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MARITIME & COASTGUARD AGENCY

Technical Advice Project TA 16/99(b)
The Stability of Fishing Vessels Engaged in Twin Beam Trawling – Phase 2

1 INTRODUCTION

This report describes a programme of work aimed at determining the influence of gear handling on the stability characteristics of UK registered beam trawlers. Following an inquiry into the loss of the beam trawler Margaretha Maria, the MAIB made the recommendation that the MCA should:

Make a study of the actual seagoing stability levels of a sample of operational beam trawlers. The study should be made in the condition where the beams are freely suspended from their derricks topped to normal maximum operational angles and the results compared to the present stability requirements. They should also be used to the adequacy of the existing stability and freeboard requirements. The findings must be made known to the industry as a matter of urgency.

The work was commissioned in a letter Ref. MSA 10/6/148, dated the 9th September 1999.

2 OBJECTIVES

The following objectives were listed in the MCA project specification.

2.1 To establish what proportion of beam trawlers cannot comply with current criteria under all foreseeable operating conditions.

2.2 To calculate the maximum length of derricks and beams to ensure that the vessel's stability continues to satisfy current criteria under certain operating conditions.

2.3 To determine whether the current additional 20% factor of safety for beam trawling stability criteria, compared with those for other fishing vessels, is sufficient. If not, to determine a more effective figure or alternative prescriptions.

2.4 To identify practical and effective means for preventing reduction in stability as identified in the MAIB report on the loss of the Margaretha Maria.

3 INDUSTRY STANDARDS IN THE NETHERLANDS

3.1 Meeting with the Dutch Authority

A meeting was attended at the Netherlands Shipping Inspectorate in Rotterdam on 17th November 1999, with R. Ackerboom of the Safety Management Division, and C.H.M. van Schie of the Shipping Inspectorate. These representatives respectively are responsible for developing and implementing the safety regulations for fishing vessels registered in the Netherlands.

They described the recent history of their regulations, from an extensive programme of research which began around 1967, to the present time. The research conducted 30 years ago resulted in a general raising of their stability requirements, accompanied by substantial improvements to vessels in their fleet. Some vessels were ballasted, others had insufficient freeboard to enable ballasting and many of these were lengthened. Vessels for which modification was not viable were sold out of the Dutch registry or scrapped. Substantial government aid was made available to assist in the programme of modifications, with compensation in the cases of unsuitable vessels. Many Dutch vessels are now within the UK registry, but it is not known what proportion of these failed to comply with the Dutch regulations.

3.2 Dutch Beam Trawler Standards

The Dutch stability criteria are the same as the current UK criteria, with the addition of a power factor which requires the stability to be increased if propulsion power is relatively high. The limiting power for application of the minimum stability criteria is:

Limiting Power = $0.6(LOA)^2$ for vessels of LOA less than35 metres.
Limiting Power = $0.7(LOA)^2$ for vessels of LOA more than37 metres.
A linear interpolation is used for vessels between 35 and 37 metres.

For vessels with installed power greater than these values, the minimum GM, GZ values and GZ curve areas in the stability criteria are increased by the ratio of installed power to limiting power. Many Dutch registered vessels, particularly the larger ones, are required to meet increased stability requirements because of their installed power.

All new vessels are required to be equipped with warp tension monitoring equipment and a large proportion, perhaps 90%, of the older vessels have been retro fitted. The skippers appreciate its value, perhaps in terms of reducing wear and damage to the gear rather than safety, and tend not to sail if the equipment is faulty.

All new vessels are required to have the towing block release cable led permanently to a winch which is controlled from the wheelhouse. To attempt to free a fastened trawl with the towing block at the derrick head contravenes their operational regulations, but this does not prevent crews from making initial attempts at freeing the gear in this configuration.

3.3 Dutch Casualties

A copy of an internal NSI report was supplied, in Dutch, describing the recent casualties, and alternative methods of bringing the trawl warp lead inboard for the purposes of recovery of heavy loads or freeing from an obstruction. This was translated into English.

Between 1985 and 1999, 8 vessels between 15 and 24 metres capsized. A brief description was given of each incident and its cause. In two cases the capsize was attributed to attempts to free a fastener while hauling from the derrick head. In four cases it was attributed to attempts to raise or board heavily laden trawls. In two cases the cause has not been established.

Of the cases where large loads were being lifted, one capsize was the result of derrick failure, and the other three were caused by the gear and, or, the derrick on the higher side swinging across to contribute to the heeling moment. All casualties were attributed to human error.

4 VESSEL SURVEYS

A number of beam trawlers were surveyed briefly in order to gather data which were required for the study, but not available in stability booklets. These data included the derrick and winch arrangement, and the type and size of gear in use. Each visit was arranged with the skipper present to enable a discussion of the gear handling procedures, both for normal operation, and for attempting to recover trawls heavily loaded or fastened.

Whilst visits to the ports were prearranged between the MCA and a local fishing industry representative, it was not possible to guarantee visits to specific vessels. The visits tended to be on an ad hoc basis, taking advantage of the vessels in port with skippers present during the period of the visit to the port. Because of this arrangement, MCA stability files were not available until after the visit. In some cases it was realised then that a vessel surveyed did not have a full stability booklet but was certificated on the basis of a roll test.

The following visits were made:

Penzance and Newlyn,	15th and 16th October
Brixham	29th and 30th October
Lowestoft	8th and 9th December

In each case the Wolfson Unit engineer was accompanied by representatives of the MCA. A questionnaire was prepared prior to the port visits, and this was completed by the Wolfson Unit engineer during the discussion with the skipper. Typically one hour was spent on each vessel, engaged in discussions, taking measurements, and obtaining a photographic record of the fishing gear and handling equipment. Figure 1 illustrates the range of vessels included in the study in terms of their length and age.

5 GEAR HANDLING PROCEDURES

Interviews with the skippers revealed that standard procedures for handling the gear are common to most vessels, with detailed variations depending on the vessel layout, and personal preference in the rigging and handling arrangements. In the following sections it should be borne in mind that the skippers were asked for their opinions on the effect of the operations on the stability of the vessel, rather than on the personal safety of the crew. Some parts of the operation may be relatively hazardous in terms of the potential for personal injury, but this was not considered in the study.

5.1 Shooting The Gear

The gear is deployed with way on the vessel so that the nets stream aft, clear of the propeller. Deploying beam trawls is done on arrival at the grounds, and they are not normally boarded again until the fishing operations are complete. The vessel has a large quantity of fuel and a relatively high displacement, so the righting moments are, in most cases, at their highest level during the fishing period. None of the skippers indicated that this operation gave them any cause for concern.

Scallop dredging gear must be brought aboard the bulwark to empty the dredges, and so shooting and boarding the gear is carried out throughout the fishing period.

5.2 Trawling

The gear is towed, typically at 4 to 6 knots, from the ends of the horizontal derricks. The loads may be high, but are angled well aft rather than vertical. If a load increases as a result of debris in nets, or a fastener, a change in the helm or heading of the vessel are likely to be the first indications rather than heeling of the vessel. None of the skippers indicated that their vessel was endangered by the sudden fouling of the gear.

5.3 Raising The Gear

With speed reduced, the gear is raised periodically to board the catch and, initially, the warps are hauled with the derricks in the horizontal position. Most skippers top the derricks to about 30 - 45 degrees when a certain length of warp remains to be hauled, but there appeared to be little consensus on the length, it varying from 10 to 100 fathoms. The purpose of topping the derricks at this stage was unclear, with varying reasons given. It may save some time in the hauling operation.

From the stability point of view this aspect of the procedure appears to be undesirable, because it transfers the loads to a higher location than perhaps is necessary. None of the skippers indicated it to be a potential hazard.

5.4 Boarding The Cod End

With the beams at the surface and the derricks topped to 30 - 45 degrees, the lazy decky is retrieved from the inboard end of the boom, connected to the gilson, and hauled aboard. The gilson passes over a block at the gantry, or mast head, rather than on the derrick, and so the weight of the gear is distributed between the derrick end and the gantry head. Some vessels use an alternative arrangement with a buoyed line to the cod end which is retrieved with a boat hook, and then attached to the gilson. None of the skippers indicated this operation to be particularly hazardous.

5.5 Retrieving Heavy Gear

At times the trawls may become fouled with stones, sand, weed, shells, starfish, or other debris, or some combination of these. In many cases the net fails when raised from the sea bed. If the net remains intact, various methods are employed to remove such loads from the gear, and they may involve loss of the catch which is unlikely to be of value in such circumstances.

5.5.1 Hauling the gear and removing the debris. If the load is not excessive the cod end, or scallop dredges, may be retrieved in the normal way and either boarded, opened over the side, or held fast while the beam is lowered to invert the net.

5.5.2 Hauling the gear and steaming with the cod ends at the surface. The beams may be brought above the surface with the derricks topped to about 45 degrees, and the cod ends streamed at speed to wash out sand.

5.5.3 Steaming with the gear off the sea bed. It may be possible to wash out sand with the gear raised just above the bottom, in which case the derricks may remain horizontal.

5.5.4 Chafing out the net. The gear may be raised from the sea bed then lowered upside down, and towed over rough ground to chafe out the weaker top section of the net. This may take some time, and may require steaming to appropriate rough ground. Repairing the net is a relatively simple process and not regarded as a serious drawback.

Retrieving abnormally loaded gear in heavy weather was cited by some skippers as a procedure which might render the vessel relatively vulnerable.

5.6 Freeing Fastened Gear

If the gear comes fast on an obstruction such as a rock or wreck, the vessel is stopped, then hauled over the obstruction on the winch. The gear on the free side is raised and suspended in the water with the derrick horizontal. (The advice given in a Department of Trade, Merchant Shipping Notice M1657, states that the gear on the free side should be raised and suspended close to the vessel's side, but all skippers considered this procedure to be less safe.) Attempts are then made to free the gear by hauling, or by steaming in the opposite direction to that in which the obstruction was fouled.

Attempts are made with the towing block at the derrick head, and in very rare circumstances the slip hook may be released to drop the towing block and take the load on the shoulder block. Typically the skippers interviewed had released the block from the derrick on one occasion in their career.

Attempting to free fastened gear in a strong tidal stream and heavy weather was regarded as potentially hazardous by most skippers, and many stressed that patience is required to await slack water and suitable conditions for the operation.

5.7 Boarding The Gear

At the end of the fishing trip the beams and chains are boarded for the passage to port. With the cod end aboard, the derrick is topped up so that the beam is above bulwark height, and the gear is swung aboard using the roll motion of the vessel. It is lowered to the deck and made fast, and the gear on the other side is boarded.

Because the weight of a beam trawler's catch is considerably less than the weight of fuel consumed in a typical trip, for most vessels the righting moment is at its lowest level at the end of the trip. This may come as a surprise to those familiar with the stability booklet presentation of righting arms, because the GZ values typically are greater at the end of the trip, because of the greater freeboard. It is, however, recognised by the skippers, and lifting the gear from the topped derricks was cited by most skippers as perhaps the most vulnerable procedure in the normal fishing operation. If the weather is severe, the vessel may steam with the gear towed from the derricks until calmer conditions are reached.

6 WINCH CONFIGURATIONS

Some concern had been expressed regarding the use of dog clutches on trawl winches. One of the vessels surveyed was equipped with a pair of such winches, each with two drums, the others having wheelhouse controlled friction clutches. The dog clutch winch is held on the brake with the clutch disengaged when trawling, so that the warp may be payed out if a trawl comes fast. The fear is that it is not possible to release the clutch instantly in the event of the vessel suffering a sudden offset moment when hauling. The skipper of the vessel surveyed did not regard the winch as a potential problem provided it was operated by a competent person.

Examples of belt driven, hydraulic and electric winches were seen, most with pneumatic friction clutches. On one vessel surveyed the electric winch was installed in the forward hold. This is beneficial in terms of stability, and the vessel's characteristics were well above the average.

Some vessels have four drum winches, to control the trawl warp and topping lift on each side, with separate manual drums for hauling on the gilsons. Most of the winches have six drums, enabling the gilsons to be wound on permanently. Some recent installations have eight drums, and the additional two drums enable the trawl block release mechanism to be operated from the wheelhouse.

With the controls in the wheelhouse the winch is under the command of the skipper, or another competent crew member on watch, who is in the best position to monitor the other factors affecting the stability and safety of the vessel. The controls are generally positioned forward in the wheelhouse, in order that the operator can stand adjacent to one of the forward windows. In spite of this favourable position, his view of the after part of the working deck is not good, and in many cases it is normal to lean through the open forward window when handling gear.

In every case the trawl warp was terminated with a weak link, usually a light line, so that it may be let go in the event of danger such as a trawl becoming fouled with another vessel. Under normal operation between one and five layers of warp remains on the winch.

7 STABILITY INFORMATION

7.1 Acquisition of Data

Extracts from MCA stability files were made available for those vessels surveyed, and for a selection of additional vessels. The extracts included relevant parts of the stability information booklets, general arrangement drawings, inclining experiment reports and lightship check reports. The presentation of the information was variable, having been prepared by different consultants and surveyors, and some originated in the Netherlands.

It is usual to conduct the inclining experiment with the derricks topped and fishing gear on deck, although in deriving the lightship condition, the derrick position frequently is adjusted to 45 degrees. This adjustment is beneficial to the assessment of a vessel with marginal stability, increasing the likelihood of compliance with the criteria. It has been allowed by the MCA following the argument that, typically, the vessel operates with the derricks at 45 degrees when on passage, and horizontal when trawling. The angle of the derricks used for the stability booklet presentation was noted, and adjusted as appropriate in the analysis. Where derricks were quoted as fully topped for inclining, it was assumed that they were at 80 degrees.

The regulatory requirements are for presentation of freeboard and stability information at a number of stages during the voyage cycle. Due to the variability of individual voyage cycles, the tank contents as a percentage of total capacity are not consistent. For example, the fuel tank contents for the Arrive Grounds condition varied from 50% to 94% for the vessels surveyed.

The operations of most concern were gear handling during, or at the end of, the fishing period. The 'Arrive Grounds', and 'Depart Grounds with 20% Catch' conditions were taken as most representative. In the latter case the relatively low catch, compared with the fish hold 100% full with homogeneous catch, is more representative of beam trawling operations because the catch typically is a low volume of high value fish. The GZ curves for these conditions were obtained from the stability booklets.

7.2 Accuracy of Data

No attempt was made to verify the data as it was not the intention of this study to investigate the precise stability characteristics of particular vessels, but to study the general level of stability of a representative sample of the fleet. During the course of the study, however, a number of indicators of possible inaccuracies were noted.

7.2.1 Vessel Modification

Most of the vessels had been modified since the general arrangement drawings were prepared for the original construction, and some appeared to have been modified since the last inclining experiment. Modifications typically included an increase in the length of the derricks, presumably in order to handle longer beams.

Some of the stability files contained detailed information on the weights and centres of items added or removed, but it appeared that some had not been detailed in this way, and perhaps not reported.

7.2.2 Inclining Experiment Technique

In general inclining experiments are based on sound practice, and most of the inclining reports indicated efficient procedures. There are a number of common faults which are seen in particular on small vessels however. While similar procedures were identified in several of the inclining experiments, one example has been selected to illustrate a number of them.

It appears to be customary to conduct an inclining experiment with seven or more people on board. This has the potential to reduce the accuracy of readings considerably. For example, a 15 metre vessel displacing 58 tonnes was inclined with seven men on board. Weights of 0.15 tonnes were shifted 4 metres. The weight of the men amounted to 3.5 times that of each group of weights. If all of the 7 men moved position by 0.1 metre in the same direction their combined moment would be 10% of the intended applied moment. A similar error would arise if one of the men moved 0.8 metre.

Experience with inclining small vessels has revealed that it is extremely difficult to persuade personnel, other than trained consultants or surveyors, of the importance of precisely maintaining their position during the experiment. This difficulty extends to the process of reading draughts and freeboards, when it is equally important to maintain constant positions on a small vessel.

The readings for consistent applied moments are presented below, and it is not surprising that the pendulum readings deviate from the mean by up to 17% for the aft pendulum, and up to 30% for the forward pendulum.

Some people conducting an experiment expect a pendulum to return to a previous position when weights are returned to a previous location. This leads to a tendency to mark the inclining batten at a previous mark without due regard to the pendulum movements. In the example the person reading the aft pendulum marked a different position for each of the eight readings, while the person reading the forward pendulum recorded the pendulum returning to previously marked positions each time, despite considerable variation in the deflections.

Shift No.	Direction	Fwd Pendulum	Aft Pendulum
1	Port	34	37
2	Port	21	52
3	Stbd	21	45
4	Stbd	34	39
5	Stbd	23	46
6	Stbd	27	46
7	Port	27	44
8	Port	23	49

The requirement for two pendula to increase the accuracy sometimes is taken to imply that they must be in different parts of the vessel. This may result in a short pendulum being used, leading to a reduction in the overall accuracy of the experiment. The above example also demonstrates this problem where the small deflections resulted from the use of a 1.5 metre forward pendulum.

7.3 Characteristics of the Data

7.3.1 Margin of Stability over the UK Criteria.

The stability data for a large proportion of the vessels were very similar in character. The margins of stability over the current minimum criteria tend to be small, as illustrated by Figure 2. In this presentation each vessel's stability was compared against the current UK beam trawler criteria, and the most marginal characteristic is shown as a percentage of the appropriate criterion. It shows that many vessels are within 10% of the minimum requirement. In most cases the critical criterion was that the maximum righting lever between 30° and 90° must be greater than 0.25 m. As elsewhere in this study, only the stability data for the 'Arrive Grounds' and 'Depart Grounds with 20% Catch' conditions were considered, and the worst case is presented.

One vessel of 25 metres stands out as having relatively high stability, with its most marginal characteristic 100% in excess of the minimum criteria for fishing vessels, and 80% in excess of the beam trawling criteria. This vessel is similar to the other samples in many respects, but has relatively wide beam and a transom stern. In terms of initial stiffness, its GM is 40% greater than its nearest rival, and the wide beam is the principle factor. Its range of stability is not particularly high in relation to the other vessels.

Some of the small vessels also have very good stability, and in some cases the performance may be attributed to a relatively high freeboard, and results in a relatively large range of stability.

The larger vessels do not appear to be exceptional in any way. They have a GM a little above average, and moderately high freeboard, and it appears to be this combination of good proportions which accounts for their relatively good stability. It may be that their size enables a combination of design parameters and arrangement which results in good stability, and the data on this plot suggest a trend of increasing stability margin with size, for vessels over 20 metres.

In Figure 2, the casualty presented with the small stability margin is the Margaretha Maria, and the one which fails to comply is the Pescado. The latter was approved on the basis of a roll test. It is important to note that the stability data for the Margaretha Maria are those used for approval of the vessel, and include the aft shelter as a watertight contribution. The vessel was found with the doors to this space fastened open however, and the range of stability was substantially less in this configuration.

7.3.2 Stability Variation with Age of Vessel.

Figure 3 offers an alternative presentation of these data on the basis of the age of the vessels. It suggests that there may be a general trend for the more recent vessels to achieve better stability, but there are some recent vessels which comply by the smallest of margins. The tendency for vessels to become heavier and less stable with age, because of increased lightship weight or heavier fishing gear, may contribute to this trend.

7.3.3 Variation of Beam and GM.

Figures 4 & 5 show the variations of overall beam and GM with the length of the vessels studied. The data in Figure 4 lie generally within a narrow band, in which the beam/length ratio decreases with length. Two vessels stand out as having relatively wide beam for their size. One of these, at 25 metres, is referred to above, and Figure 5 shows that its GM is significantly higher than the others.

It is interesting that the smallest vessel in this sample also has a relatively high GM, despite a relatively narrow beam for its size. This small vessel has only a small wheelhouse, gantry and derricks above the deck, whereas the larger vessels have accommodation and other structures above deck, and this may account for the different stability characteristics.

Apart from these exceptions, the sample vessels lie within a narrow GM range, and reveal no trend of GM variation with size.

7.3.4 Variation of Displacement with Length.

Figure 6 shows the variation of displacement, taken in the 'Arrive Grounds' condition. The data lie generally within +/- 20% of the mean value for a given length.

7.3.5 The Effect of Displacement on Righting Moment.

As noted in section 5.7, the use of righting arms can be misleading because the variation in displacement may have a greater effect on the righting moment than the GZ variation during the voyage cycle. For the samples considered the GM change between the two conditions varied from an increase of 9% to a decrease of 16%, but the displacement always decreases during the voyage. For these samples the displacement reduced by amounts varying from 3% to 14%. The increased freeboard at the end of the voyage gives improved large angle stability, with higher maximum GZ values, and this gives the impression of improved stability in the conventional presentation.

8 OTHER SOURCES OF DATA

The Sea Fish Industry Authority kindly made available a summary of data derived from a survey of UK beam trawlers which they conducted ca.1992. Stability was not addressed, and the accuracy of the data could not be verified but, owing to the increased number of samples, the data enabled a better statistical study of some relationships, such as gear weight, or engine power, to vessel size.

9 DATA ANALYSIS

9.1 Effect of Derrick Position

While the vessels are normally inclined with the derricks fully topped, it is acceptable for a correction to be applied so that the stability data in the booklets is presented for the derricks at 45 degrees. Where this correction was not indicated, it was assumed that the derricks were topped to 80 degrees for the inclining experiment and lightship derivation.

The weight of the derricks is substantial, and their position will affect the centre of gravity, and hence the stability. In the analysis conducted for this study, adjustments were made to the centre of gravity, assuming the weight of the derrick is distributed with 3/4 at its mid length, and 1/4 at the end of the derrick. This latter weight was to represent the towing block, topping lift blocks, preventer, and their various attachments. While the derrick weight estimated in this study was not necessarily identical to that used in preparation of the booklet, any differences would be small and their effect on the findings negligible. A trend was identified between derrick length and derrick weight, and this was used to estimate the weight of derricks for which no data were available. See Figure 7. The weight appears to be proportional to the square of the length, as might be expected, but since much of the data is from a single consultant, this might only reflect his original assumptions. Some of the weights quoted appear to be unreliable, because they lie outside of the general envelope of data. It is unlikely, for example, that a particularly light derrick could meet the structural demands of the fishing operations.

During the vessel surveys it was noted that a number of derricks had been strengthened by welding one or more webs along the length, thus increasing their weight.

The angle of the derricks when topped up to board the gear is dependent on the derrick length and pivot location. It was assumed that the top of the derrick would be vertically over the bulwark rail, and in most cases this was the position of the derricks when surveyed. The angle was estimated from the drawings and photographs. Some skippers stated that they topped the derricks fully when boarding the gear to prevent any movement after the gear weight was transferred to the deck.

9.2 Gear Weight and Position

In most cases the gear weight used was a value quoted in the stability booklet, but the accuracy of this value was not known, although in some cases a weigh bridge measurement was referred to. It should be noted that the weight of a vessel's beam trawls vary considerably over a period of time because of the considerable wear of steel chains and other components, and their sequential replacement.

The remit of this study was to include both beam trawls and scallop dredges, and vessels operating both types were included. These types of gear are very different and this may be reflected in their weights. There are also two distinct types of beam trawl, using tickler chains or chain mat. The former, with a number of transverse chains, is used on clean ground. For operation over rocky ground, to minimise the quantity of large stones entering the trawl, longitudinal chains are also fitted and connected to the beam and each transverse chain, so that a grid of chain forms the mat. The weight of chain in the mat therefore is greater than with tickler chains alone. The number of chains fitted appears to be subject to the personal preference of the skipper, as well as the bottom conditions in the area trawled.

Figure 8 presents the data gathered on the weight of gear and its variation with beam length for the sample vessels. The data indicate that scallop dredges are generally lighter than trawl gear with the same beam length. One would not expect the gear weight to be proportional to the beam length, but to increase with the length squared, or perhaps cubed. This is reflected in the curves fitted to the data.

The weight of the smallest beam trawl was quoted in the booklet as 0.5 tonnes, but comparison with the Seafish data suggests that this may be a substantial underestimate, and its implications should be borne in mind when viewing subsequent data plots where gear weight is a factor. Such an inaccuracy would have serious implications for any assessment of the heeling moments induced by gear handling. Further data on trawls which had been carried by under 12 metre casualties was provided by MAIB. Their weights were 0.9 and 1.2 tonnes with 4 metre beams, and 1.8 tonnes with 4.5 metre beams.

Figure 9 presents the data on gear weight in relation to vessel displacement. The graph shows distinct trends of increasing gear weight with displacement, for each of the gear types identified. The increase reaches a finite limit because of an upper limit on gear size which is imposed on the fishing industry.

The scatter of data on these graphs may be due to variations in gear configuration, or to inaccuracies in the weights quoted.

The stability booklet presentation assumes gear on deck, as inclined, and it was observed during the vessel surveys that the weight of the fishing gear typically is centred about 300 mm above the deck. This value was used for all vessels.

The weight and location of trawl warps was not considered in this study, and so was assumed always to be on the winch, as for the inclining experiment and stability booklet presentation. Since the configurations of most interest were with the gear raised, this is a valid assumption.

9.3 Engine Power and its Implications

There has been a distinct trend in recent years for an increase in engine power in beam trawlers. Greater power enables the vessel to tow longer beams and heavier gear, and to maintain an effective towing speed or cover more ground in a given time. The use of longer beams requires longer derricks, and so increased engine power gives the potential for increased heeling moments. This influence of engine power was recognised by the Dutch authorities and resulted in their introduction of an engine power factor on the stability criteria, as described in section 3.2.

Figure 10 presents the relationship between beam length and engine power. A maximum aggregate length of 24 metres for beam trawls is imposed on the fishing industry, and a limit of 9 metres aggregate length applies to those vessels operating within the 12 mile limit.

The variation of installed power with vessel length is presented in Figure 11, together with the limiting value for use of the minimum stability criteria in the Dutch regulations. It is clear from this presentation that most UK vessels would be required to meet increased stability criteria if they were registered in the Netherlands, and for some of them the increase would be considerable. Several horizontal groups of data on this plot indicate the common installation of a popular engine, or a restriction imposed by fishing industry controls.

Figure 12 presents the values of the power factor which would be applied to the stability criteria if these were Dutch boats, and in Figure 13 their stability is compared with the factored criteria. It is notable that the Margaretha Maria would have met the Dutch criteria, with the stability characteristics as presented in the MAIB report, while more than half of the sample vessels would not comply.

10 EFFECTS OF GEAR HANDLING ON STABILITY

10.1 Lifting Capacity

Beam trawlers are equipped with powerful winches and strong lifting gear, which have the capacity to lift one or both trawls, plus substantial additional weight, with derricks at various attitudes. Under normal circumstances the fishing gear weight is reduced, being suspended in water for much of the time, but this is offset by the presence of additional material within the trawls.

Fish are neutrally buoyant, and their weight becomes a consideration only when the cod end load is taken on the gilson line from the gantry head. Other material such as sand, stones and shells add to the gear weight and increase the potential heeling moments. The trawls and scallop dredges have the capacity to carry considerable weights, although the nets frequently fail with large quantities of debris. The MAIB report on the Margaretha Maria casualty indicates that the weight of sand in her trawls may have been up to twice the gear weight. Examination of the data for the sample vessels indicates that very few of them would have the stability to lift such a weight on one side only, even when offset with the other gear at the end of the horizontal derrick.

It is clear that many, and perhaps all, of these vessels have sufficient capacity in their lifting gear to generate a heeling moment sufficient to cause capsize. This supports the comment offered by most of the skippers that substantial experience is required to operate a beam trawler winch system safely.

10.2 The Effects of Derrick Angles

Considering the gear weight alone as being representative of the normal fishing operations, the stability of a selection of vessels was calculated to determine the effect of various combinations of port and starboard derrick angles. Those vessels selected were: vessel A, the 25 metre vessel revealed in Figures 2 and 5 as having particularly good stability characteristics; vessel B, a typical vessel of 29 metres which meets the UK criteria with a 10% margin; and the Margaretha Maria. The results of these calculations are presented in Figures 14-16. Note that for the Margaretha Maria, the stability data are for the approved configuration with the aft shelter watertight, and this accounts for the increase in the GZ values above 40 degrees.

In each Figure four graphs are presented, each for a different angle of the port derrick. For each of the port derrick angles, GZ curves are presented for the same four starboard derrick angles. Angles of 0, 30, 45 and 80 degrees were used, representing derricks horizontal, typical angles used when washing out sand or boarding the cod end, and fully topped for boarding the gear. The graphs are drawn with heel angles to starboard positive, and they show the stability to port and starboard. There is some redundancy in the graphs, for example, the curve for port 0 and starboard 80 is the same as that for port 80 and starboard 0, albeit inverted.

On each graph there is one symmetric curve with both derricks at the same angle. None of them corresponds to the stability booklet presentation, where the derricks are topped or at 45 degrees, with the gear is on deck. When freely suspended, the effective centre of gravity of the gear is at its point of suspension, that is the derrick head. As the derricks are topped, the centre of gravity rises, and with the derricks fully topped the stability is reduced dramatically in all three cases.

With the derricks raised asymmetrically, the curves show the angle of list and the fact that the stability to the side of the list is reduced, while that to the side away from the list is increased. Although the maximum value of GZ and the range of stability are affected, the angle of maximum GZ remains roughly constant.

Considering the situation where one derrick is horizontal with the gear suspended as a counterbalance, while the other derrick is raised to board gear or empty a net laden with debris, this is illustrated by the first graph on each of Figures 14-16. With the port derrick horizontal and the starboard derrick topped up, there will be an angle of list to port, and substantially reduced stability to port. This helps to explain the casualties experienced in the Dutch fleet, where the derrick swung across the vessel towards the low side. If the starboard derrick is fully topped, to say 80 degrees, a list of 10 degrees will put the derrick vertical, and gear suspended above the water surface will be liable to swing to port, where there is little stability reserve. This suggests that it is safer to lift the gear with both derricks topped to the same angle, although this is likely to be contradictory to the perception on board, where a list against the lift will be perceived as a benefit.

10.3 The effect of Topping Both Derricks on KG and Stability

To quantify the decrease in stability for the sample vessels when handling the gear symmetrically, two configurations were considered. The first assumed that both derricks are at 45 degrees, to simulate the situation where beams are raised to access the lazy deckies and the cod ends are boarded. The second assumed that both derricks were topped up to board the gear. These configurations quantify the effects of increasing the KG by lifting the gear, and the latter gives the minimum symmetric stability condition without additional weight in the gear.

The results of these calculations are presented in Figures 17 and 18, using the same format as Figure 2. Of the 17 surviving vessels included in this sample, only 6 comply with the standard fishing vessel criteria with the gear suspended from the derricks at 45 degrees, although 2 more are very marginal failures. With the derricks fully topped, only 4 vessels comply. It may be comforting that the two casualties fare particularly badly in this assessment.

10.4 Angle of List with Gear Deployed One Side Only

To quantify and compare the effects of asymmetry, the angle of heel was calculated for the configuration of one derrick horizontal with the gear suspended from it, and the other derrick fully topped with the gear on deck. Whilst this might not represent a normal operational configuration, it was chosen as a configuration which could be achieved readily in port if it were considered to be a relevant means of assessment. Figure 19 presents the results in terms of the angle of list in each case. The angles of list vary between 5 and 15 degrees, with the majority between 8 and 12 degrees, and the casualties both at 12.5 degrees.

10.5 The Effects of Lifting Additional Weight on Stability

Figure 20 illustrates the effects of lifting additional weight, such as when washing out sand with the derricks topped to 45 degrees. It is assumed for this illustration that an additional weight equal to the weight of the gear is being lifted on each side, and the stability is compared with a standard condition illustrated in the stability booklet, with gear on deck. Because these calculations have been conducted by adjustment of the stability curves presented in the booklet, full account has not been taken of the additional displacement, which will result in earlier immersion of the deck edge. The derived curves therefore may be a little optimistic.

The calculations are presented for the three sample vessels used previously. It is very apparent that the additional load taken on the topped derricks is severely detrimental to the stability because of its effect on the VCG of the vessel. The magnitude of the GZ values is reduced to less than half of the original values, on which the vessel is assessed.

The third curve presented represents an asymmetric loading scenario, such as, when washing out sand on both sides, one net fails and its load is released. In the case of vessel A this would result in a list of 12 degrees and a residual range of stability of 25 degrees. On the more typical vessel B, the list would be similar, at 13 degrees, but the residual range would be only 19 degrees, and the maximum residual GZ only 0.04 metre. Margaretha Maria could not sustain such an asymmetric moment, and would capsize, even with the aft shelter assumed intact.

It appears that beam trawlers handle weights in excess of those used to illustrate this effect, and while they are approximately symmetric, the list of the vessel will be negligible, and the potential danger will not be apparent to the skipper. The characteristic most likely to indicate a substantial reduction in stability will be the roll period.

10.6 The Effects of Gear Handling on Roll Period

The roll period is proportional to the roll inertia, and inversely proportional to the square root of GM. With gear suspended from the derricks the roll inertia will be increased because of the increased inertia of the gear. With empty gear and derricks at 45 degrees, the roll inertia of vessel B is increased by 50%, and the roll period will be increased by the same amount. The decrease in GM would be 30%, and this would increase the roll period by a further 14%.

With an additional weight of debris in the gear, the roll period would increase by the same amount again. These estimates do not include the effects of the added inertia of water entrained within and around the fishing gear, and this is expected to be a further significant factor. The roll period in this situation may be two or three times that of the vessel with gear on deck,

These estimates demonstrate that the roll periods of these vessels fluctuate a great deal as a result of the inertial effects of gear location. The effects of GM on the roll period are much less significant and, while they may be detectable, are likely to be masked by the inertial effects.

The skippers and crews regard a long roll period as a benefit because it facilitates working on board. Some of them understand that a long roll period may be indicative of low stability, but it seems unlikely that they will use this knowledge to good effect in a critical situation. They are likely to interpret the dramatic effect of the deployed gear on increasing the roll period, and the very large roll damping effects that immersed gear will have, as stabilising influences on the vessel. The vessel will be far more comfortable, and a more stable working platform with the gear deployed, particularly if it contains additional weight.

11 COMPARISON WITH OTHER VESSEL TYPES

Vessels which are equipped to lift loads over the side generally are required to demonstrate by calculation that the lifting capacity of the gear will not overcome the stability, or have limitations on lifting based on a limiting heel angle. This may be an option for beam trawlers, using a technique such as described in section 10.4.

The operation of beam trawlers differs from most commercial vessels, where the stability is sufficient to counter any heeling moment imposed by the vessel's own equipment. Beam trawlers therefore may be compared with vessels such as sailing dinghies, sailboards or kayaks, the stability of which is totally dependent on the actions and expertise of the crew. It has not been possible to develop satisfactory stability criteria for such craft because of this dependence on the crew ability.

Sailing yachts and sailing ships present a similar problem because there will be some combination of sail area and wind strength which will lead to capsize, unless the range of stability exceeds 90 degrees. Commercial sailing vessels are required to have such a range of stability, and their skippers are provided with simplified information regarding their level of safety against downflooding when under sail, determined by their heel angle. The techniques developed for these vessels cannot be used for beam trawlers because the loads are normally applied symmetrically to the derricks, so that the heel angle gives no indication of their magnitude.

12 POSSIBLE ASSESSMENT ALTERNATIVES

12.1 Modify the Existing Minima

The existing method of adjusting the stability criteria by a constant factor for all beam trawlers could be modified to raise the minimum level of stability of the fleet. This study has demonstrated that this technique currently does not address the effects of gear handling, the existing 20% adjustment being insignificant in comparison with these effects.

To ensure that beam trawlers comply with the standard stability criteria in all operating conditions, even with unloaded trawls, might require an adjustment of the criteria by a factor of 2, rather than the existing 1.2. With a few exceptions, the existing fleet could not be adapted to meet such a standard.

A disadvantage of such a method is that it does not allow for a general development of fishing gear which may result in heavier loads being applied over a period of time. It is believed that such a development in beam trawling over the past 20 or 30 years has led to the present situation.

12.2 Adopt an Engine Power Factor

The use of the engine power is a simple attempt to take into account the potential to handle heavy gear. This study suggests that it is not a sufficiently accurate quantification of the gear weight. The Margaretha Maria casualty, if the stability data are valid, suggests that the Dutch criteria may not be set at a sufficiently high level, or may not address the situation adequately.

Many people in the industry are of the opinion that the quoted engine power may not be sufficiently representative for assessment purposes. If it were to be adopted as a factor, this problem could be addressed, but it is not considered the appropriate option.

12.3 Take Account of Raised Gear

It would appear to be more precise to assess individual vessels on the basis of their actual weight of gear and derrick arrangement, rather than some statistical assessment of the fleet in general. The derrick length is readily measured, and it does not seem unreasonable to expect the maximum weight of gear to be determined with some accuracy, in view of its significance to the stability.

The minimum level of stability could be set in some operational configuration, such as with the derricks fully topped, but very few of the existing fleet could be adapted to comply with the standard fishing vessel criteria in such a configuration.

The Margaretha Maria casualty fares poorly on this assessment, as indicated in Figure 18, and this supports its potential value.

12.4 Take Account of Offset Moments

Using the technique described in section 10.4, a maximum limit could be set on the heel angle with the gear deployed on one side only. This technique could use the vessel to check the gear weight, if a physical heeling test were undertaken at the time of the inclining experiment. The result could be used, with the measured derrick length, to determine the angle of heel in the Arrive Grounds and Depart Grounds conditions.

This technique may be of particular benefit in assessing vessels for which full stability data are not available. It may therefore be of benefit in assessing vessels of less than 15 metres, which are outside the scope of this study.

12.5 Require Load Monitoring Instrumentation

If the trawl warp loads were monitored routinely, it would be possible to advise the skippers of maximum safe working loads, based on some stability safety margin. This margin could be set with regard to the possibility of offset loading of the derricks, and the rise in KG associated with topping the derricks to enable operations such as washing out sand, boarding the load, or accessing the lazy decky to invert the net.

The general consensus among the UK skippers and owners appeared to be that load monitoring equipment could not be reliably maintained in their working environment. The experience of the Dutch fleet appears to contradict this opinion. One of the UK skippers interviewed was planning, on economic grounds, to install the same commercially available equipment which is fitted to the Dutch fleet. He considered that the equipment would reduce gear losses and wear, and improve the efficiency of his operation.

In addition to monitoring warp loads, the system can be configured to pay out warp, and reduce propeller pitch or revolutions, in the event of a sudden load increase. By detecting smaller load increases, the system will warn of debris accumulating in the nets at an early stage.

Information from the equipment supplier reveals that their system is in very widespread use throughout the world, but has been supplied to only five UK vessels. The reason for this is not known.

13 RECOMMENDATIONS

13.1 Gear Handling

It is clear that no beam trawler should be operated without experienced crew available to control the winch system. It is understood that there is no formal requirement for qualifications or experience in this aspect of the operation, and no training courses are offered in the UK. Most of the skippers interviewed had considerable experience, and provide informal instruction to crew members at sea to train them in winch operation.

Crew training is beyond the remit of this study, but it is suggested that some form of training would be beneficial in enabling a better understanding of the potential hazards of gear handling. The use of physical models have been found to be particularly useful in this type of training, see the reference in section 14.3.

13.2 Winch Configuration

There is widespread concern over the safety of dog clutch winches, but the evidence of this study is that few remain in service on these vessels, and new installations are not of that type. It is likely therefore that they will cease to be a problem in the near future, and the introduction of new regulations regarding their use may not be required.

13.3 Stability Assessment

13.3.1 Stability Measurement.

The MCA should provide training of surveyors in the different techniques required when inclining small vessels compared to those developed for large ships. The codes of practice recently developed for various small commercial vessels, other than fishing vessels, have resulted in more inclining experiments being undertaken on small vessels, and such training would be of great benefit.

13.3.2 Derrick Position.

The allowance of an adjustment of VCG for derricks lowered to 45 degrees should be discontinued. The inclining experiment should be conducted with the derricks fully topped, and no adjustment to their VCG made. Whilst they may not be fully topped during normal operation, the difference between the VCG when fully topped, and when topped for boarding the gear is negligible.

13.3.3 Gear Weight and Derrick Length.

As these parameters are fundamental to the stability of the vessel they should be determined accurately, and presented prominently in the stability booklet, together with the beam length. The gear weight may vary considerably with wear, and the weight presented should reflect the maximum weight of new gear. If a vessel is fitted with warp tension monitoring equipment, the gear weight could be checked during any inspection of the vessel.

13.4 Stability Requirements

The legal requirement for all fishing vessels to meet the standard minimum criteria '*in all foreseeable operating conditions*' is not met in the case of most beam trawlers. Figure 17 illustrates that fewer than 50% of those surveyed comply with the requirements when the gear is deployed with derricks at 45 degrees, fewer still will comply with additional weight in the gear. It is the technical and practical aspects which are the subject of this study, however, rather than the legal implications.

The stability characteristics of some vessels may be considered to be inadequate for their operation and it may be preferable to increase the minimum requirements. To increase the level of stability of the fleet to ensure fail safe operation of the lifting gear is not considered practical. Similarly, to reduce the derrick lengths or gear weights to ensure fail safe operation would render the existing fleet uneconomic.

It is unclear, therefore, what level of increase can be justified. The number of well documented casualties is insufficient to enable a new minimum level of stability to be justified on statistical grounds, and the level cannot be increased to ensure fail safe operation. In view of the political implications it may be preferable to maintain the current stability criteria and to concentrate any new regulatory effort on the operational aspects.

If it is considered appropriate to adopt a revised method of assessment, it is recommended that this should address the effects of gear handling by incorporating gear weight and derrick length. This may be by calculating the stability with the gear raised, as illustrated in Figure 17, and by applying some relaxation of one or more of the standard criteria, such as the maximum value of GZ which is most frequently the critical criterion. The minimum level might be set at, say, 75% of the standard value, justified in the assumption that this situation would not occur in severe weather conditions.

An alternative method might use the angle of heel with an offset load, as illustrated in Figure 19, with a maximum allowable angle of, say, 12 degrees.

These assessments would need to be made in the worst operating conditions, which might be either 'Arrive Grounds' or 'Depart Grounds'.

13.5 Vessel Equipment

The value of warp tension monitoring equipment should be demonstrated to the owners of UK vessels. It is likely that the economic benefits will be perceived as more valuable than the safety benefits, and therefore the involvement of Seafish may assist in delivering a convincing argument.

The requirement for warp tension monitoring equipment to be fitted should be considered, particularly on new vessels.

13.6 Information for Skippers

The existing format of stability information booklets is not generally understood or used by fishing vessel skippers. The loading condition of the vessel does not deviate substantially from the standard voyage cycle, and so there is no requirement to calculate the stability as there may be on a cargo vessel. The booklet contains information which may be useful to the consultant considering possible modifications to the vessel, or the authority assessing the stability, but is not suitable as an on board safety reference document.

A standard, single page presentation, which shows the relative level of safety of the vessel during gear handling operations, might be posted in the wheelhouse and memorised or referred to on a daily basis. It might state the maximum safe warp load if warp tension monitoring equipment is fitted, or be in the form of a stability diagram such as in Figure 20. In the latter case, a standard set of configurations should be adopted, with which fishermen may become familiar. They might use standard gear loads with an indication of their effect on stability, or use selected stability criteria to determine the maximum safe loads. It is unclear from the interviews conducted, whether skippers are sufficiently familiar with the conventional GZ curve presentation, or whether some alternative presentation would be preferable.

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APPENDIX. SUMMARY OF VESSEL DIMENSIONS AND CHARACTERISTICS

Registered Length metres	Year Built	LOA metres	Max Beam metres	L/B	Displace-ment tonnes	Gear Type	Beam Length metres	Gear Weight tonnes	Derrick Length metres	Derrick Weight tonnes	Topped Angle degrees	Engine Power kW	GM Arrive Grounds metres	GM Depart Grounds metres
21.54	1958	22.80	5.82	3.92	138	Mat	7.00	2.05	7.36	1.01		221	0.68	
21.55	1956	22.00	5.83	3.77	125	Scallop	8.84	1.84	9.20	1.10		400	0.67	
25.05	1968	28.60	6.40	4.47	235	Mat	8.00	3.13	10.40	1.82	70	492	0.79	0.80
29.37	1971	32.82	7.50	4.38	435	Mat	9.85	3.50	11.85	1.60	80	671	0.81	0.84
37.08	1974	39.10	7.70	5.08	513	Mat	11.90	5.75	13.10	2.88	70	1850	0.81	0.72
29.21	1973	31.80	7.60	4.18	388	Scallop	12.90	3.50	12.00	2.30	65	671	0.77	0.74
23.91	1977	25.31	7.32	3.46	229	Mat	9.00	3.50	9.45	1.26	70	615	1.20	1.14
25.82	1968	27.00	6.40	4.22	229	Mat	8.40	2.50	10.00	1.60	85	537	0.78	0.75
26.46	1968	28.00	7.00	4.00	262	Ticklers	9.00	3.00	10.00	1.60	65	597	0.81	0.85
26.18	1964	30.00	6.50	4.62	260	Mat	8.30	4.00	9.00	1.15	85	596	0.70	0.76
32.00	1981	35.67	7.50	4.76	479	Ticklers	12.00	5.42	12.50	2.50	80	1044	0.72	0.64
34.52	1980	35.90	7.50	4.79	556	Ticklers	12.00	4.75	11.00	2.10	65	1177	0.83	0.73
34.85	1987	36.50	8.00	4.56	546	Ticklers	12.00	5.50	12.80	2.80	80	1343	0.64	0.54
33.02	1988	37.75	8.50	4.44	679	Ticklers	12.00	6.30	12.40	2.50	80	1492	0.75	0.75
24.30	1970	26.25	6.60	3.98	225	Mat	8.70	3.32	9.00	1.58	70	597	0.76	
29.00	1974	33.53	7.50	4.47	341	Scallop	11.00	2.50	10.80	1.80	65	746	0.66	0.59
16.49	1962	18.37	5.10	3.60	66	Scallop	4.00	0.50	7.30	0.75	60	179	0.84	0.86
25.82	1968	27.50	6.30	4.37	214	Mat	8.00	2.50	8.50	1.00	70	596	0.68	0.69
15.24	1984	15.24	5.14	2.96	70	Mat	4.00	0.50	6.50	0.60	70	186	0.71	0.70
15.24	1984	15.24	5.14	2.96	67	Scallop	4.00	0.81	6.50	0.60	70	186	0.66	0.66
40.00	1999	42.35	8.50	4.98	796	Ticklers	12.00	6.00	13.00	2.75	80	1490	0.75	0.69
14.77	1969	15.57	4.85	3.21	62	Shrimp	8.00	1.25	6.50			177	0.78	0.79
34.04	1974	35.40	7.80	4.54	477							1044	0.72	0.72
14.10	1982	14.67	4.33	3.39	46	Shrimp							1.01	1.01
14.96	1966	15.72	5.16	3.05	66	Scallop		1.50					0.80	0.75
16.44	1989	18.25	6.50	2.81	142				7.10				0.93	0.90
20.93	1991	23.20	6.28	3.69	190			3.00	7.80			223	0.70	0.68
32.43	1968	29.95	7.00	4.28	359			4.00					0.86	0.87
32.58	1981	36.45	8.00	4.56	524								0.66	0.64
27.49	1972	28.90	6.63	4.36		Mat	9.50	4.50			70	671		
22.90	1962	23.98	6.00	4.00		Mat	4.00				65	221		

Figure 1

Distribution of Vessels Included in the Study

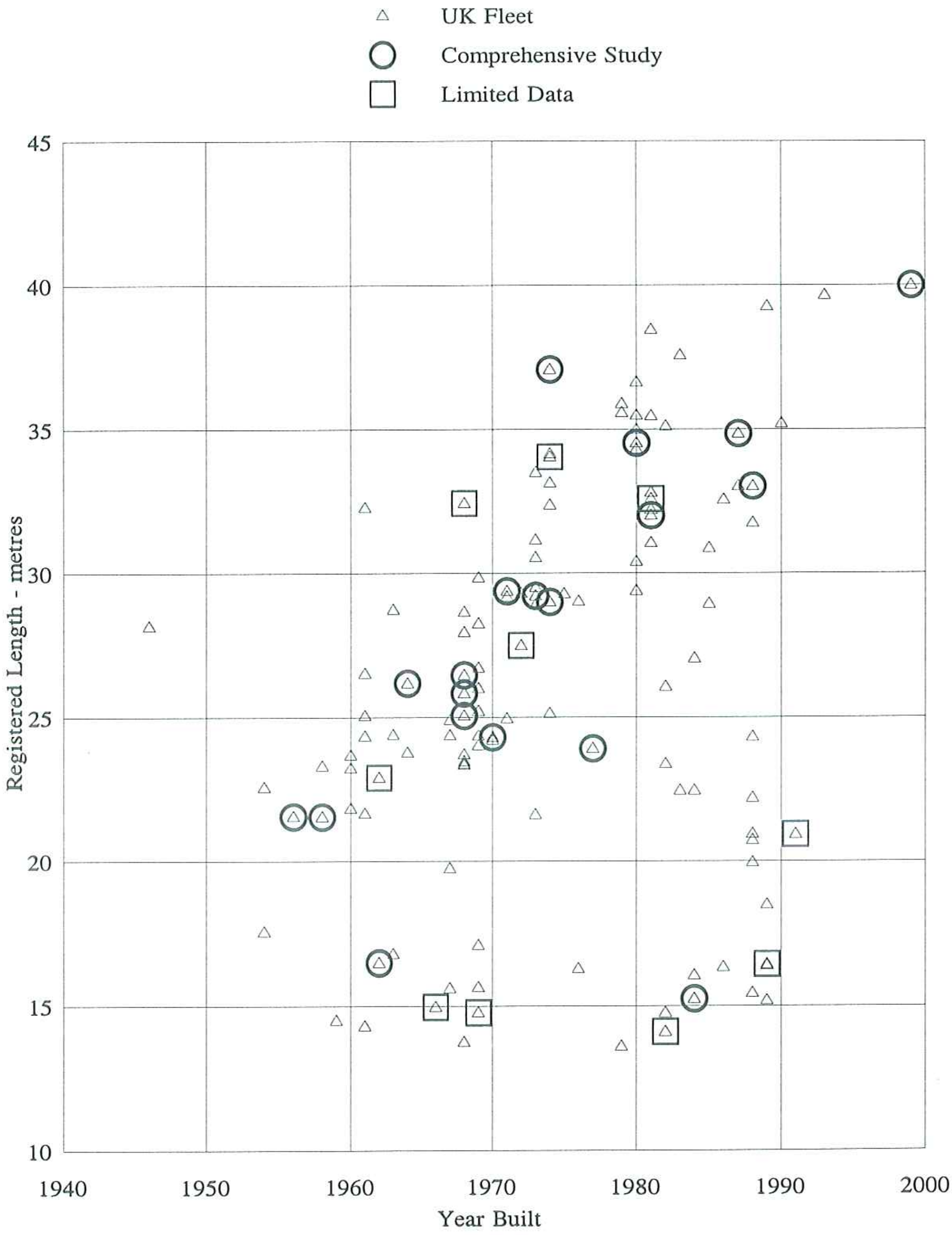


Figure 2

Comparison of the Stability of the Sample Vessels with the UK Criteria

The data shows a percentage comparison with the most marginal criterion

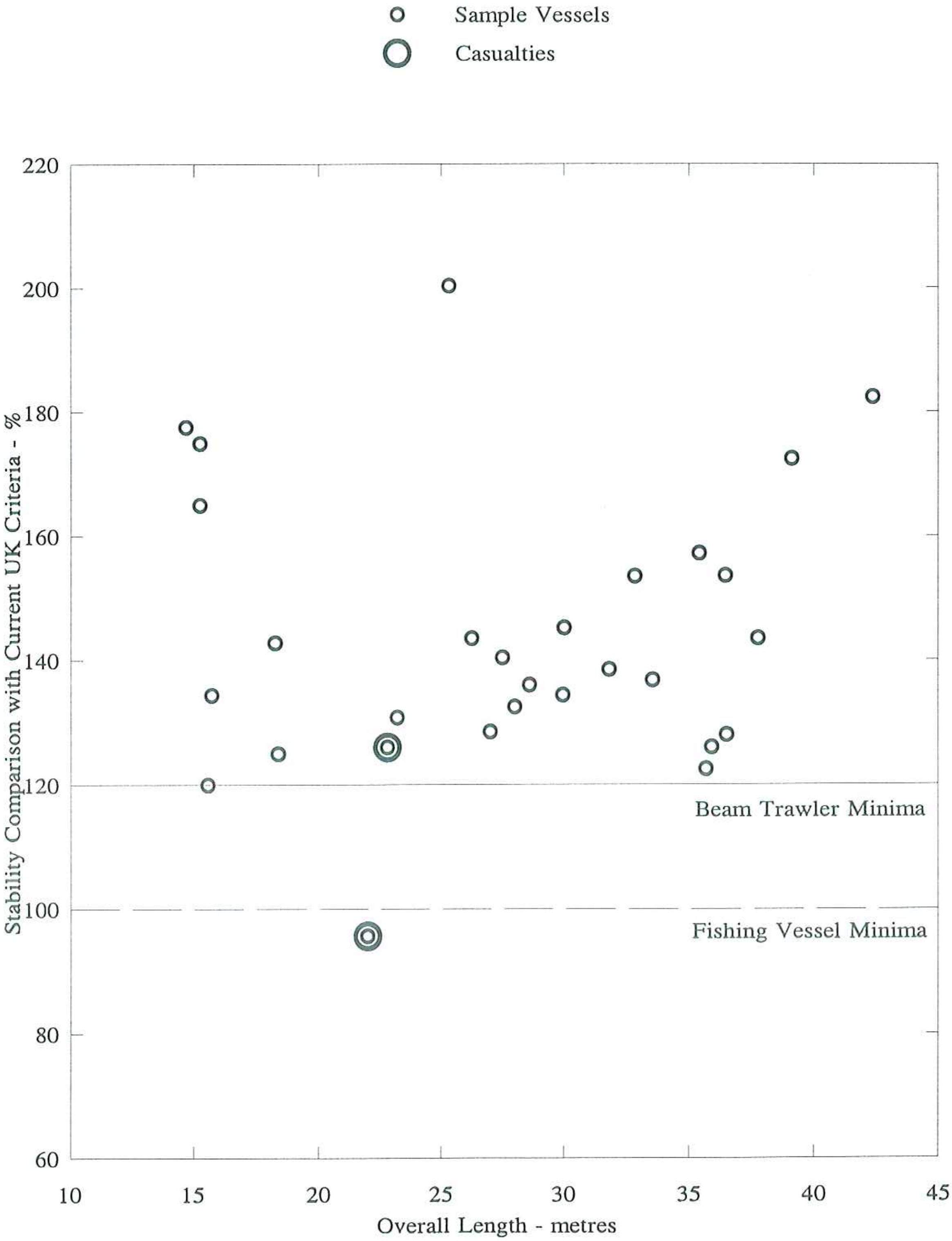


Figure 3

Comparison of the Stability of the Sample Vessels with the UK Criteria

The data shows a percentage comparison with the most marginal criterion

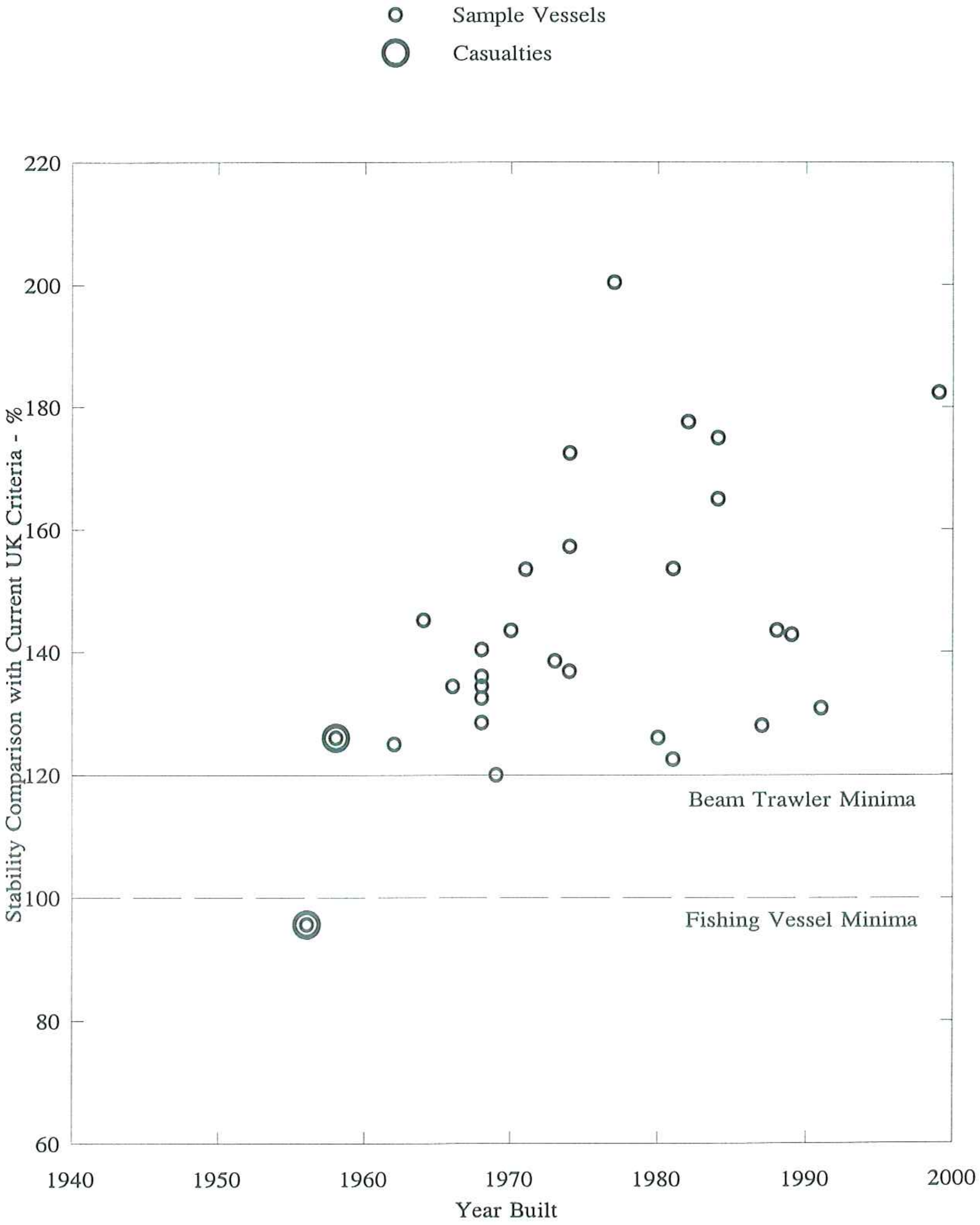


Figure 4

Variation of Overall Beam with Length of Vessel

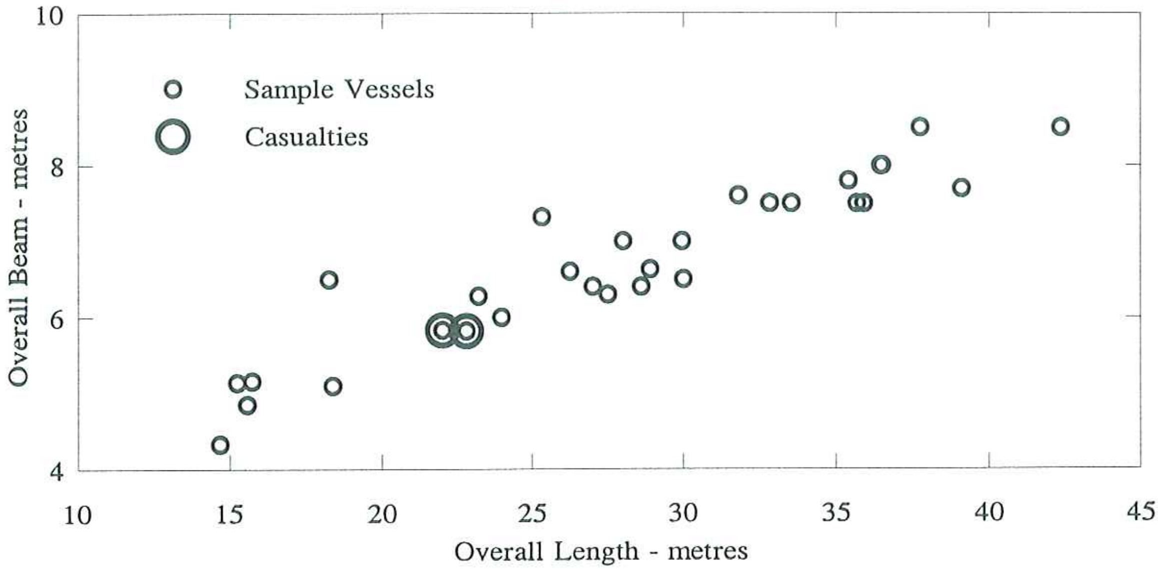


Figure 5

Variation of GM with Length

Data are for two loading conditions for each vessel, where available

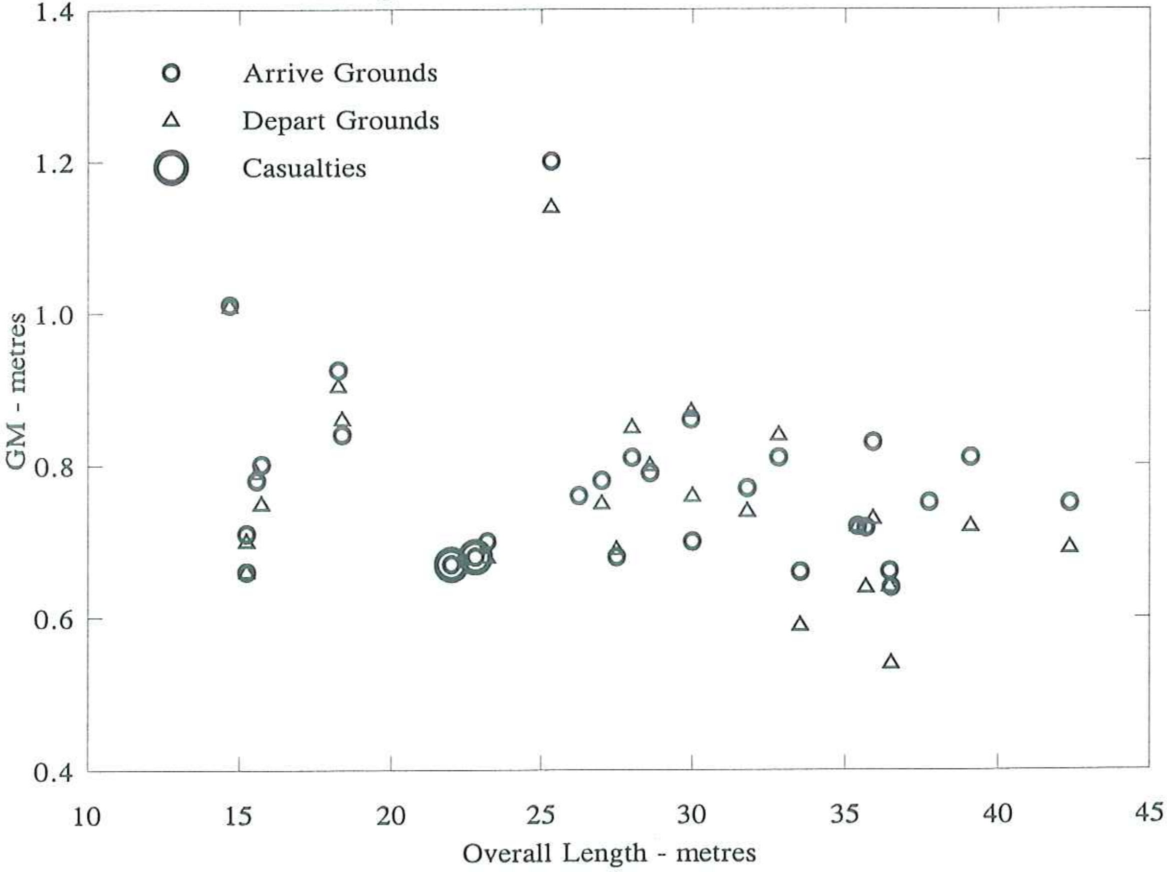


Figure 6

Variation of Displacement with Length

Displacements are for the 'Arrive Grounds' condition

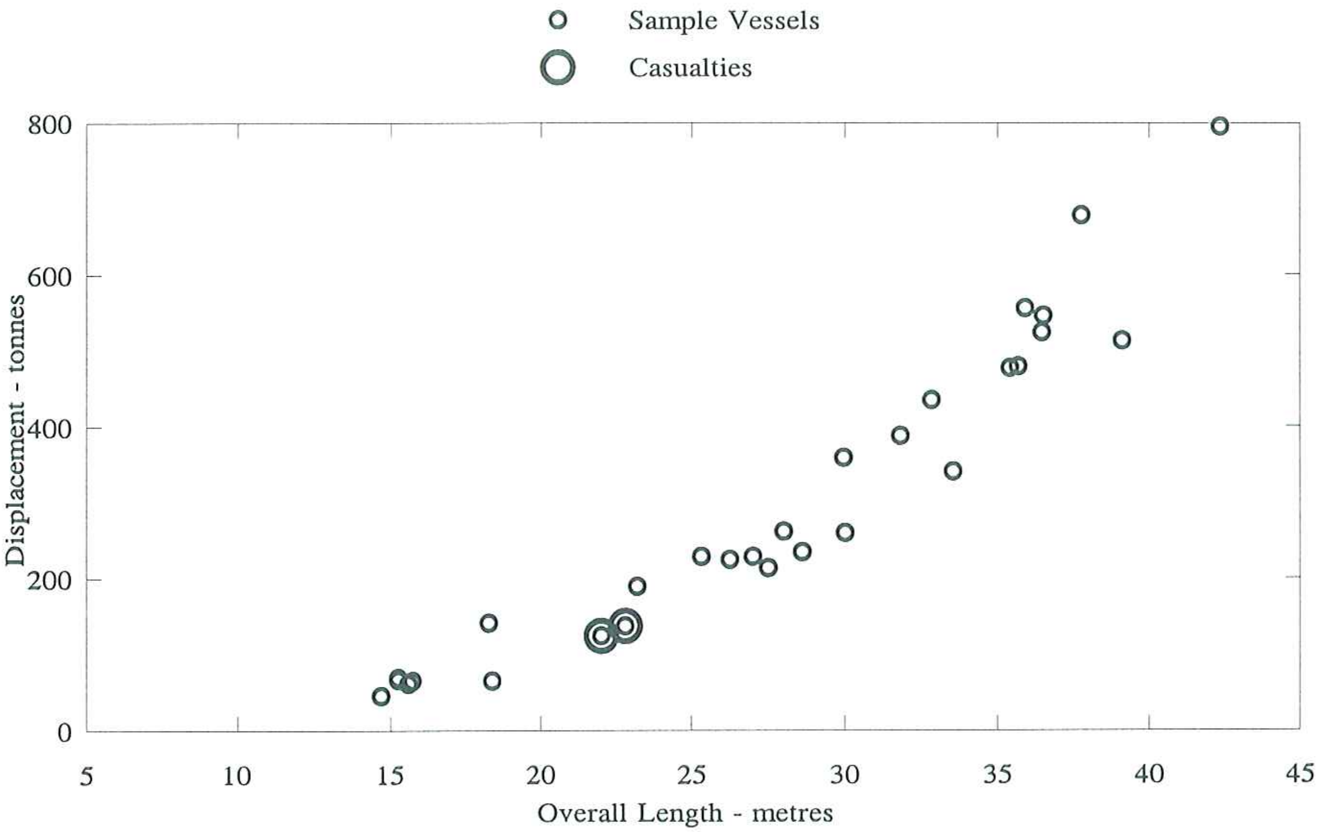


Figure 7

Variation of Derrick Weight with Length

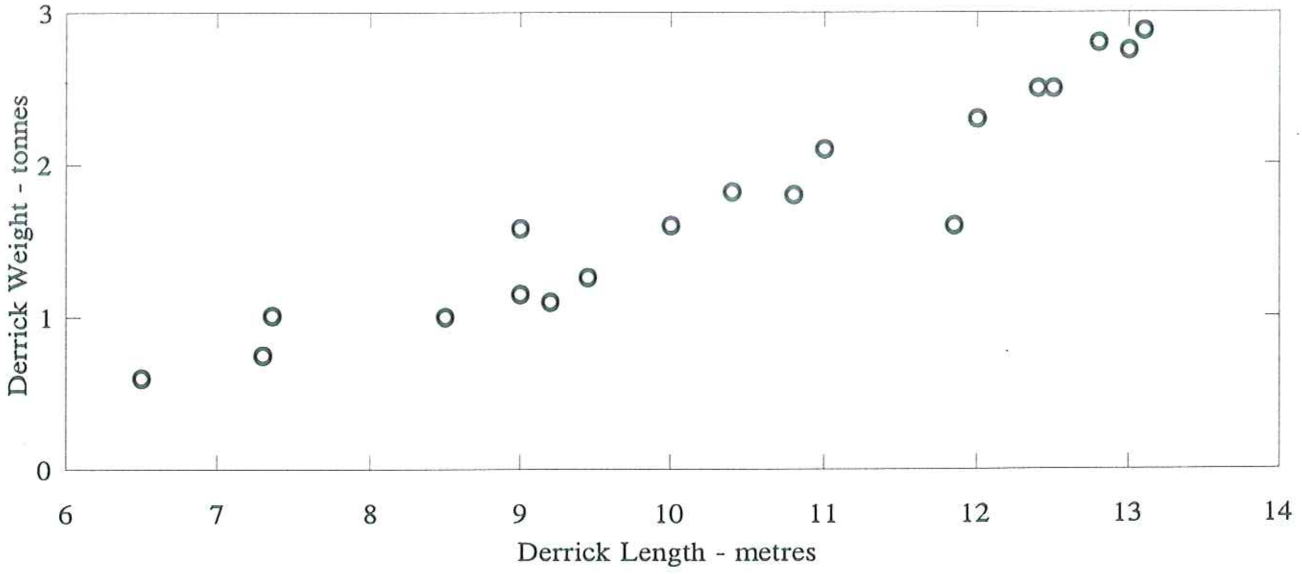


Figure 8

Variation of Beam Length with Gear Weight

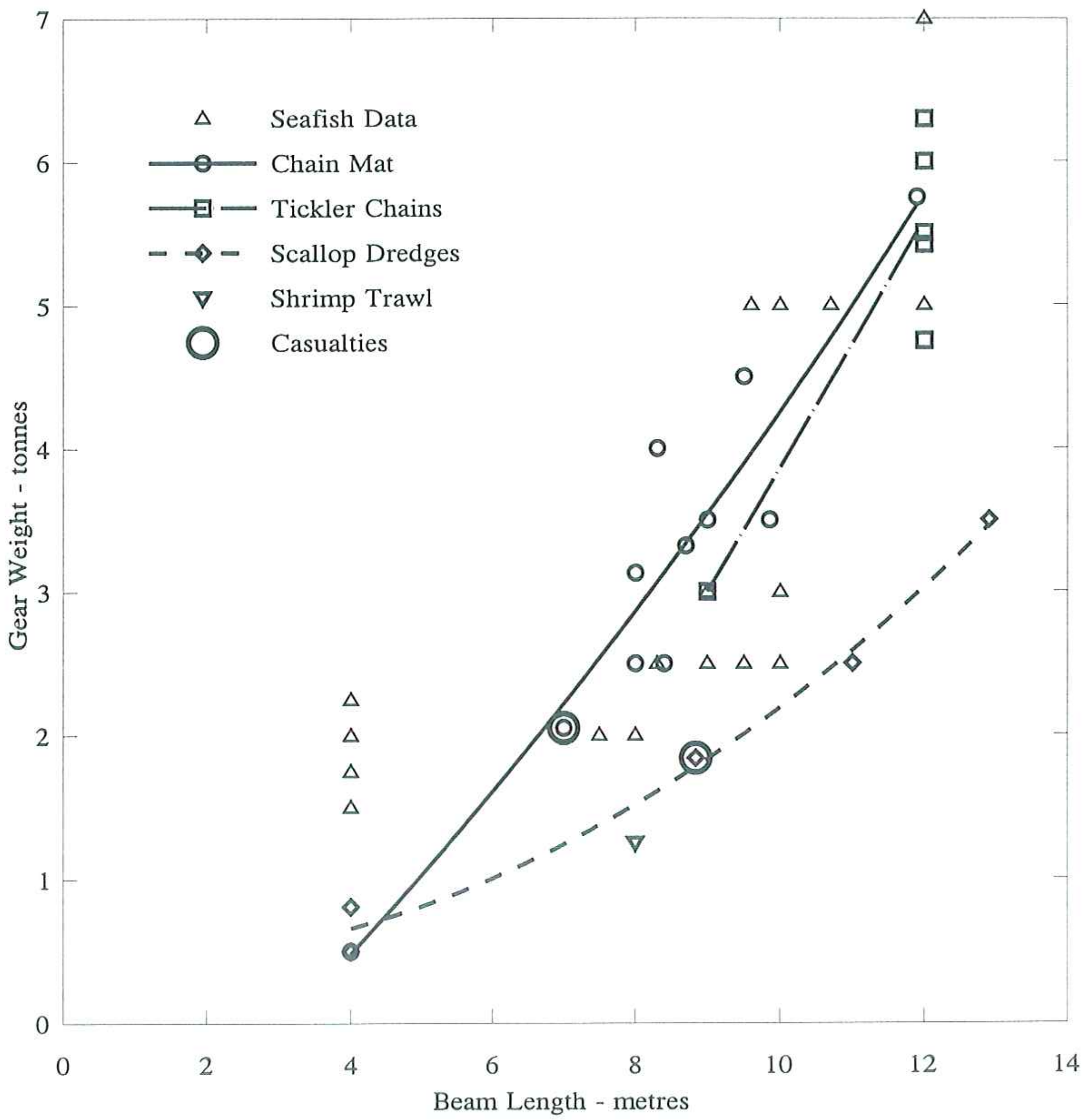


Figure 9

Variation of Gear Weight with Displacement

Displacements are for the Arrive Grounds condition

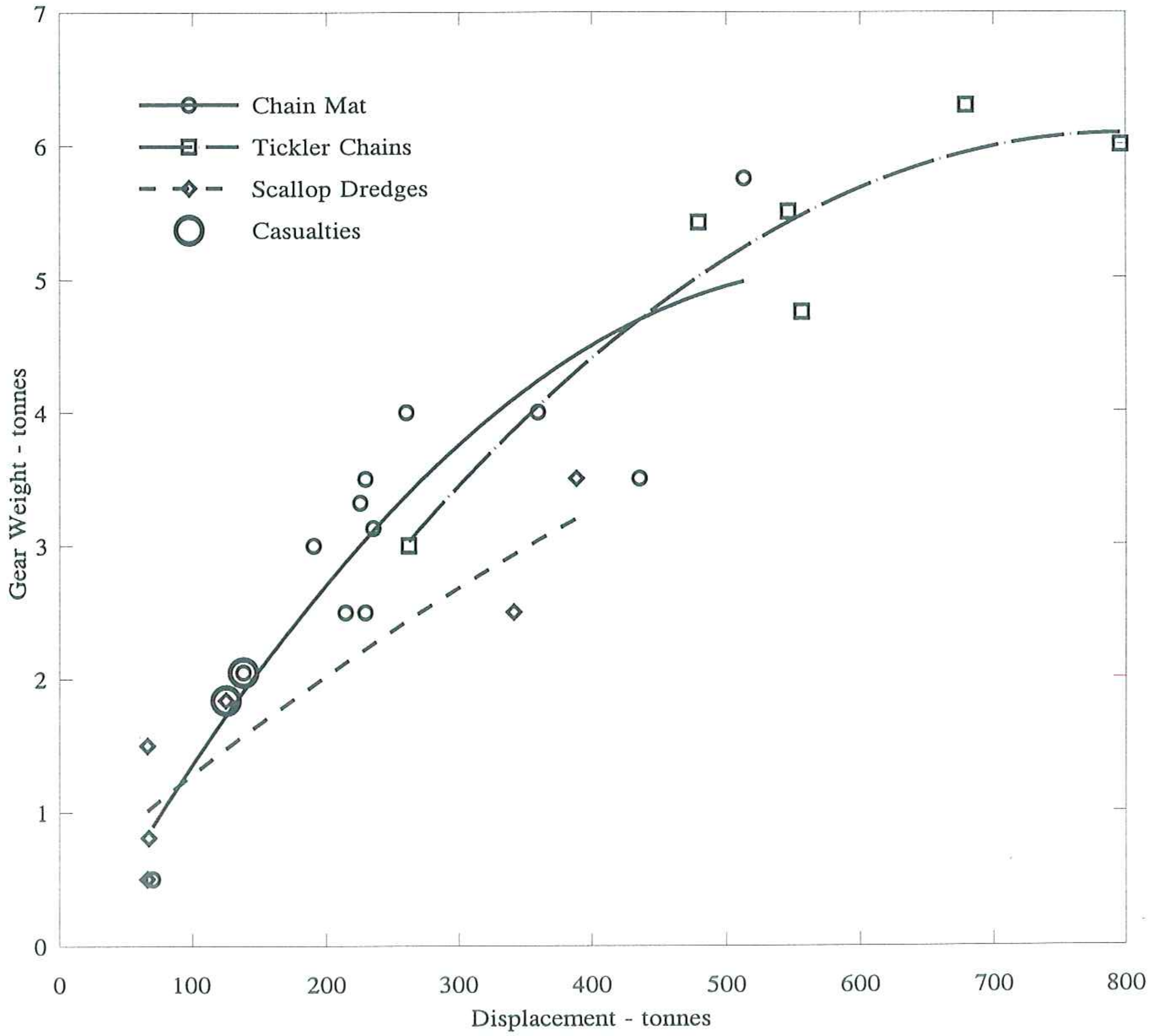


Figure 10

Variation of Beam Length with Engine Power

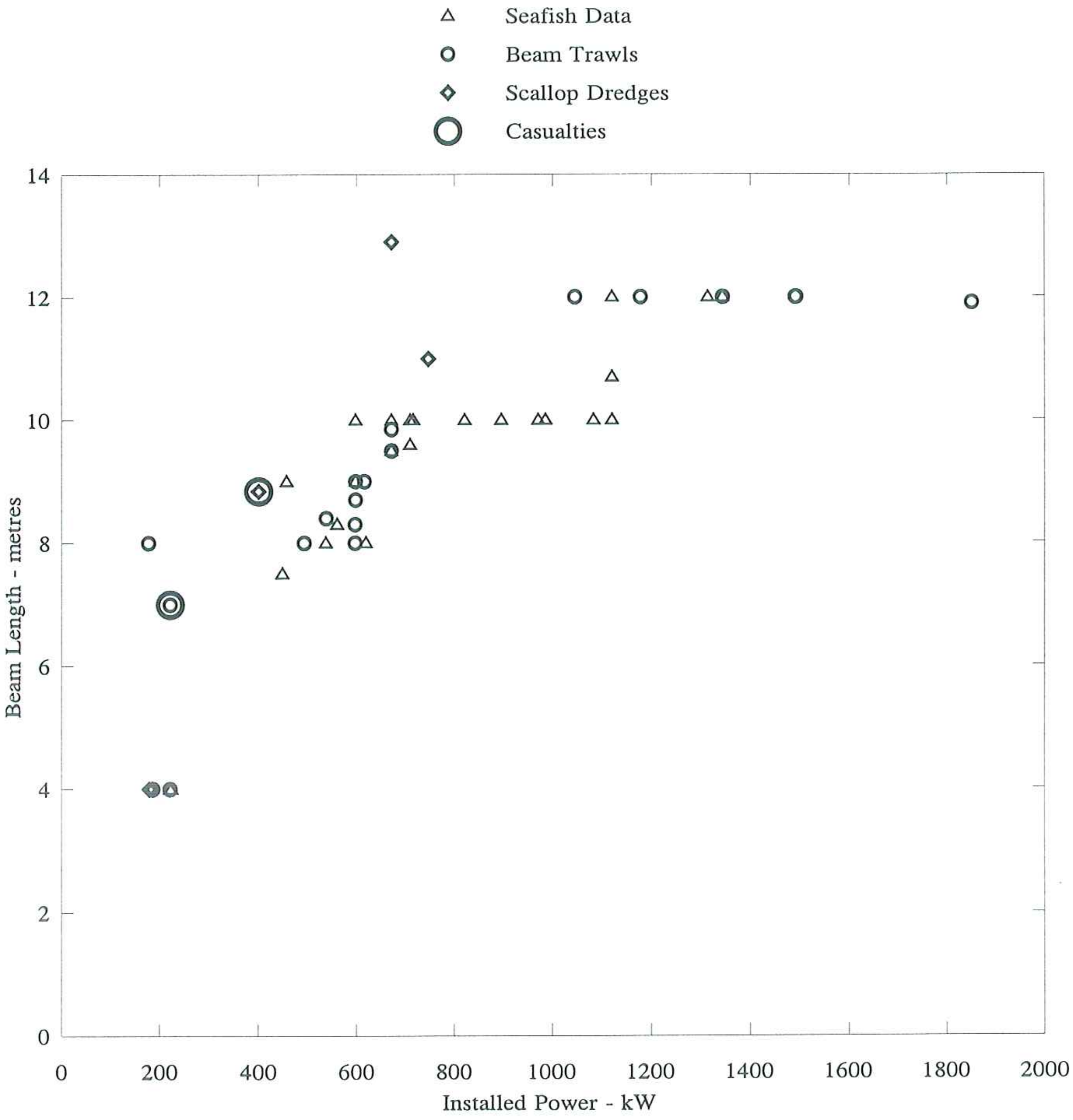


Figure 11

Variation of Engine Power with Vessel Length

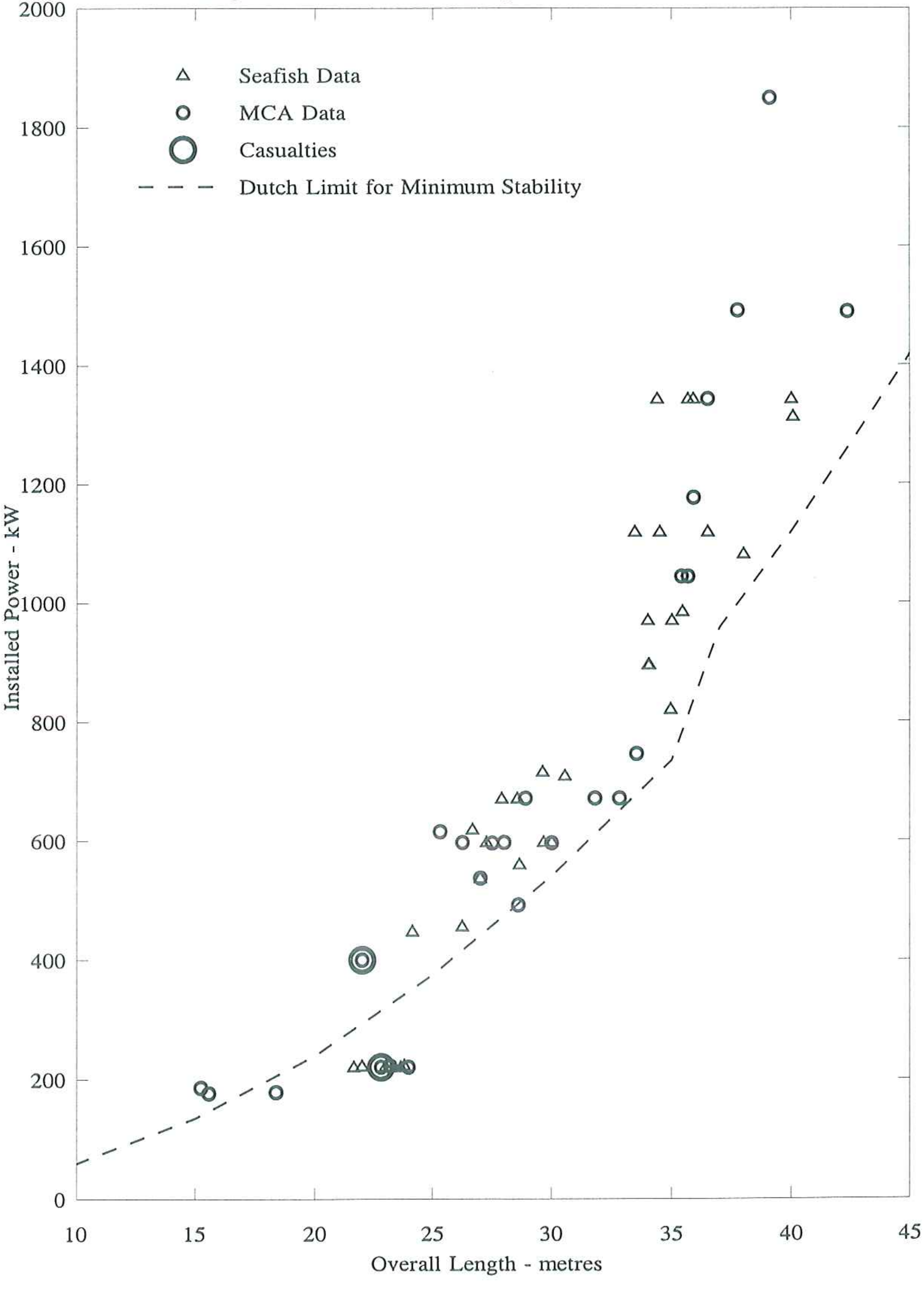


Figure 12

Presentation of the Power Factor Applied in the Dutch Regulations

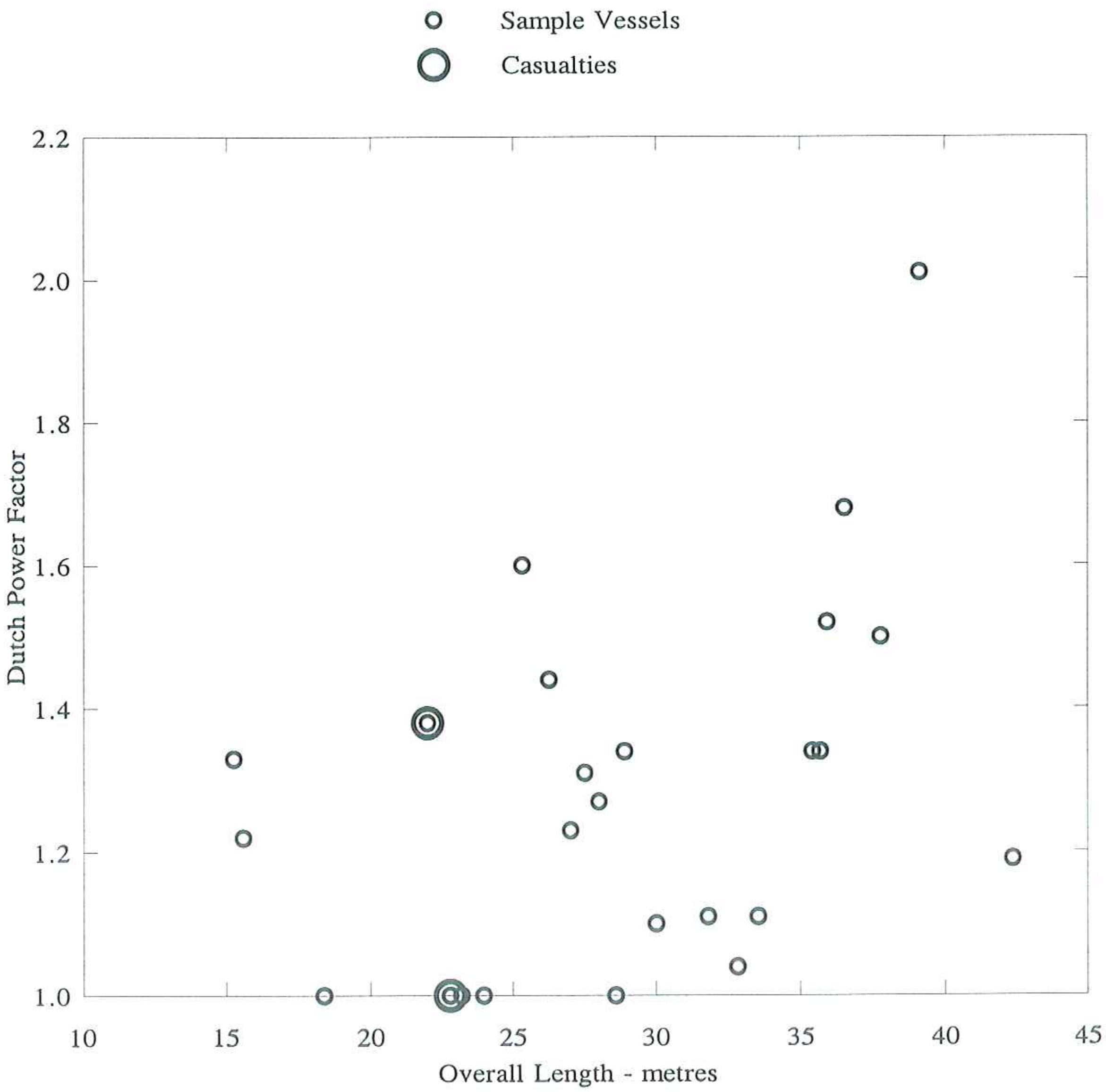


Figure 13

Comparison of the Stability of the Sample Vessels with the Dutch Criteria

The data shows a percentage comparison with the most marginal criterion

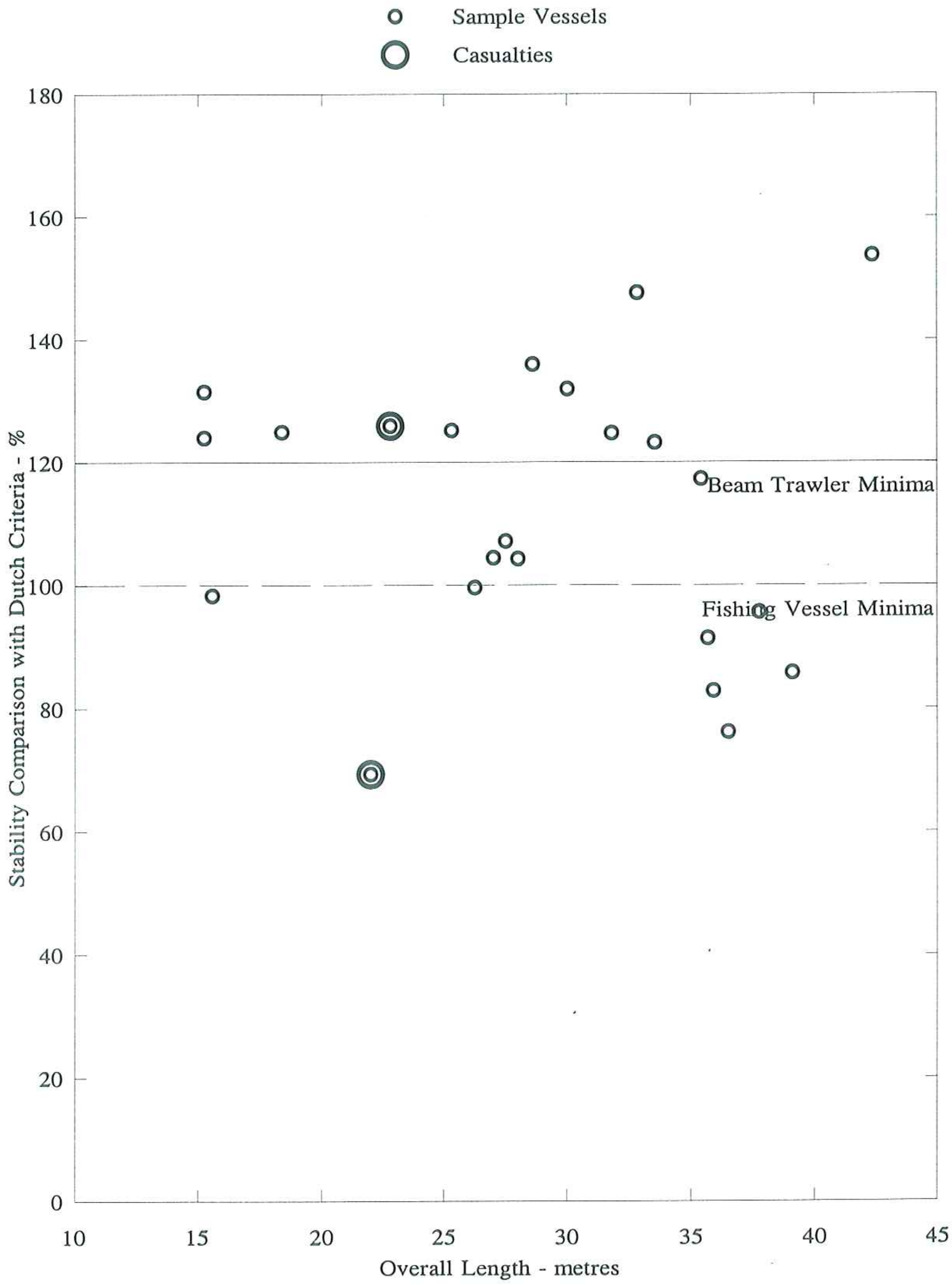


Figure 14

Effect of Derrick Angle and Gear Weight on Stability

Vessel A

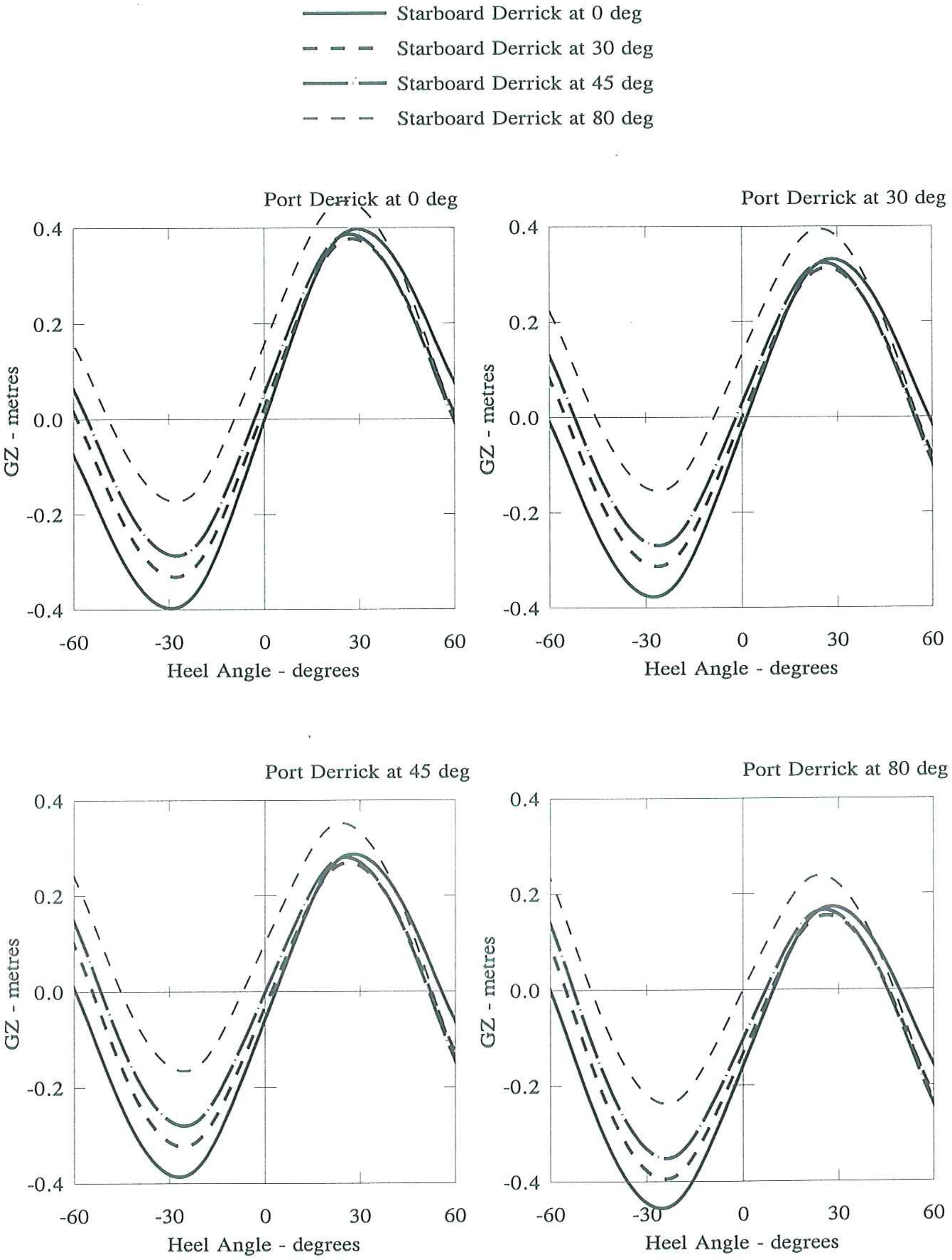


Figure 15

Effect of Derrick Angle and Gear Weight on Stability

Vessel B

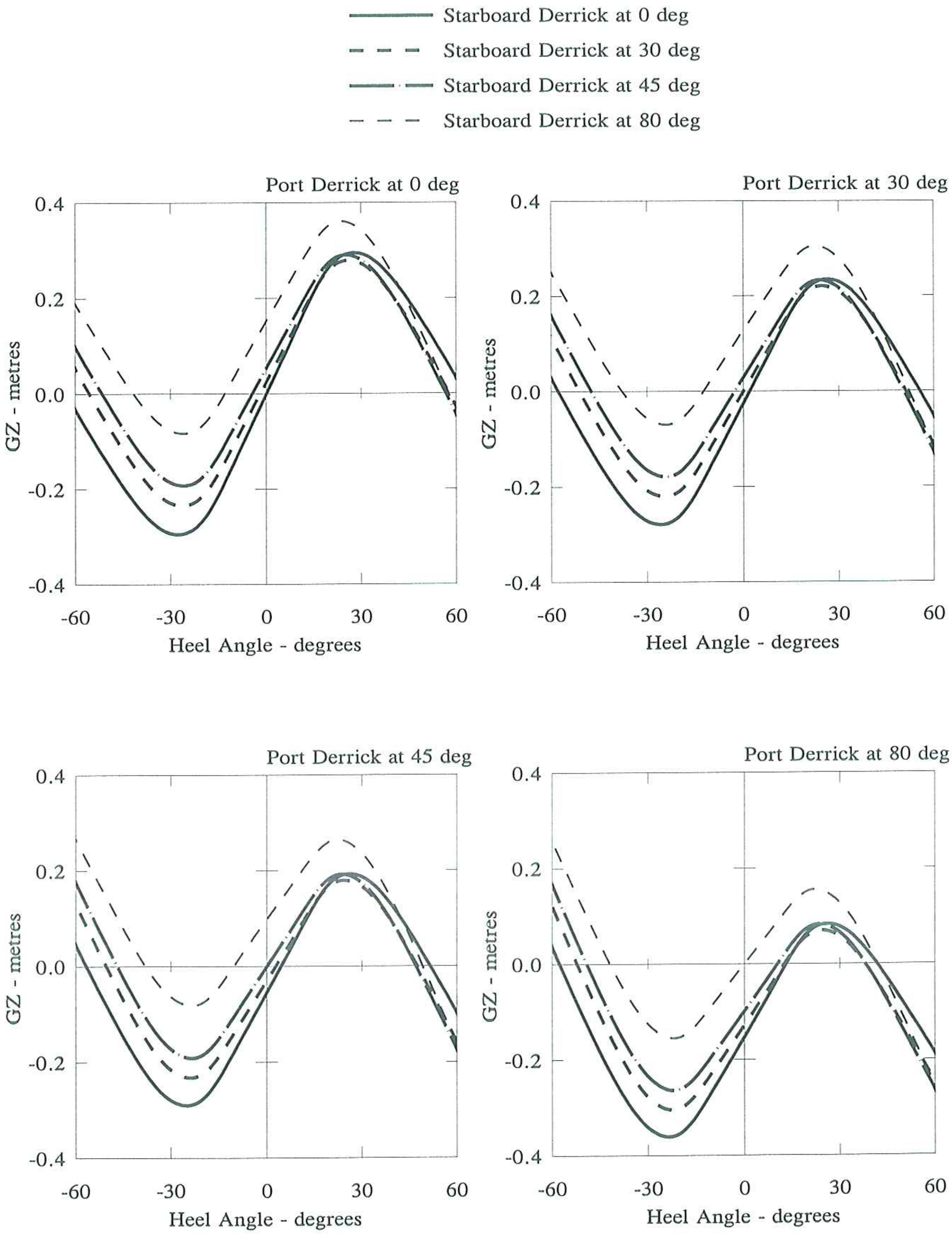


Figure 16

Effect of Derrick Angle and Gear Weight on Stability

Margaretha Maria

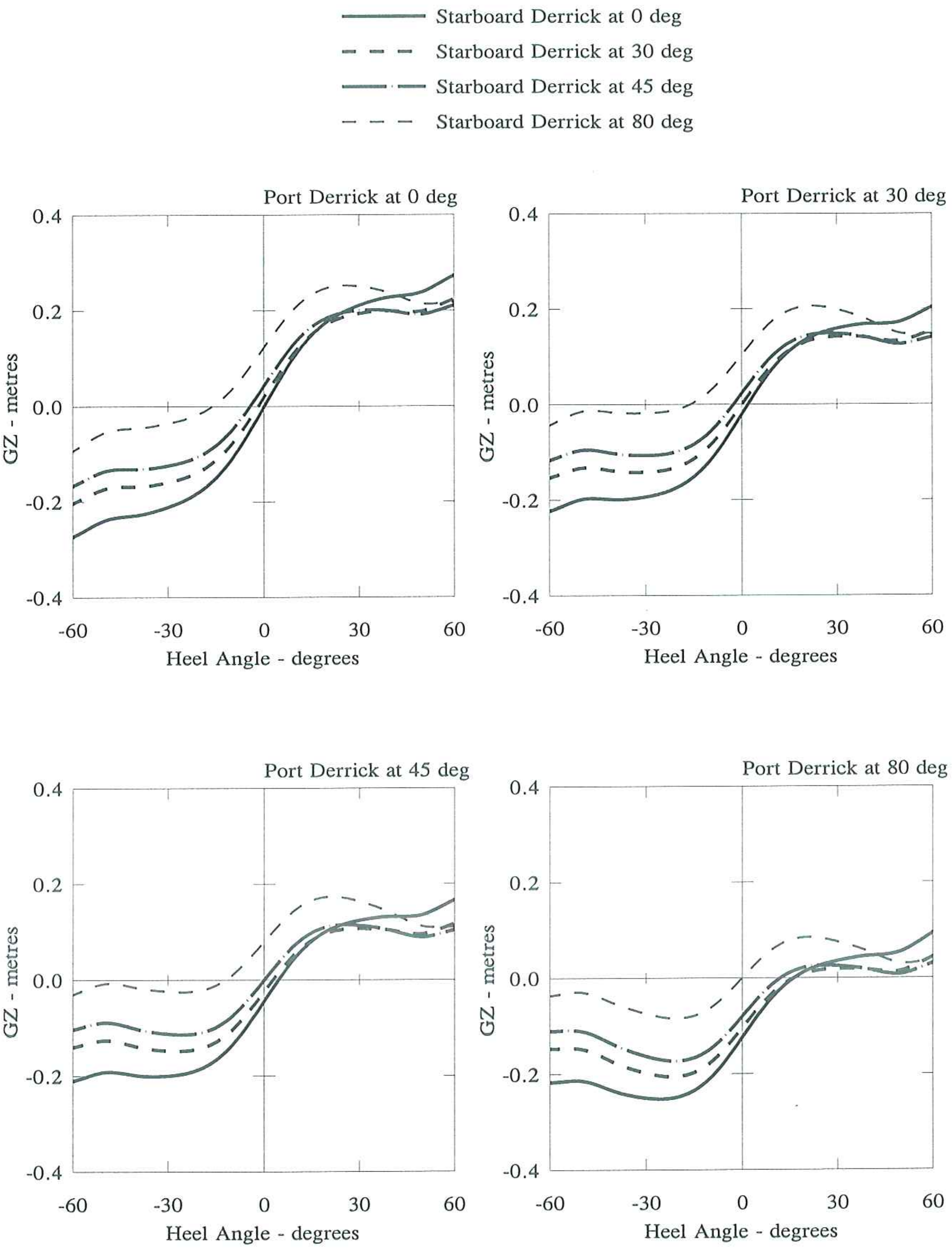


Figure 17

Comparison of the Stability, with the Gear Raised, with the UK Criteria

Derricks at 45 degrees

The data shows a percentage comparison with the most marginal criterion

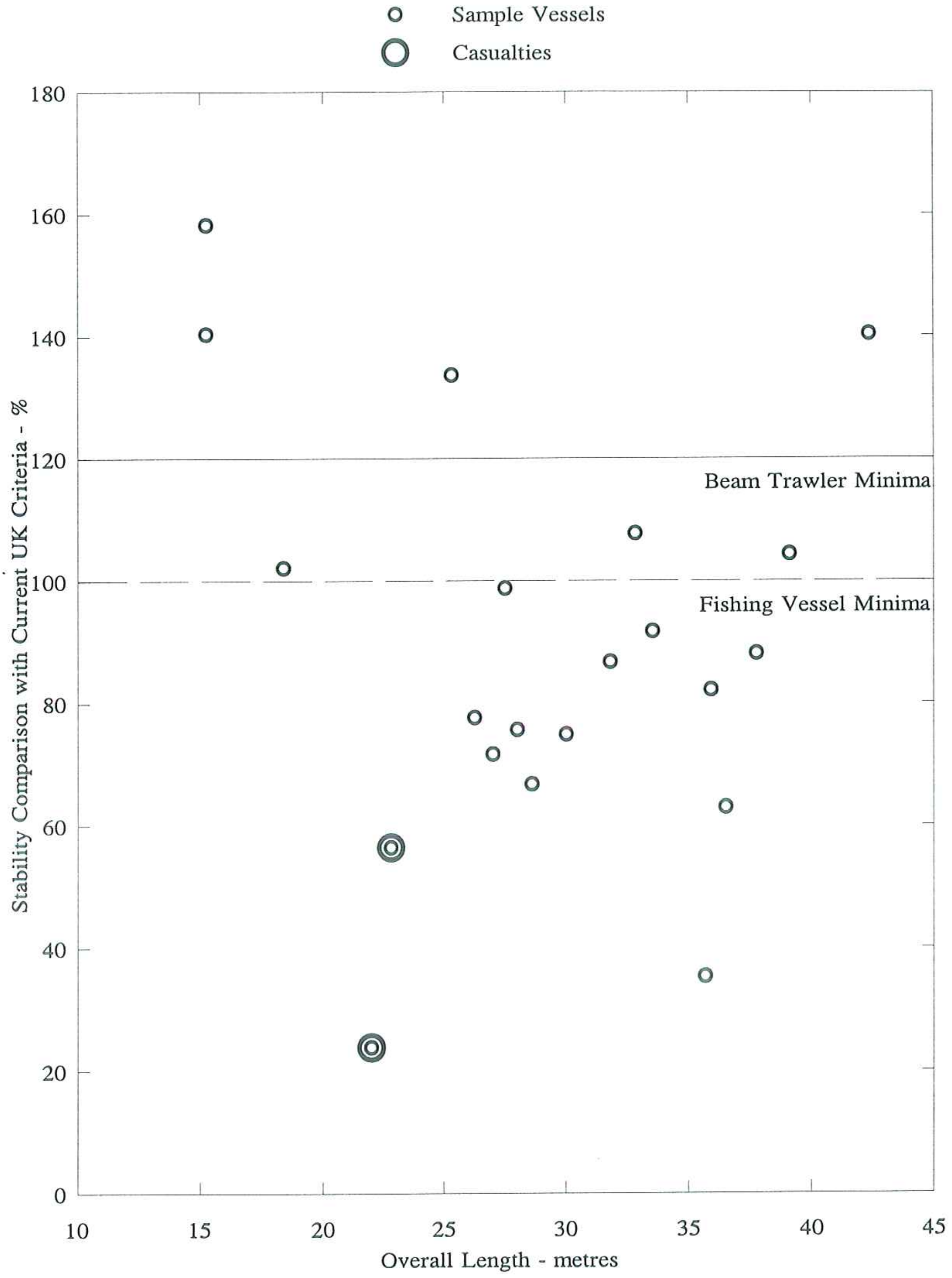


Figure 18

Comparison of the Stability, When Boarding the Gear, with the UK Criteria

Derricks Fully Topped

The data shows a percentage comparison with the most marginal criterion

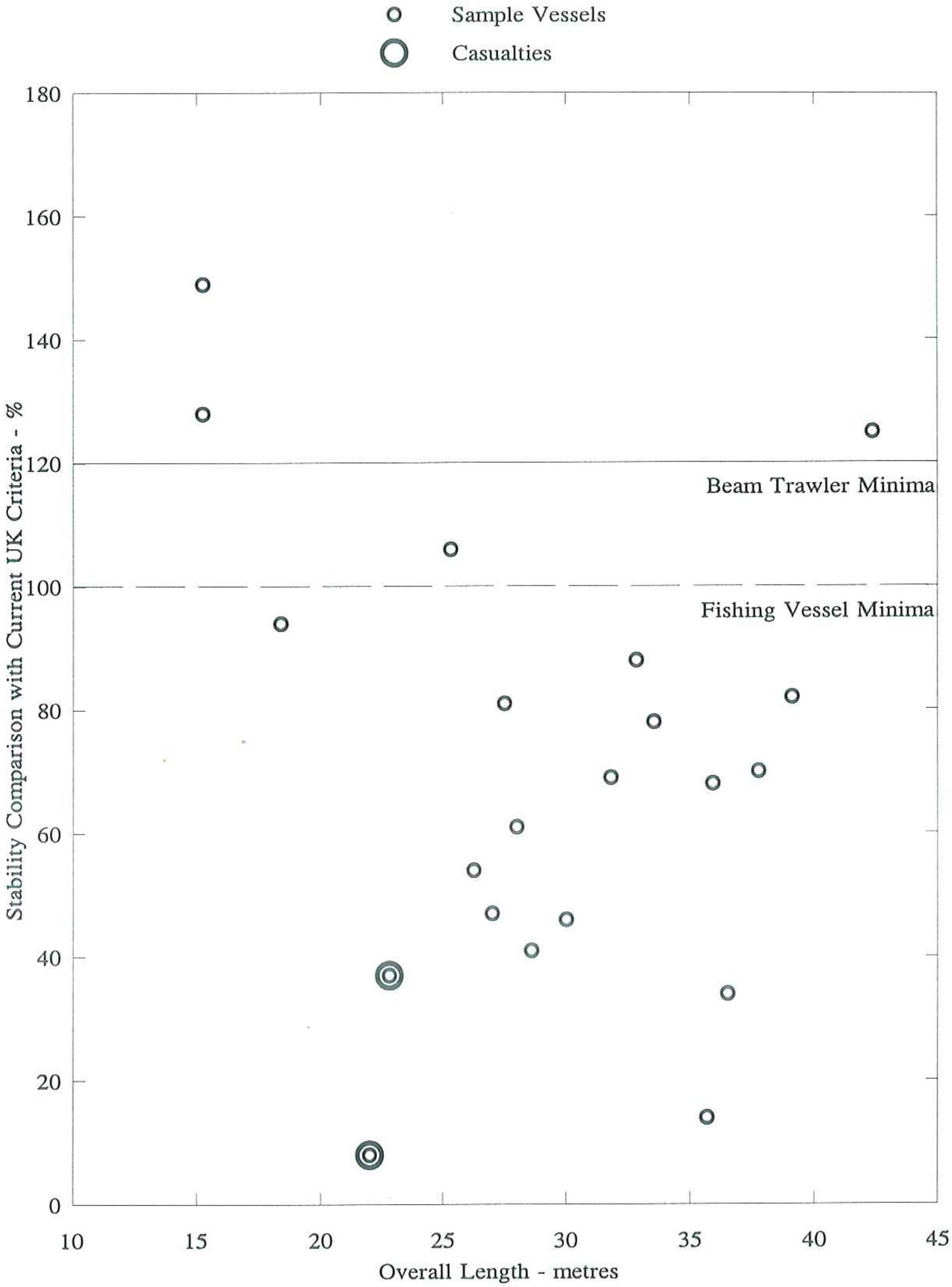


Figure 19

Angle of List with Gear Deployed on One Side Only

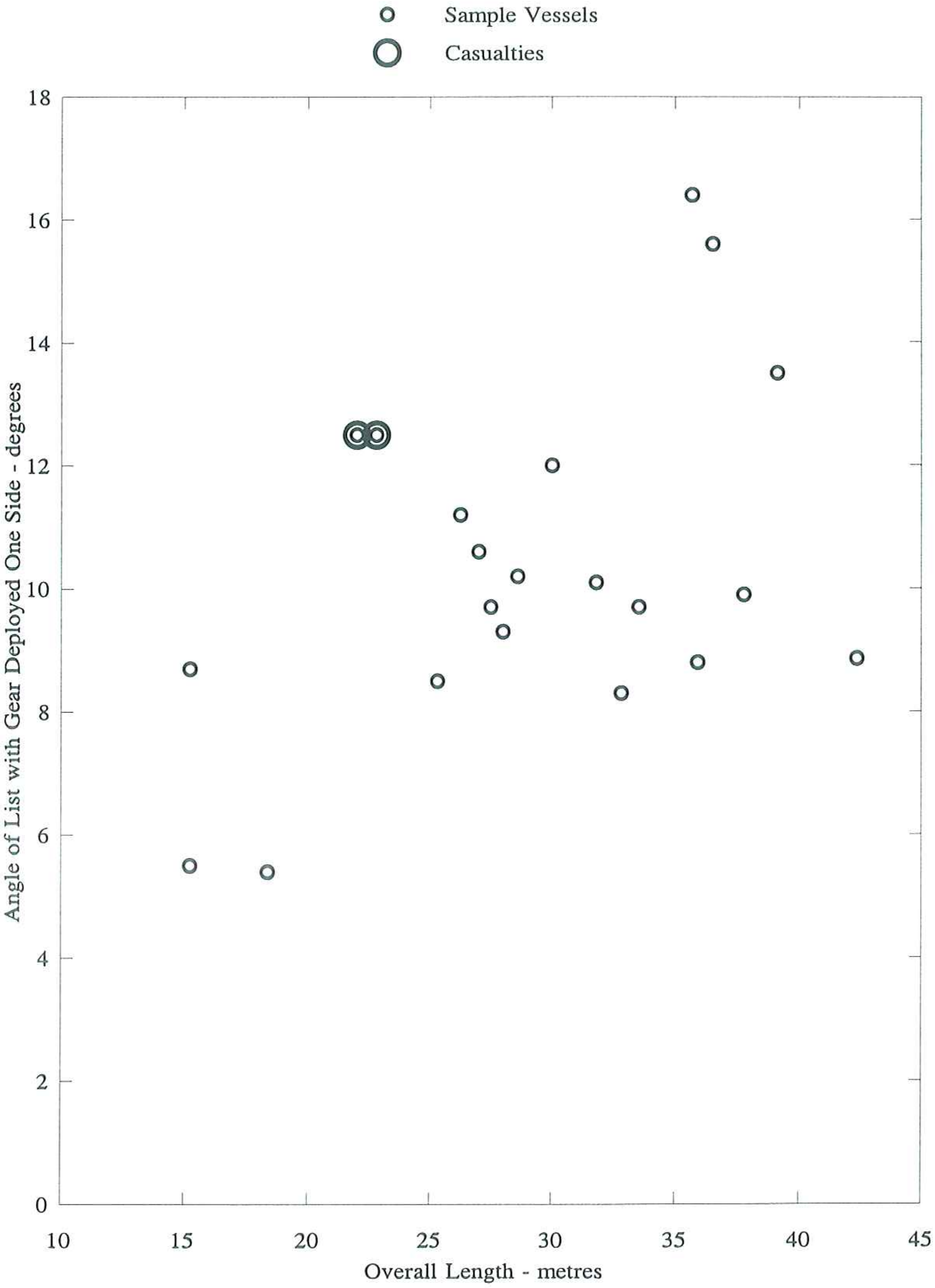
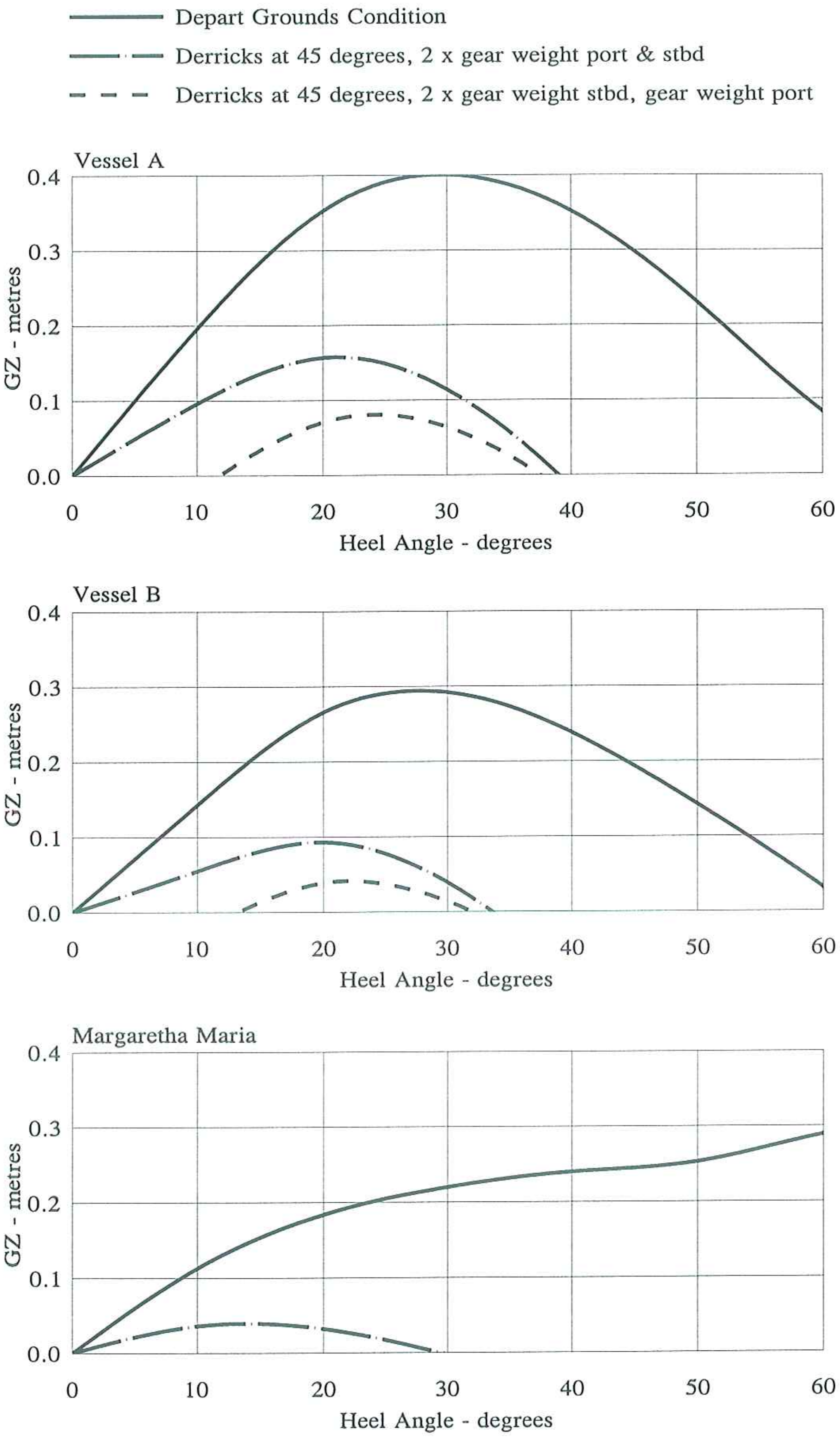


Figure 20

The Effects of Lifting Additional Weights, on Three Sample Vessels



FAXED

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Fax Message

To:	MCA	**Date:**	20 January 2000
Attention:	Paul Wilkins	**Your Fax No:**	329161
From:	Barry Deakin	**Your Ref:**	
No. of pages:	4	**Our Ref:**	
Subject:	Beam Trawler Stability Study - Implications		

Dear Paul,

I hope that your visit this morning was worthwhile. Following are three pages of additional information derived from the database.

The vessel names and fishing numbers are tabulated with a vessel identifier. They are listed in the same order as in the table presented as an Appendix to the report.

Figure 17 of the report is reproduced with the vessel identifier against each symbol.

With this information you will be able to correlate the data tabulated in the Appendix with Figure 17, and identify each of the vessels.

Also following is a further plot, derived from the data presented in Figures 17 and 19 of the report. The ordinates of both graphs have been plotted against each other to facilitate the correlation between the two different methods of assessing the effect of gear handling on the stability. Both methods incorporate the gear weight and derrick length into the stability, but the angle of list incorporates only the initial stability, while the assessment against the criteria incorporates stability at larger angles. One would therefore expect a degree of correlation between the two calculations, and this is confirmed in this presentation.

If you continue to use the standard criteria as a means of assessment, you can see from this presentation that the angle of list could be used as an approximate alternative to full stability analysis, if a vessel is subjected to the simple practical heel test in port. As an example, superimposed on the presented Figure are lines at 10 degrees and 80%. These lines indicate that, with one exception, vessels which heel to less than 10 degrees have more than 80% of the required stability, while, with two exceptions, vessels which heel to more than 10 degrees have less than 80%.

It should be borne in mind that these data relate to the calculated angle of heel in the Depart Grounds condition, and the conditions of vessels in port may vary widely from that. Some additional analysis may therefore be required to determine the implications of these variations on the practical heel test result.

We appreciate that you are faced with a large number of vessels without stability booklets, and we are of the firm opinion that a carefully conducted heel test would enable particularly good or poor vessels to be screened out. Perhaps marginal ones could be assessed with full stability analysis.

Regards,

Barry Deakin

Barry Deakin,
Senior Engineer.

Figure 21

Correlation of Angle of List with Stability Assessment, Figs 17 & 19.