparent that the principal concern of those developing the methods of presenting simplified stability information, that is methods 1 to 4 in the table, has been the loading of the vessel. In addition, the stability notice used in Iceland and Norway includes warning notes referring to some of the hazards, and the motion monitoring systems will detect significant modifications to the vessel or fishing gear.

In contrast, the warp tension monitoring system does not address the vessel's righting moment characteristics, but provides information on the heeling force; a variable that the others lack.

Whilst overloading of the vessel frequently is a contributory factor in stability incidents, it is not likely to occur in some cases, such as beam trawlers, where a low volume, high value catch frequently weighs less than the fuel consumed on the voyage. On such vessels other hazards need to be highlighted, and it is there that warp tension monitoring may be more important.

Table 8.1 Hazards addressed by the methods considered

Method → / Hazard ↓	1 Stability Notice	2 Loading Matrix	3 Loading Matrix + Motion Monitoring	4 Motion + Environmental Monitoring	5 Warp Tension Monitoring
Handling the gear					Yes
Boarding the catch					Yes
Handling abnormal loads	Warning note				Yes
Coming fast					Yes
Freeing fastened gear	Warning note				Yes
Overloading the boat	Yes	Yes	Yes	Yes	
Modifying the gear			Yes	Yes	Yes
Modifying the boat			Yes	Yes	
Wind heeling					
Shipping water	Min. freeboard	Min. freeboard	Min. freeboard	Draught gauge	
Loss of stability on a wave				Yes	
Breaking waves				Yes	
Icing	Warning note				

While the loading guidance methods include advice on minimum freeboard, the Icelandic authority, in developing their stability monitoring system, have included draught gauges that will provide an opportunity to monitor the freeboard at sea, provided that the system can give a reliable mean value in a seaway. The use of load lines or freeboard marks is not generally applied to fishing fleets because they load their cargo at sea where the marks cannot be seen easily. The use of draught gauges might present a potential alternative.

The environmental monitoring efforts being made in Iceland are directed primarily at the hazards of steep, high waves. The system cannot prevent encounters but provides an efficient warning system that other weather forecasting systems lack. All weather forecasts enable fishermen to make some judgement on the likelihood of encountering icing conditions, or storm force winds, and so these hazards have not been highlighted in the table in the Environmental Monitoring column.

9 COMMENTS ON THE SAFETY CULTURE

The ‘safety culture’ is often discussed in studies of safety in the fishing industry. Fishing necessarily involves the operation of dangerous machinery, under difficult conditions, in a hazardous environment. Such working conditions would not be tolerated in most land-based industries. It is recognised by those outside the industry however, that the poor safety record also is due in part to a lack of awareness of the dangers and, furthermore, an unwillingness to take sufficient precautions.

The MAIB Chief Inspector states, in his foreword to Ref. 24: ‘While many fishermen have an intuitive feel about their vessel’s stability and rarely refer to their stability book, a significant percentage of those involved in founderings showed little in-depth knowledge of the subject.’ Whilst larger vessels are required to carry deck officers whose training includes some instruction in stability, vessels of 12 to 16.5 metres are required to carry stability information booklets but are not required to carry officers trained to understand them.

Fishermen believe that they operate their own vessels safely, or at least with sufficient safety to avoid serious incidents. For various reasons, not least commercial pressures, a fisherman may take risks in loading and operating his vessel. In the absence of other adverse factors an accident will be avoided and he may learn from the experience that the vessel is safe when operated in that way. He may subsequently feel confident in repeating the situation, or in increasing the risk even further.

It is a common assumption, not restricted to fishermen or even seafarers, that a history of safe operation implies a safe operation. This is a message conveyed to the fishing industry by the MCA, with an explicit statement in MGN 265 (F) 'Fishing Vessels: The Hazards Associated with Trawling Including Beam Trawling and Scallop Dredging'. A paragraph in section 6.8 of that document states '*Generally a beam trawler will continue to operate safely if it has a history of safe operation and its operating profile remains substantially unchanged.*' This is highly misleading advice that encourages a serious flaw in the safety culture. By this argument all vessels are safe until the day that they capsize, at which point they become unsafe. A history of safe operation is no indication of safe operation, rather it is an indication that the vessel has, so far, been lucky enough not to have encountered the forces required to capsize it. A good example of this is described in Ref.25, which is the most recent investigation report issued by MAIB. A fishing vessel was operated for two and a half years, without substantial change, by the same owner/skipper, then capsized with the loss of all crew.

When accidents occur to a vessel, the crew and others in the community should learn from the experience. Unfortunately, stability incidents frequently are fatal, and those involved cannot learn lessons from them or pass advice on to others. In discussing fatal casualties within the industry it is very common for the accident to be regarded as a freak 'one-off' situation, or for the vessel to be described as unusual and particularly unsafe for reasons of design, modification or mode of operation. It is unlikely that members of the community will regard the accident as something that might occur to them.

Fishermen, naturally, claim that they are best qualified to understand the dangers of their operations. For some aspects that may be the case, and if they understand the danger but fail to take appropriate precautions there is little that can be done without a change to the safety culture. That is, greater importance needs to be placed on safety, for the fishermen to give it greater weight in the balance against profit.

The fishing industry should not be singled out for this apparent disregard for safety. Their approach perhaps may be compared with that of car drivers. Statistics reveal that road traffic accidents account for around 10 deaths and 90 serious injuries per day in Great Britain. Despite this alarming figure most drivers regulate their speed in fear of being caught rather than in fear of injuring themselves or others. It is understood that, in most industries, where safety has been increased it has been as a result of a combination of enforcement of safety procedures and improvements in the safety culture.

At present fishermen tend to take the view that, because their vessel's stability has been approved, it must be safe to operate and they need not concern themselves with it. It is with regard to this lack of awareness that simplified stability information is likely to prove most valuable. It will be an additional benefit if it can also prompt fishermen to give safety a higher priority.

It is apparent that fishermen resent, and frequently reject, attempts to introduce safety legislation to their industry. The emphasis of any method introduced should be to provide information with which the fishermen are able to improve their assessment of their level of safety. It must be information that they understand and respect, or it will be ignored.

10 ADEQUACY OF STABILITY ASSESSMENT

The legal requirement, stated in The Fishing Vessels (Safety Provisions) Rules 1975, for all fishing vessels to meet the standard minimum criteria '*in all foreseeable operating conditions*' is not enforced in the UK with regard to the operation of fishing gear or the boarding and handling of the catch prior to stowage. This fact is known to the MCA and is brought to the attention of owners in MGN 265 (F) with the statement '*Owners should note that possession of approved stability is no guarantee of satisfactory stability during fishing operations*.'

The study of beam trawlers described in Ref.2 found that fewer than 50% of the trawlers studied complied with the criteria with the empty trawls raised from the derricks as for deployment or retrieval. Fewer still would comply with additional weight of fish or debris in the trawls. Beam trawlers are known to be an extreme case but, since many fishing vessels have very small stability margins over the minimum criteria, it is likely that other types of vessel would fail to comply if gear handling were considered in the assessment. Because these operational aspects are not assessed, they are not included in the stability booklet and no information is provided to the fishermen on the effects they have on vessel safety.

On some vessels, when fish are boarded they are transferred to their permanent stowage via hoppers or temporary holding areas on deck. If such arrangements are not considered in the stability assessment, the level of safety during that phase of the operation cannot be known.

It is understandable for fishermen to take the view that their vessel has passed the MCA stability assessment, and therefore must be safe to operate. Because they do not have the naval architect's understanding of the subject they may not appreciate that such operational aspects have not been taken into account.

Many designers and consultants are of the opinion that these aspects should be addressed, while some believe that the existing criteria incorporate adequate safety margins to cover operational aspects, particularly those of a transient nature.

It is the belief of the authors that the minimum criteria provide minimal margins of safety. Model tests on other vessel types have revealed that, when ballasted to just comply with the minimum criteria, a stationary vessel may capsize in surprisingly small, non-breaking waves, of the order of wave height = beam/4. Any operational factors that degrade these stability margins may lead to capsize in adverse conditions, and these '*adverse conditions*' may appear quite benign to the crew.

Since the stability requirements, as interpreted and applied in the UK, do not ensure adequate stability margins in all foreseeable operating conditions, it is essential that the fishermen understand that. In the first instance it would be beneficial if it were made clear to designers and consultants with requirements for them to include information in the stability booklet. It is not adequate to state qualitative warnings that some operations may be dangerous. Such advice must be quantified, for example, with the maximum hopper capacity, or maximum possible lift from a derrick clearly stated.

A further difficulty arises because fishing vessels are not required to carry freeboard marks. They are required to comply with minimum freeboards, but it is recognised that physical marks cannot be seen when loading at sea. Some vessels have the capacity to load beyond the minimum freeboard, and there is much anecdotal and photographic evidence that overloading does take place. The requirements tend not to be enforced and therefore are of little value.

11 RECOMMENDATIONS

11.1 Limitations

The range of vessel types and fishing methods is diverse, even within the UK fleet, and methods of presentation will need to be tailored to some extent to reflect the particular hazards applicable to each combination. In this brief study it has not been possible to consider these particular requirements in detail, but they have been borne in mind when formulating the recommendations. General suggestions are offered that should be developed and assessed in Phase 2 of this project.

11.2 Basic Philosophy

The method should aim to present information concisely and simply.

The method should bring to the attention of the fishermen, the fact that the safety of the vessel is variable, may be made inadequate, and is under their control.

It should be understandable by all of the crew and a copy should be placed in a prominent position where it is visible to them so that they too can judge the level of safety at which they are being asked to work.

The method should address both the safe loading of the vessel and consideration of the moments applied to it.

The method should draw attention to the implications of environmental hazards that might be encountered.

11.3 Stability Notice

Most of the people contacted for the purposes of this study expressed the opinion that a simple poster presentation would be beneficial. None expressed the view that it would not.

A notice should be prepared in a format similar to that used in Iceland and Norway. The format has been developed and implemented there and so it has a positive history. It is preferred to the more detailed presentation proposed by John Womack because of its simplicity, which will be of benefit both in its preparation and use.

For vessels that are capable of being loaded beyond the minimum freeboard, or in such a way that the stability cannot comply with the criteria, the notice should reflect that. The loading cases used to illustrate the notice must be related to easily identifiable physical features of the vessel in order that the crew can relate to, and interpret the information adequately. The example presentation shown in Appendix 1 uses the difference between catch on deck and in the hold, but equally one might need to differentiate between hold half full and three quarters full. In such a case it may be beneficial to place conspicuous marks in the hold accordingly.

Some vessels may not load a large weight of catch, but their stability may be poor when fuel is low. Such conditions should be highlighted as appropriate. The temptation to incorporate a large number of variables or conditions should be resisted because it is not possible to define safety from capsize precisely, and additional complexity will detract from the primary message.

The emphasis should be on portraying the fact that the stability is variable, and the vessel can be loaded in such a way that the margins are reduced. In some cases they may become unacceptably low or even make the vessel unstable. Illustrations used on the notice should be representative of the actual vessel. Since a profile sketch of the vessel is required to be presented in the stability booklet it should be possible to use the same, or a simplified version of the drawing on the stability notice.

For vessels with high lifting blocks or derricks, where the stability may be affected significantly by boarding a large catch or abnormal load, or in attempts to free fastened gear, the notice should include information to that effect. The maximum recommended heeling moment should be calculated for presentation in the stability booklet and referred to on the notice as a maximum load at the lifting block. This will require some criteria to be applied in order to define what is ‘safe’. It will not be adequate simply to relate the moment to the maximum GZ calculated for the worst operating condition for two reasons. Lifting from a high block increases the displacement and raises the effective VCG, and hence reduces the GZ values. Use of the maximum value, even for the GZ curve adjusted for the effective VCG in the lift, would eliminate the margin of stability. Some residual GZ would need to be agreed for application in such a method. UK requirements exist for other types of vessel that are equipped for lifting and these should provide a basis for such recommendations.

For vessels equipped to lift from a fixed point a single value may suffice. Where more than one lifting point is used, or for vessels with moving derricks such as beam trawlers, the notice may need to present additional information. A suggestion for lifting information on a beam trawler stability notice is presented in Appendix 5. Three lifting configurations are shown in this example, but the configurations most valuable to the fishermen, and the criteria used to define them, should be given further consideration. The illustrations might replace the loading guidance diagrams on the example given in Appendix 1.

It is recommended that all types of vessel should be provided with a stability notice of some form.

In addition to the loading or lifting advice the notice should include advice on other operational procedures that have an important effect on the stability, as is the case with those produced in Iceland and Norway. For example, a notice on a beam trawler should include advice on releasing the towing block from the derrick when attempting to break out fastened gear or lift an abnormal load, and on all vessels equipped for towing or lifting, it should state the importance of ensuring that all closing appliances are secured when attempting a heavy lift. The details of such notes will depend on the type of vessel and the fishing method, and on any features of the vessel that might give rise to a particular hazard.

11.4 Vessel Monitoring

For vessels with good margins of stability and freeboard, monitoring of the condition should not be necessary. For vessels that are capable of being loaded beyond the minimum freeboard, or in such a way that the stability cannot comply with the criteria, monitoring would be of great value and should be encouraged.

Beam trawler operations are unlikely to benefit from vessel monitoring as the most likely hazards are due to excessive heeling moments rather than poor loading of the vessel. It may be argued that a roll monitoring system would detect excessive heel during lifting of excessive weight, but the crew would be aware of the heel angle when making their decision on whether to continue or abort the lift. Their attention should be on the winch controls during such an operation rather than on a visual display, although an audible alarm could be used. This would not be of benefit, however, in the case of lifting both sets of gear with excessive quantities of sand, for example.

Both roll period and draught monitoring systems have been in use on other vessels, or on fishing vessels in other countries, and so the technology exists. It is acknowledged that there may be difficulties of interpretation in some environmental conditions, but casualties frequently occur as a result of loading factors in good conditions.

Vessels vulnerable to poor loading configurations would also benefit from a stability notice, and it may be possible to relate the two in some way. If freeboard is a primary concern, for example, the limiting freeboard between the safe and marginal freeboard, as displayed on the stability notice, may be set as a warning alarm on the draught gauge.

In addition to warning of low stability as a result of overloading or hazardous loading, a system should also give warning of flooding. Whilst bilge alarms are fitted to provide such warning, they are notoriously unreliable and have been found to be ineffective in a number of casualty investigations. A second system to warn of such a severe hazard would be a great benefit.

The application of vessel monitoring systems, and the operational hazards that they address directly, are summarised in Table 11.1.

11.5 Load Monitoring

Vessels that are vulnerable to lifting would benefit from load monitors on the lifting blocks and their installation should be encouraged. Whilst a simple load cell could be used, or a simple system developed to comply with some minimum requirements, it is most likely that an existing, commercially available system would be of greater benefit to the fishermen, having been designed to provide additional operational benefits.

Vessels vulnerable to lifting would also benefit from a stability notice, and it should be possible to relate the two. The maximum recommended lift should be used to set the level of any alarm that the system may incorporate. The value of the information suggested in Appendix 5 would be seriously reduced without the availability of reliable load monitoring, perhaps rendering it worthless.

The application of load monitoring systems, and the operational hazards that they address directly, are summarised in Table 11.1. Although load monitoring appears in all columns of the table, it may not be appropriate for all vessels to be equipped with it. A pelagic stern trawler with a ramp recessed into the transom might not lift heavy loads above the deck, and so its stability might not be affected by gear or trawl handling. There would be no need to equip it with warp tension monitoring equipment or load cells on the grounds of stability.

Table 11.1 Use of monitoring systems to address the operational hazards

		Pelagic Trawling	Demersal Trawling	Beam Trawling	Scallop Dredging
Regular, transient hazards	Handling the gear	Not required	Not required	Load monitoring	Load monitoring
	Boarding the catch	Load monitoring	Load monitoring	Not required	Load monitoring
Occasional, prolonged hazards	Handling abnormal loads	Not required	Load monitoring	Load monitoring	Load monitoring
	Coming fast	Not required	Load monitoring	Load monitoring	Load monitoring
	Freeing fastened gear	Not required	Load monitoring	Load monitoring	Load monitoring
	Overloading the boat	Vessel monitoring	Vessel monitoring	Not required	Not required
Progressive, permanent hazards	Modifying the gear				
	Modifying the boat				

11.6 Stability Booklet

The stability booklet is a valuable source of information on the vessel. It is a convenient document for the purposes of stability approval. It is a useful reference for surveyors representing the regulatory authorities and consultants advising on refits or modifications. To satisfy these functions it should be comprehensive in terms of presenting all of the information required to assess the stability and freeboard of the vessel in any anticipated operation. It should include information on the weight of fishing gear and lifting equipment.

The format of the booklet currently is the subject of development by the Fishing Safety – Stability Review Sub Group, and is not addressed here.

It is generally accepted that the booklet is not used by fishermen and it is not recommended that it should be relied upon to provide the safety information required. As noted in section 9, some of the smaller vessels that are required to carry stability booklets may have no one on board trained to understand them.

Where maximum recommended lifts are calculated for presentation on the stability notice, or for setting of load monitoring alarms, these should be included in the approved stability booklet so that the inspecting surveyor can confirm the accuracy of the documentation and settings.

11.7 Other Measures

Table 11.1 shows that two of the hazards identified are not addressed directly by the monitoring systems. It was indicated in Table 8.1 that modifications to the vessel or its gear might be addressed by stability or draught monitoring systems. Large modifications will be detected by such systems if they increase the draught or raise the centre of gravity significantly. Such measures are a costly way of attempting to measure the effects of an obvious change to the vessel and it seems rather a complicated way of addressing what should be a simple problem.

Changes to the vessel are well known to the fishermen, but their effects may not be fully understood. They are required to be brought to the attention of the MCA but frequently are not.

Regular surveys are required but may be inadequate for two reasons. The survey interval may be long in relation to the rate of modification of some vessels. An MCA surveyor observing or inspecting the vessel may not be familiar with it and hence may not be aware of the modifications.

Details of gear weights and derrick dimensions may appear in the stability booklet and provide detailed information that can be checked, but only with control of the vessel. Drawings of the profile also appear in the stability booklet but cannot be relied upon to provide an accurate representation of all of the structures and rigging.

Photographs of the vessel, perhaps taken during the inclining experiment, and presented in the stability booklet, would provide a simple means of checking the basic structure and gear handling arrangement. It would involve minimal time and cost in terms of obtaining and presenting the information, as well as in checking it on a subsequent occasion.

It would be beneficial if a photograph were included on the stability notice. That would perhaps be a constant reminder to the crew of a recently modified vessel, that it had not been assessed in its current configuration. It would also be obvious to any visiting surveyor, or to a new crew member joining the vessel.

Existing Marine Guidance Notes should be checked for the quality of the advice and revised as necessary. In particular, MGN 265 (F) contains a highly misleading statement as discussed in section 9.

12 CONCLUSIONS

The recommendations in section 11 provide a basis for the development of methods of providing simplified information on fishing vessels for which stability booklets are prepared.

The methods include:

1. Provision of a stability notice advising the crew of the most likely operational hazards

And

2. Provision of equipment to monitor the freeboard and initial stability of the vessel

And, or

3. Provision of equipment to monitor the loads applied by the fishing gear handling system.

It is suggested that these components be designed to relate to each other, with any warning alarms that may be incorporated into the monitoring equipment set to limits presented on the stability notice.

The details of the methods, and the vessels to which they apply, should be addressed in phase 2 of this project.

Consideration should be given to revising MGN 265 (F).

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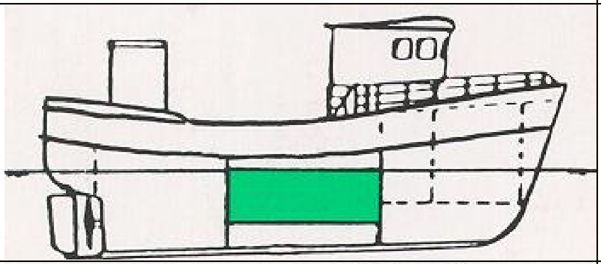
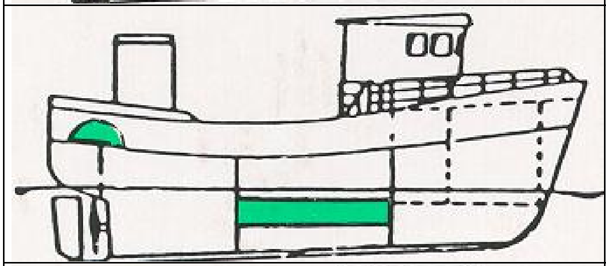
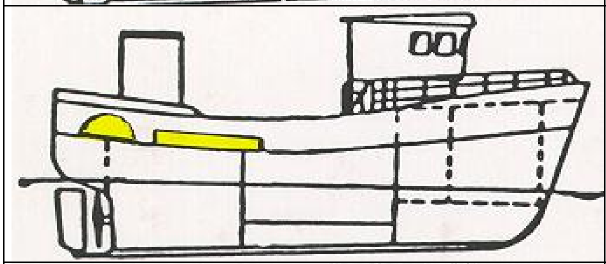
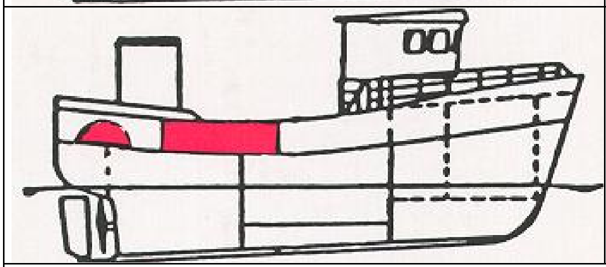
Appendix 1 Presentation Used in Norway and Iceland

STABILITY NOTICE

	PLACEMENT OF GEAR AND CATCH	STABILITY		
		Acceptable	On the Limit	Danger of Capsize
	• Catch in cargo hold			
	• Part load in hold • Gear on deck			
	• Some catch on deck • Gear on deck • Empty cargo hold			
	• Considerable catch on deck • Gear on deck • Empty cargo hold			

Simple efforts for maintaining stability:

Close doors of hatches
Ensure scuppers are open to allow water to drain
Secure catch and gear against shifting
Move gear and catch from deck into cargo hold
Freeboard amidships should be at least 20cm
Avoid excessive aft trim
Minimum Freeboard at stern should be 20 cm
Avoid following seas
Large heeling moments when hauling gear are to be avoided.
Change of trim and heel when trying to free snagged gear can impair stability of vessel.
Do not go to areas with danger of icing.
Remove snow and ice from vessel.

Appendix 2 Basic Presentation Developed by John Womack

F/V #2 130 Foot Stern Trawler - Safe Loading Table B-1 - Unrestricted Ocean Service

Fresh Water Tank any Level

50 Pound Frozen Boxes of Fish in Hold From	To	Loose Fish on Deck	No Loose Fish on Deck	Loose Fish on Deck	No Loose Fish on Deck	Loose Fish on Deck	No Loose Fish on Deck	Loose Fish on Deck	No Loose Fish on Deck	Loose Fish on Deck	No Loose Fish on Deck	Loose Fish on Deck	No Loose Fish on Deck	Loose Fish on Deck	No Loose Fish on Deck	Loose Fish on Deck	No Loose Fish on Deck	Loose Fish on Deck
4,501	5,000	Black	Black	Black	Red	Red	Red	Red	Red	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green
4,001	4,500	Black	Red	Red	Red	Red	Yellow	Red	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green
3,501	4,000	Black	Red	Red	Red	Red	Yellow	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green	Green
3,001	3,500	Red	Red	Red	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green
2,501	3,000	Red	Red	Red	Yellow	Yellow	Green	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green	Yellow
2,001	2,500	Red	Red	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Yellow
1,501	2,000	Red	Red	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Green	Yellow
1,001	1,500	Red	Red	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Green	Yellow	Yellow	Red
501	1,000	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Green	Yellow	Yellow	Red	Yellow	Red
0	500	Yellow	Green	Green	Green	Green	Green	Green	Green	Yellow	Green	Yellow	Yellow	Red	Yellow	Red	Yellow	Red
Total Fuel Onboard	Gallons	14,401 to 16,000		12,801 to 14,400		11,201 to 12,800		9,601 to 11.200		8,001 to 9,600		6,001 to 8,000		4,801 to 6,400		3,201 to 4,800		1,600 t
	Percent	91% to 100%		81% to 90%		71% to 80%		61% to 70%		51% to 60%		41% to 50%		31% to 40%		21% to 30%		10% t

Green: Safe to Operate
Yellow: Operate with Caution
Red: Unsafe to Operate
Black: Imminent Danger of Capsize

Appendix 3 Basic Presentation Developed by John Womack, Including Environmental Conditions

F/V 130 Foot Mid-Atlantic Offshore Clammer - Safe Loading Table A-1

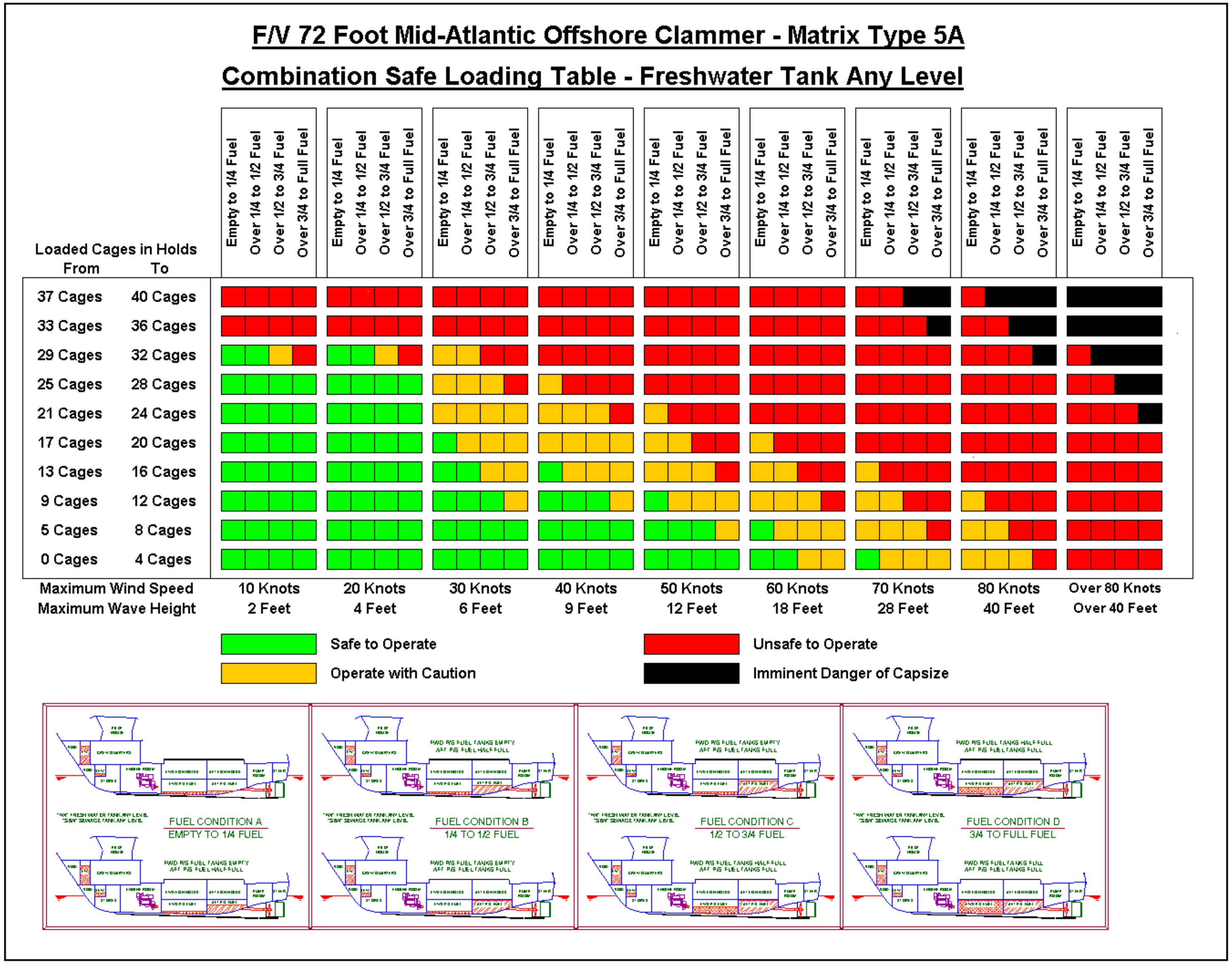
Fuel Tanks 70% or Lower - Fresh Water Tank any Level

Loaded Cages on Deck From	To	10 Knots 2 Feet	20 Knots 4 Feet	30 Knots 6 Feet	40 Knots 9 Feet	50 Knots 12 Feet	60 Knots 18 Feet	70 Knots 28 Feet	80 Knots 40 Feet	Over 80 Knots Over 40 Feet
117 Cages	120 Cages	Red	Red	Red	Red	Red	Red	Black	Black	Black
113 Cages	116 Cages	Red	Red	Red	Red	Red	Red	Red	Black	Black
109 Cages	112 Cages	Green	Yellow	Yellow	Red	Red	Red	Red	Red	Black
105 Cages	108 Cages	Green	Yellow	Yellow	Red	Red	Red	Red	Red	Black
101 Cages	104 Cages	Green	Green	Yellow	Yellow	Red	Red	Red	Red	Red
97 Cages	100 Cages	Green	Green	Green	Yellow	Red	Red	Red	Red	Red
93 Cages	96 Cages	Green	Green	Green	Yellow	Yellow	Red	Red	Red	Red
89 Cages	92 Cages	Green	Green	Green	Green	Yellow	Yellow	Red	Red	Red
85 Cages	88 Cages	Green	Green	Green	Green	Yellow	Yellow	Yellow	Red	Red
81 Cages	84 Cages	Green	Green	Green	Green	Green	Yellow	Yellow	Yellow	Red
77 Cages	80 Cages	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Red
73 Cages	76 Cages	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Red
69 Cages	72 Cages	Green	Green	Green	Green	Green	Green	Green	Yellow	Red
0 Cages	68 Cages	Green	Green	Green	Green	Green	Green	Green	Green	Red

Maximum Wind Speed / Maximum Wave Height

Green: Safe to Operate
Red: Unsafe to Operate
Yellow: Operate with Caution
Black: Imminent Danger of Capsize

Appendix 4 Comprehensive Presentation Developed by John Womack, Including Environmental Conditions



Appendix 5 Suggestion for lifting guidance that might appear on a beam trawler Stability Notice