Annex A

Inspection report (with addendum)

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23rd March 2012

THIS IS TO CERTIFY

that at the request of the Marine Accident Investigation Branch (MAIB), Mountbatten House Grosvenor Square, Southampton, SO15 2JU, a survey was held on the wooden single screw fishing vessel

"HEATHER ANNE"

of the port of Fowey, FY126, GT 11.67, whilst shored up on the Queens Wharf in Falmouth Docks, Cornwall, for the purpose of assisting with an investigation following the vessels sinking on the 20th December 2011.

BACKGROUND

The vessel had been fishing for pilchards and was returning to port when at about 2213 hours on the 20th December 2011 she capsized and sank in Gerrans Bay. The incident was seen by the crew of the fishing vessel LAUREN KATE who raised the alarm and recovered the two man crew from the water. Sadly one of the crewmen died.

VISITS TO VESSEL

The undersigned visited the vessel on the following dates:-

27th February 2012 – Meet with representatives of the MAIB to discuss the survey of the vessel.

7th March 2012 – Attend the vessel in the company of a representative of the MAIB to conduct a survey in accordance with the instructions below.

8th March 2012 – Attend the vessel to obtain additional data for this report.

14th March 2012 – Attend the vessel in the company of the Salver to discuss sealing the hull in order to re-launch the vessel for a stability test.

15th March 2012 – Attend the vessel to examine the work carried out to seal the hull.

GENERAL

The vessel, a wooden single screw ring netter, has the following principal particulars:-

LOA	-	11.00 metres
Breadth	-	4.21 metres
Built:	-	G. Percy Mitchell & Sons, Portmellon - 1971
Construction	-	Larch planks on oak frames with iron fastenings.
Main Engine	-	Thornycroft 760 diesel engine, 164 Kw, driving a fixed pitch propeller through a reduction gearbox.

SURVEY REQUIREMENTS

The following instructions were received from the MAIB and all surveys and inspections were to these instructions:-

1. Review the general condition of the hull, its planking, supporting structure, fixings and whether there is any sign of hogging or sagging.
2. Specifically examine the sprung planks and damaged plank on the starboard side to establish what may have caused the damage.
3. Liaise and advise salvage contractor, in consultation with MAIB, how best to make a temporary repair to the hull to make it watertight ready for inclining.
4. Identify and examine hull penetrations and their isolation valves and whether NRVs are fitted.
5. Examine condition of external doors and hatches and their closures.
6. Examine condition of hull bulkheads and their degree of watertightness.
7. Examine freeing port arrangement and likely effectiveness.
8. Examine condition of pipework systems, but in particular the bilge pumping arrangement and its likely effectiveness.
9. Review bilge alarm arrangement and establish, if possible, its working status.
10. Review machinery condition in general and whether it appears to have been maintained.
11. Examine steering gear and determine any possible faults, if feasible.

FINDINGS

1. A general examination of the outer hull was carried out with the soundness of the hull planks tested with a metal spike. This excluded the area in way of the damage to the starboard bottom planking which is covered later in the report. The examination commenced with the deadwood area around the stern gear and then the first and second garboard planks on the port and starboard sides of the keel. No soft areas were found and apart from the damaged area on the starboard side the coatings were in reasonable order. In view of the very good condition of the garboard timbers random checks of the remaining hull timbers, both above and below the waterline, were carried out and no soft areas found.

Some areas of minor contact damage in way of the transom had been repaired with some kind of putty but on removing this the underlying timbers were found with very little indication of softness. The vessel is of very heavy construction and there was no indication of any unusual deformation in the form of hogging or sagging.

Fastenings were generally checked away from the damage and the following found:-
There were several areas where rust weeping was noted, both from the seams and the heads of fastenings. When the Salvers were preparing the hold for a cement box the remains of one fastening on the port side forward came out leaving a hole right through the plank into the hold and this was plugged prior to re-floating the vessel. Just below this disturbed fastening substantial rust staining was noted in way of other fastenings but these were not disturbed.

During the preliminary examination the following was also checked:-

i) Tailshaft clearance, found in order.

ii) Rudder stock and heel pintle clearances, found in order. (Further rudder information later in this report)

iii) Skeg fastening. The timber skeg of the vessel had been supplemented on the port and starboard sides with a steel plate arrangement and it was noted that this had been moving slightly and that some welding was damaged.

iv) Anodes, these were fairly well depleted but still providing adequate cathodic protection to the vessel.

v) Hull penetrations and appendages, all appeared in order with the exception of the steel plated frame appendage (transducer housing) at the keel and in way of the starboard side damage which was slightly bucked and with a fractured weld. This structure contained a transducer.

2. The area in way of the starboard damage was examined closely, especially in way of the fastenings and some fastenings were removed. The bottom coating was scuffed off from about frame 8 to frame 17/18 with the area over which the planks were damaged being from the keel extending outboard over a distance of about 1300mm and from the after part of frame 13 forward for about 1900mm.

Each individual plank in way of the damages was examined from the keel to the outer extreme of the damage and from just aft of frame 13 to the forward extent of the damage excluding the area where the bottom support block was located. The damaged area was over 10 planks and each plank is commented on individually, with No. 1 being the garboard plank next to the keel, but with general comments where applicable.

Plank No. 1

Only a small area was visible in way of the actual damage as the majority was concealed by the transducer housing extending out from the keel. Coating reasonably intact and heads of fastenings not visible. Water was noted dripping down from between the inner part of the transducer housing and the keel and the rate of this discharge appeared not to have reduced over the week between the initial inspection and when the Salvers commenced sealing the hull for re-launching. Forward of the transducer housing the garboard plank appeared to have moved slightly as there was staining in way of the keel and the seam of the second plank.

Plank No. 2

Only a small area was visible in way of the actual damage with a large part being concealed by the steel plated frame appendage extending out from the keel. Coating reasonably intact with some fastening heads visible and in place. Forward of the transducer housing this plank appeared to have moved slightly as there was staining in way of the seams of the first and third planks.

Plank No. 3

Some of this plank in way of the damage was visible with only a small part being concealed by the steel plated frame appendage extending out from the keel. Coating partially scuffed away with some fastening heads visible and in place. Slight movement of plank noted at forward part.

Plank No. 4

All of this plank in way of the damage was visible Coating fully scuffed away with some fastening heads visible and in place and some fastening heads missing. Some movement of this plank noted.

Plank No. 5

This plank had sprung at frame 12 and there was no evidence of any new fastenings having been recently fitted from the sprung butt for a distance of about 1500mm forward of this. Coating fully scuffed and some fastening heads were visible but some fastenings were found completely missing from the plank.

Plank No. 6

This plank was found in place and some new fastenings had recently been fitted away from the damaged area. Coating fully scuffed and some original fastening heads visible but some missing. Fastenings removed from this plank found severely corroded.

Plank No. 7

This plank had sprung at frame 10 and there was no evidence of any new fastenings having been recently fitted from the sprung butt for a distance of about 1100mm aft of this.

Coating fully scuffed and some fastening heads were visible but a large number of fastenings were found completely missing from the plank. Some holes were found with putty where the fastening heads should have been and in the frames corroded ends of some fastenings could be seen.

Plank No. 8

This plank was found in place and some new fastenings had recently been fitted away from the damaged area. Coating fully scuffed and some original fastening heads visible but some missing and putty found in some fastening holes where the heads of the fastenings should have been. A longitudinal fracture was also noted in this plank in way of the damage and this fracture was about 500mm long.

Plank No. 9

This plank was found with a section about 800mm missing from about frame 11 to frame position 13 which is the hold to engine room bulkhead. The coating was completely scuffed and the following was found:-

One fastening removed in way of the forward plank fracture at frame 11 was found with slight corrosion towards the head. About 300mm forward of this at frame 10 two fastenings were removed, one appeared to be new with no corrosion and one was severely corroded just below the head.

The plank aft of the missing section was found with a gap of about 15 to 20mm between the plank butt and frame 13 and there was no evidence of any fastenings in this gap. At the next frame aft (14) new fastenings were noted.

Some of the missing section of plank 9 was recovered from the seabed and the largest piece was found with one sheared fastening at about mid length. This fastening appeared to have been recently renewed.

Plank 10

This plank appeared to have been recently renewed and to be of pine rather than larch. All fastenings were noted to have been renewed recently, the following was found:-

Plank slightly sprung at butt join at frame 9 leading aft. About 1500mm aft of this and in way of the missing section of plank 9 the plank was noted to be torn inboard side to out.

In way of this damage one of the new fastenings had sheared about 50mm from the top of the head and one other fastening forward of this has been slightly pulled out but could not be removed using a crowbar.

Some of the fastenings had been hammered well under the surface of the plank and the holes left filled with putty. At the forward butt where the plank had sprung there was no evidence that any caulking had been carried out but that the gaps between the planks had been filled with putty.

3. The requirement to incline the vessel was discussed with the Salver and the following agreed as the way forward to seal the hull prior to re-launching the vessel.

i) Plank 9 in way of the forward part of fracture squared off and a piece of timber screwed in place of the missing section.

ii) Damage to plank 10 in way of the missing section of plank 9 cropped out and a piece of timber screwed in place of the missing section.

iii) Sprung planks jacked back into place and secured with woodscrews

iv) Planks where inadequate fastening was noted secured with additional woodscrews.

v) Plywood sheeting screwed in place over the starboard hull from the keel outboard to plank 11 in way of the damages. This sheeting shaped around the steel transducer appendage. Prior to securing the plywood sheet in place the whole area was covered with trowelling mastic to which the plywood was bedded into.

vi) There was no access to seal the inner part of the steel transducer appendage to the keel and in view of this a cement box was fitted into the bilge area between frames 10 to 13. This was constructed using plywood shuttering and quick drying cement. Once in place additional securing timbers were fitted over the top of the frames and the cement box.

4. Hull Penetrations

Close up access to hull penetrations in the engine room was not possible due to the large amount of debris in the bilges and other areas. When attempting to move forward on the port side of the engine room to the main sea intakes the hydrogen sulphide alarm on the portable gas meter being worn sounded so the inspection was aborted. In view of this no isolation valves were tested but the main sea intake was noted to be in the open position.

From the after part of the engine room it was noted that the majority of hoses were double clipped but one at the top of the main sea intake was noted with only one clip.

It was not possible to determine if all overboard valves were fitted with non return valves but some exiting the hull aft of the fuel tanks were noted with non return valves.

The hold bilge pump overboard valve located on the starboard side towards the forecastle was fitted with a non return valve which appeared to be open.

5 External doors and hatches including closures.

The main wheelhouse door was off its runners and appeared in satisfactory condition. Access to the accommodation and engine room was from the wheelhouse and hatches were provided but these were of hinged timber and not of the watertight type.

The companionway into the accommodation was lower than the hatch and it appeared that a removable washboard could be fitted but this was not in place nor sighted on the vessel.

Access to the fish room was by a large hatch on the foredeck towards starboard and no hatch cover for this was found on the vessel. The salvers advised that the hatch cover for the fish hold was not found when the vessel was being salvaged. Two securing dogs for this hatch were noted, one each on the forward and aft sides of the coaming. These were found screwed out almost to the limit of their thread at the time of our inspection.

6 Bulkheads.

The vessel is fitted with two bulkheads one at frame 13 which divides the fish hold from the engine room and one at frame 21 which divides the engine room from the accommodation.

Both bulkheads were examined and found with various penetrations as follows:-

Hold to engine room port side - hole approximately 50mm diameter cut in bulkhead just above floor level.

Hold to engine room starboard side – hole approximately 100mm diameter cut in bulkhead at floor level.

Hold to engine room bottom – where the section of plank 9 was missing at frame 13 and extending inboard a gap about 15 to 20mm was evident between the hull planks and the frame timber. It is not known how far this gap extended as access to check this was limited.

Engine room to accommodation port side – hole approximately 50mm diameter cut in bulkhead about 500mm above floor level.

Engine room to accommodation starboard side off centre – a section of the bottom of the bulkhead appeared to be missing.

7. Freeing port arrangement.

The vessel is provided with 4 reasonably large freeing ports, two just forward of the wheelhouse and two by the fish hold hatch coaming. Aft of the wheelhouse several very small freeing ports were noted on the port and starboard side and these would be inadequate were the aft deck to become flooded.

8. Examine condition of pipework systems.

In view of the presence of hydrogen sulphide gas in the engine room and the amount of debris from the sinking it was not possible to carry out a close up inspection of the engine room pipework systems.

Accessible pipework at the after part of the engine room appeared intact and in reasonable order following the sinking. Some overboard discharges were fitted with non return valves which most probably came from the engine room bilge pump(s) but these were not sighted as access to the bilges was not possible from the aft part of the engine room which was free of gas. The fish hold was provided with three bilge pumps, one tandem set and one single pump, the size of these pumps was indistinguishable but they all appeared above the 3000 GPH size and discharged over the side forward through non return valves above main deck level.

9. Review bilge alarm arrangement.

A bilge alarm panel was noted on the port side of the wheelhouse and this was very poorly labelled.

The panel has two red lights, a hole for another light below the two fitted, a sound alarm opening and is fitted with a switch which was found in the up off position. The down position marking was just legible and this was buzzer. It was not possible to ascertain where the float switches for the bilge alarm(s) were fitted but we were advised by the Salvers that when they prepared the aft lower part of the fish hold for the cement box they moved the 3 bilge pumps but did not sight a float switch suitable for a bilge alarm.

10. Review machinery condition.

In view of the vessel being submerged for about 2 months the engine room was in very poor condition and was only accessible below the hatch due to the presence of hydrogen sulphide gas. The main engine was very rusty and some of the exhaust lagging was hanging off but this could have been due to water damage. It was not possible to ascertain the maintenance status of the machinery in the engine room but the following general comments are made:-

i) Electrical cabling was generally untidy and poorly clipped.
ii) Engine room hoses appeared in reasonable order and were almost all double clipped.
iii) The deck net hauler appeared in satisfactory order.

11. Examine steering gear.

At the commencement of our inspection the rudder was hard to starboard. The steering gear was examined and albeit rusty was found intact. Using the wheelhouse wheel the rudder was moved from hard to starboard to hard to port several times and then left in the amidships position. During this test the steering gear appeared to function correctly and there was no unusual resistance in the rudder movement.

[redacted]

1 - Vessel on quayside in Falmouth Docks..JPG

2 - Fore deck.JPG

3 - View looking forward to damage starboard side.JPG

4 - Port side bottom planking looking aft.JPG

5 - Stern Gear.JPG

6 - Main engine port side.JPG

7 - Accommodation space looking aft.JPG

8 - Hold double bilge pump.JPG

9 - 9th plank out from keel starboard side with section missing.JPG

10 - Plank 7 starboard side sprung at butt.JPG

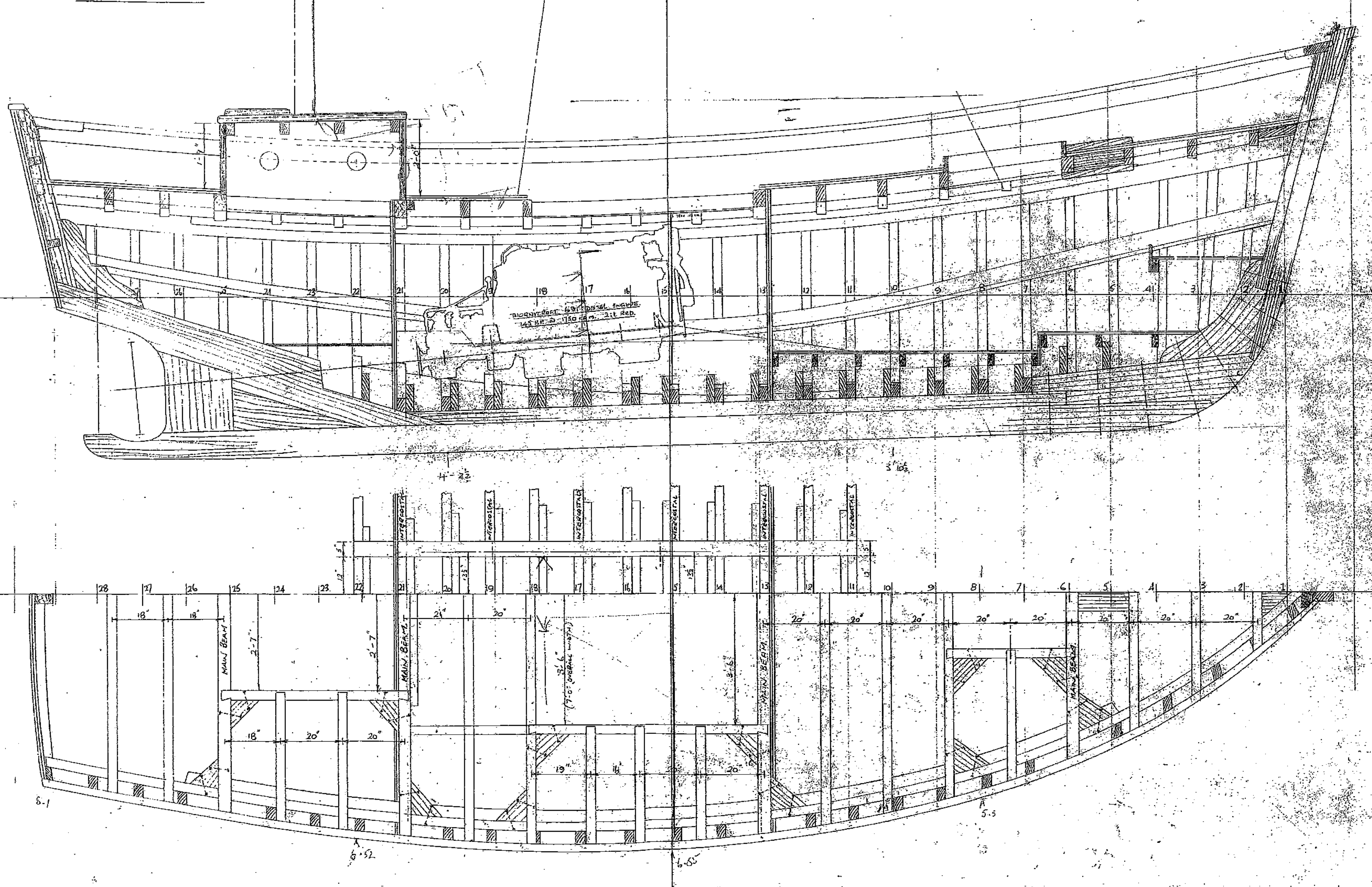
11 - Plank 5 starboard side sprung at butt.JPG

12 - Fastenings removed from starboard side of hull.JPG

36'-0" FISHING VESSEL

CONSTRUCTION PLAN

SCALE:- 1"=1'-0"



J. Gary Mitchell

G. P. MITCHELL & SONS,
BOATBUILDERS & DESIGNERS,
PORTMELLON,
MEVAGISSEY.

August 1970

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10th April 2012

"HEATHER ANNE"

Capsized and Sank in Gerrans Bay – 20th December 2012

ADDENDUM

To report dated 23rd March 2012

Remarks & Conclusions

Following our factual report, issued on the above date, the undersigned now comments on the findings in this report.

Comments are made under each of the sections below which were the survey instructions of the MAIB.

1. Review the general condition of the hull, its planking, supporting structure, fixings and whether there is any sign of hogging or sagging.
2. Specifically examine the sprung planks and damaged plank on the starboard side to establish what may have caused the damage.
3. Liaise and advise salvage contractor, in consultation with MAIB, how best to make a temporary repair to the hull to make it watertight ready for inclining.
4. Identify and examine hull penetrations and their isolation valves and whether NRVs are fitted.
5. Examine condition of external doors and hatches and their closures.
6. Examine condition of hull bulkheads and their degree of watertightness.
7. Examine freeing port arrangement and likely effectiveness.
8. Examine condition of pipework systems, but in particular the bilge pumping arrangement and its likely effectiveness.
9. Review bilge alarm arrangement and establish, if possible, its working status.
10. Review machinery condition in general and whether it appears to have been maintained.
11. Examine steering gear and determine any possible faults, if feasible.

Remarks

Item 1. From our general examination of the hull we found the planking, away from the damage, and hull equipment in reasonable order for the age and type of vessel. There were no indications of rot in areas examined and where contact damages had been filled on the corners of the transom the remaining timbers did not show any signs of rot. Fastenings are commented on in the next section.

The hull damages found were all on the starboard side just forward of amidships where we understand the vessel had been sitting on the bottom. There were no hull damages on the port side in this area.

When the vessel was ashore in its initial position, about half way along the Queens Wharf, we could not determine any hogging or sagging in the hull but following the inclining when the vessel was re-located to the end of the Queens Wharf some slight hogging was noted.

Item 2. The timbers in way of the damages were all in reasonable condition with no sign of any rot. The 10th timber out from the keel appeared to have been renewed recently in a different wood from the original hull. There appeared to have been some refastening carried out fairly recently in way of the damaged area but this was not as extensive as it could have been with several planks having not been refastened over quite some considerable length. The two sprung planks, 5 & 7, were examples of this.

From our factual report and the sample fastenings taken at the time of our survey it can be seen that hull fastening in way of the damages was very poor with a large number of the iron fastenings completely corroded away or with severe necking.

Whilst we did not remove any fastenings away from the damaged area all indications are that the iron fastenings in general are poor and where heavy rust staining is evident have probably corroded away. When the hull was disturbed by the salvers in fitting the cement box one hole appeared on the port side and just below this there were two fastening heads which looked in very poor condition.

When examining the framing in the damaged area through the missing and sprung planks there was evidence that a large number of fastenings had failed and there was a gap between the planking and the frames. The fastening failure could have been aggravated by the vessel "bumping" up and down on the seabed but the gap appeared to have been in existence for some considerable time as the planks in way of the gap were tight together away from the actual damages.

This was especially noticeable in way of the fastening of the planks at the bottom of bulkhead 13 between the fish room and engine room and even though the bulkhead had been penetrated higher up water would have free flowed between the two spaces had this not been the case.

The damage to planks 9 & 10 appears to have been caused by the hull striking or fouling a hard object but we have not been given any evidence that this might have occurred. As plank 9 appears to have failed outwards it could have been torn away during the salvage operation by the buoyancy bag webbing straps and taking a piece of the new 10 plank with it.

With the very poor state of the fastenings in the general area around the missing sections of planking the damage could have occurred when the vessel was lying on the bottom and may have been moving slightly. We have been advised that there is video evidence of the hull "bumping" on the seabed in benign conditions.

Item 3. From the efforts by the salvers to seal the hull and the subsequent leakage between the transducer housing and keel which required the cement box it is our opinion that the problems with the fastenings could be much more extensive than just in the area of the damage. This became apparent when the hold was being prepared for the cement box and the remains of one fastening on the port side, just forward of the starboard damage and about 800mm up from the keel, came out leaving a hole right through the plank into the hold. Just below this substantial rust staining was noted in way of other fastenings but these were not disturbed.

Item 4. Whilst we were unable to fully examine the skin fittings they all appeared to be in place and intact, in view of other findings with the hull etc., we do not consider hull penetrations or skin fittings to have contributed to the vessels sinking in any way.

Item 5. We do not consider doors or hatches to have contributed to the vessels sinking in any way but it is most probable that the fish room hatch cover was either not in place or, in place and not secured, at the time of the incident.

Item 6. As can be seen in our factual report we found several deliberate penetrations through the main bulkheads between both the fish room and engine room and accommodation and engine room and we find it most surprising that these man made deficiencies were not picked up by the MCA when inspecting the vessel for its fishing boat certification.

Item 7. We consider the freeing port arrangements on the vessel to be adequate providing the shutter boards which were noted were not kept in place.

Item 8. In view of the presence of hydrogen sulphide gas in the engine room and the amount of debris from the sinking it was not possible to carry out a close up inspection of the engine room pipework systems but from what we saw and in view of the condition of the hull fastenings we do not consider deficiencies in the pipework systems to have contributed to the vessels sinking in any way.

Item 9. From the position of the switch on the bilge alarm panel it is more than likely that the bilge alarm was in the mute position. As it could not be ascertained if there was a bilge alarm float switch in the fish hold then there would most probably have been one at the back of the engine room.

Item 10. In view of the vessel being submerged for about 2 months the engine room was in very poor condition and was only accessible below the hatch due to the presence of hydrogen sulphide gas. Whilst the condition of machinery was poor due to the sinking there was evidence that there could have been problems with electrical systems as the wiring was very untidy and poorly clipped with some unapproved cabling and fittings having been used at some time.

Item 11. We were able to test the steering gear and this appeared in order.

Conclusions

The very poor condition of the hull fastenings, either removed from the vessel or noted to be missing, most probably led to the failure of the hull and this could have occurred or have been exacerbated when the vessel was sitting on the seabed. The remedial work recently carried out to refasten the planking on the starboard side was not adequate and this also could have worsened the situation.

We have unofficially been advised that this vessel has suffered with plank fastening problems in the past and this could be why some refastening had been carried out. We assume that when this work was carried out that the certifying authority for the vessel would have been involved and should have insisted on all planks in way of the problem area being refastened.

If the vessel is to be repaired we would recommend that that all fastenings either be renewed or supplemented at each and every frame position.

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Annex B

Stability Assessment (with selected appendices)

Stability Assessment

Investigation into capsize of FV 'Heather Anne'

Marine Accident Investigation Branch

May 2012

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Report on stability investigation

Appendices

Tables

Diagrams

Report on Stability Investigation - FV ‘Heather Anne’

1. *Introduction*

The objective of this report is firstly to assess the general stability of the fishing vessel ‘Heather Anne’ against the requirements of the 1975 Fishing Vessel Regulations and secondly to assess the level of statical stability in the accident condition.

Section 2 explains the means by which the hull and compartments were defined for the analysis and Section 3 specifies the vessel’s principal dimensions. Section 4 illustrates the relationship between KN and righting lever values and outlines the assumptions made in the computation of this data. Section 5 details the stability and freeboard requirements in the 1975 Fishing Vessel Regulations. At less than 12 metres registered length, Heather Anne did not have to comply but many vessels of this size have been checked against the requirements over the years – for example, compliance was a Sea Fish Industry Authority requirement when grants were available for construction. Section 6 lists seven loading conditions which would have been included in a stability information booklet had it been required and tabulates the related trim and stability data whilst Section 7 examines the stability in the accident condition and in a similar 2011 condition. The report conclusions form Section 8.

2. *Hull and compartment definition*

The shape of the vessel’s hull and its compartments and tanks were defined by measurements taken from the lines plan and the hull. Half breadth and height dimensions for 17 transverse hull sections were digitised from the lines plan to create a coordinate model of the hull shape, adjusted where necessary to match check measurements taken from the hull. An additional 19 sections were then interpolated automatically from the input data to refine the model. Diagram 1 below is a section view of the model and Appendix 1 is comprised of section, plan, profile and isometric views.

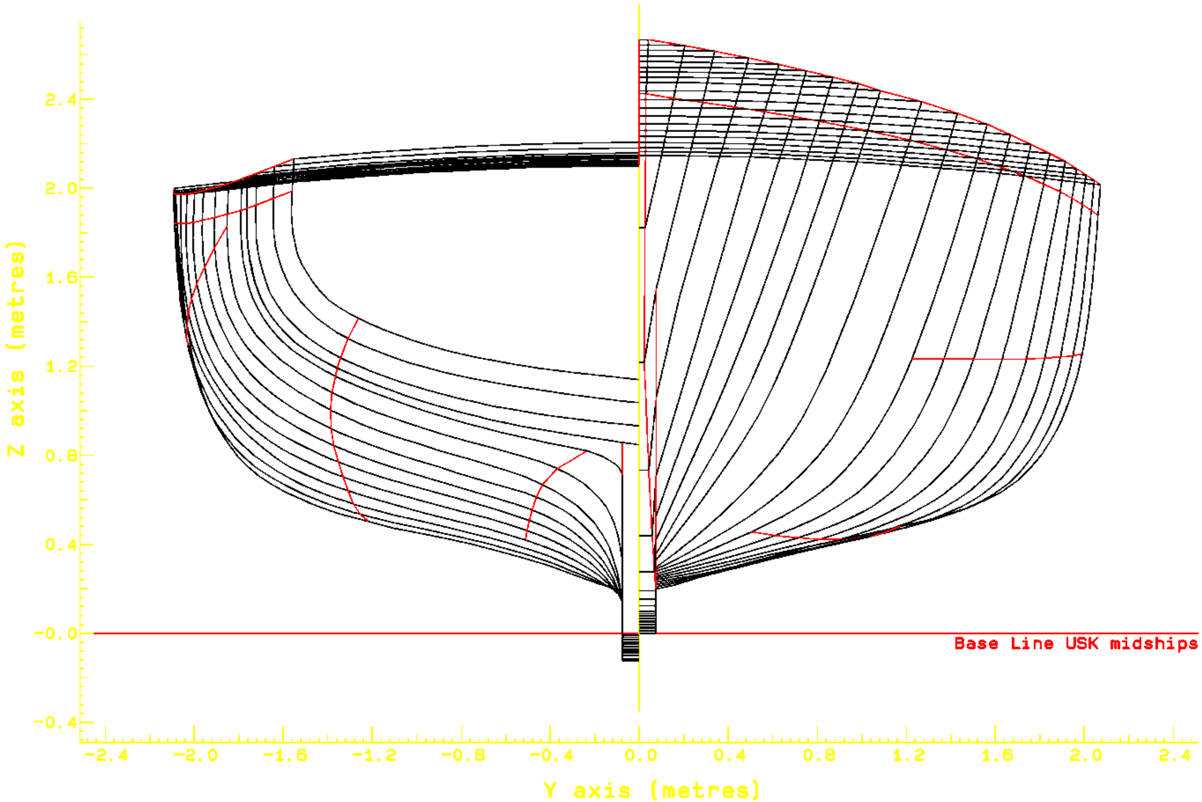


Diagram 1 – Hull sections

The centreline keel was modelled as a part of the hull form whilst all other appendages (rudder skeg, rudder and sonar unit) were modelled as separate entities. A digital model of the plywood repair patch on the starboard side was also created to improve the accuracy of the displacement calculations solely for the inclining trial calculations. The hydrostatic and KN data comprising Appendices 2 and 3 include all appendages with the exception of the repair patch.

For the purposes of this report, all longitudinal dimensions are taken about a Forward Perpendicular (FP) located at the intersection of the datum waterline and the stem (Station 1 on the Lines Plan); dimensions positive aft and negative forward of the FP. All vertical dimensions are about a Base Line passing through the underside of the keel at midships on the LBP; dimensions are positive above the Base Line, negative below. Transverse dimensions are about the centreline and are positive to Port, negative to Starboard. The dimension axes are shown on the General Arrangement below.

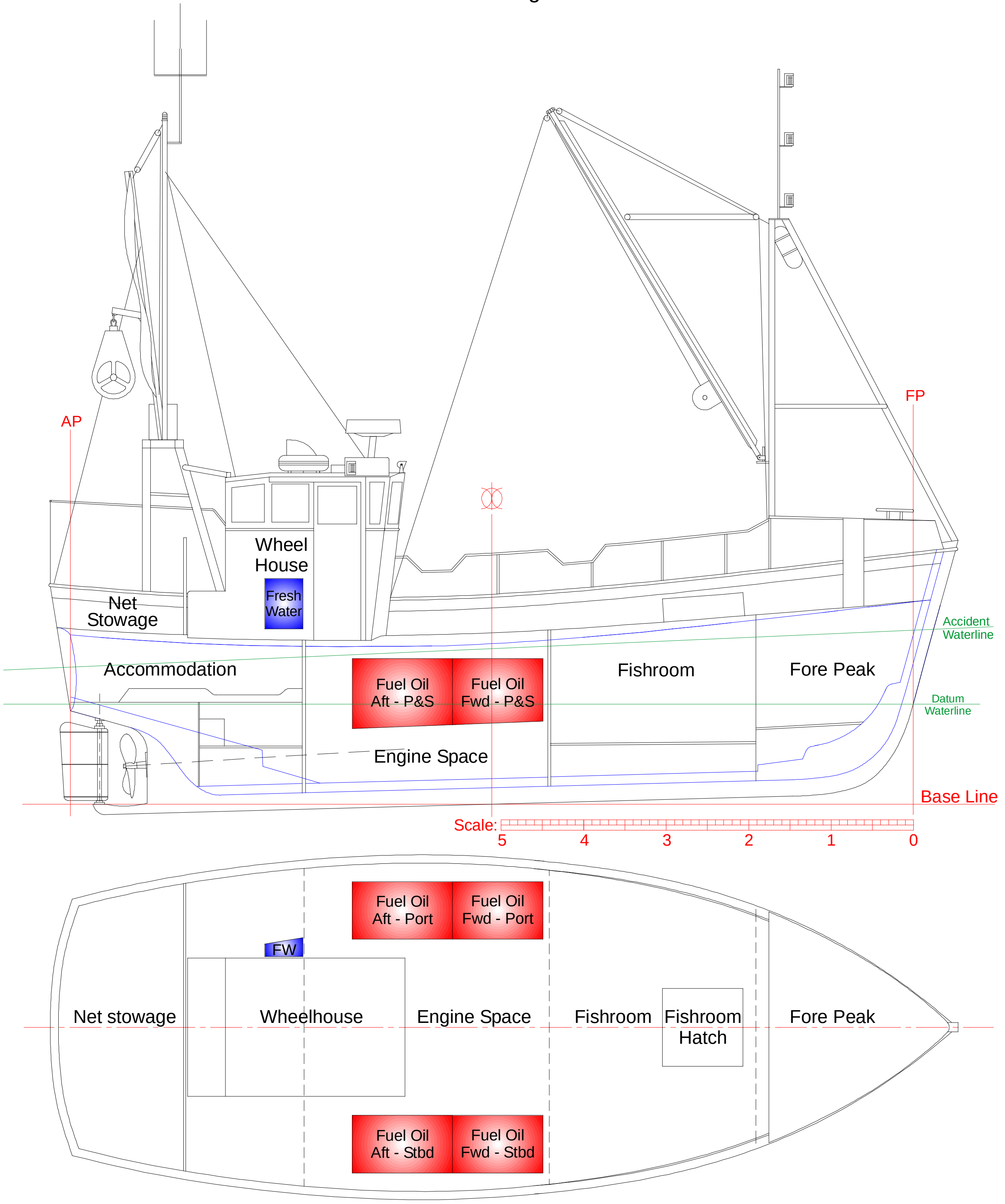


Diagram 2 – General Arrangement

The principal data for the tanks is summarised in table 1 below:

	Tank	Capacity metres^3 (100%)	SG	Capacity tonnes (100%)	LCG - m about FP	VCG - m about Base Line	Max. FSM t.m
1	Fuel Oil Forward - Port	0.544	0.840	0.457	5.052	1.397	0.049
2	Fuel Oil Forward - Stbd	0.544	0.840	0.457	5.052	1.397	0.049
3	Fuel Oil Aft - Port	0.640	0.840	0.538	6.213	1.375	0.060
4	Fuel Oil Aft - Stbd	0.640	0.840	0.538	6.213	1.375	0.060
5	Fuel tanks cross-connected	2.368	0.840	1.988	5.680	1.385	5.414
6	Fresh Water	0.053	1.000	0.053	7.631	2.437	0.000
7	Fishroom liner – old	3.390	0.935	3.170	3.213	1.143	0.634
8	Fishroom liner - new	5.015	0.935	4.689	3.070	1.216	2.156

Table 1 – Tank capacities, CG locations and free surface moments

The cross-connect linking fore and aft and port and starboard fuel oil tanks was open when the accident occurred. The tank contents were thus free to move from port to starboard and vice versa, albeit with a restricted flow rate through the 50-60mm diameter pipework. The data for the combined tanks has also been included as item 5 in table 1 to illustrate the very significant increase in free surface moment that results from an open cross-connection. The specific gravity of 0.935 for items 7 and 8 in the table is higher than the 0.8 SG assumed for the catch on deck. This higher value for the fishroom catch reflects a greater quantity of seawater entrained with the catch as both liners lacked drains.

Further details on the tanks with detailed calibration data and including longitudinal and vertical centres of gravity and free surface moments are to be found in Appendix 4.

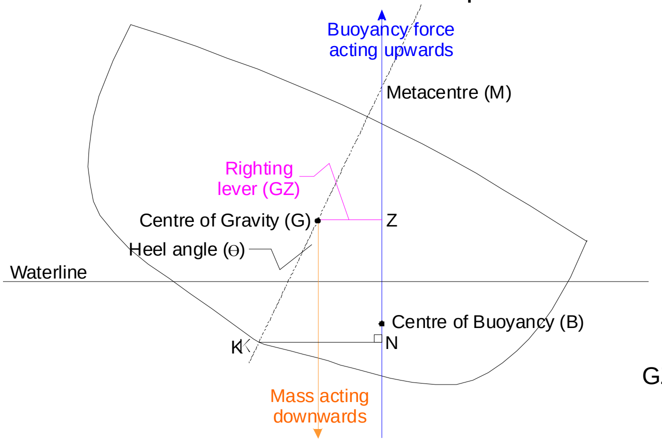
3. Principal dimensions

The vessel's principal dimensions are as follows:

Length Overall (LOA)................................: 11.05 metres
Length Registered (L)................................: 10.045 metres
Length Between Perpendiculars (LBP).......: 10.242 metres
Maximum beam (at deck level)...................: 4.19 metres
Depth (base line to deck edge at midships) : 2.017 metres
Lightship displacement...............................: 23.986 tonnes (from March 2012 inclining)
Keel rake ....: 0.275 metres over LBP

4. Hydrostatic, KN and tank data

Appendices 2 and 3 are comprised of hydrostatic and free-trim KN data computed from the hull model. Diagram 3 below illustrates the relationship between KN and righting levers (GZ):



GZ = KN – (KG x SIN(Θ))

Diagram 3 – Relationship of KN to righting lever (GZ)

The KN data used for the calculation of the stability data discussed in Section 6 of this report includes the volume of the hull below the deck and excludes the volume of the wheelhouse. This is normal practice in compiling a stability booklet for submission to the MCA as this space cannot be considered watertight.

5. Criteria used for assessment of stability and freeboards

The Heather Anne, originally named Aquarius II, was built in 1971. At that time, the Fishing Vessel Safety Provisions Rules 1975 were not in force and when introduced, these did not apply to a vessel with a registered length of less than 12 metres; Heather Anne has a registered length of 10.045 metres. The 1975 Rules were superseded in 2001 by the Fishing Vessels (Code of Practice for the Safety of Small Fishing Vessels) Regulations 2001 and in 2002 by the Fishing Vessels 15 to 24 metres regulations. With regard to stability, the provisions of the 1975 rules were identical to the 2002 regulations for vessels of 15 metres in length or greater, with no stability requirements for vessels of less than 15 metres in length. Merchant Shipping Notice (MSN) 1770(F) draws attention to the provisions of the 2002 regulations and paragraph 3.1.2 states that any fishing vessel of 15 metres in length or greater must comply with the following stability requirements:

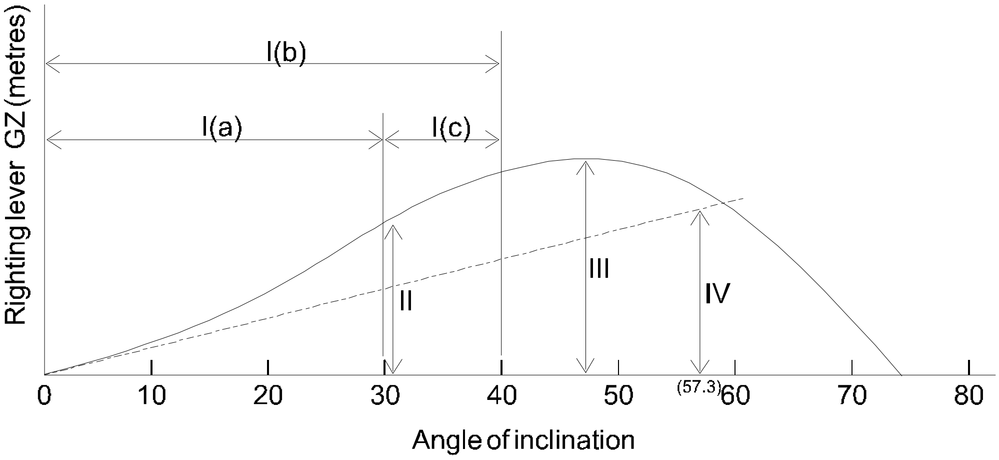


Diagram 4 – Example of righting lever curve with requirement key points

I) The area under the righting lever curve (GZ curve) shall not be less than:
   - (a) 0.055 metre.radians up to an angle of 30 degrees;
   - (b) 0.09 metre.radians up to an angle of 40 degrees or such lesser angle of heel at which the lower edges of any opening in the hull, superstructure, deckhouses, or companionways being openings which cannot be closed weathertight are immersed;
   - (c) 0.030 metre.radians between the angles of heel of 30 degrees and 40 degrees or such lesser angle as defined in (b) above;

II) The righting lever (GZ) shall be at least 0.20 metres at an angle of heel equal to or greater than 30 degrees;

III) The maximum righting lever (GZ) shall occur at an angle of heel not less than 25 degrees;

IV) In the upright position the transverse metacentric height (GM) shall not be less than 350 millimetres;

Minimum freeboard requirements for fishing vessels with a registered length greater than 12 metres were included in Rule 15(1) of the 1975 Safety Provisions Rules (Merchant Shipping Notice M975 issued in 1981 explained the freeboard requirements in greater detail). With a registered length of less than 12 metres Heather Anne did not have to comply with these, but had it been obligatory, the minimum freeboards at the forward and aft ends of the registered length would have been respectively 1.093 metres ($H_D = 0.8+7L/240$) and 0.635 metres ($H_{DA} = 0.3+L/30$). M975 did not include a requirement for a minimum at the point where the lowest freeboard occurred.

Freeboard requirements were updated in 2002 by the introduction of the Code of Practice for Fishing Vessels 15 to 24 metres regulations (MSN 1770(F)). Paragraph 3.2.1 of this document specifies that fishing vessels of over 15 metres length shall be designed, constructed and operated so as to maintain adequate freeboards in all foreseeable operating conditions – paragraphs 3.2.2 to 3.2.7 define these minima which are applied at FP, AP and the point where the minimum freeboard occurs. If these requirements had been applicable to Heather Anne, the minimum freeboards would have been 1.447 metres forward

(Hf_{min} = 0.75+6.6xLBP/240+0.415(bulwark height correction)), 0.513 metres aft (Ha_{min} = 0.24+LBP/37.5) and 0.256 metres (H_{min} = LBP/40) at the lowest point of the deck.

In 2010, the MCA published a Marine Guidance Notice (MGN 427(F)) entitled 'Stability Guidance for Fishing Vessels of under 15m Overall Length'. This document summarises a number of approaches to assessing the safety of small fishing boats, including simplified methods easily usable by all Skippers. The use of minimum freeboards to reduce capsize risk is also discussed – in the context of this report, the Wolfson method outlined in Annex 5 of MGN 427 (F) is of particular relevance.

6. *Assessment of standard loading conditions*

A fishing vessel is judged to comply with the requirements if its stability and freeboard characteristics exceed the criteria stated in Section 5 in 'all foreseeable operating conditions'. It is usual practice for any stability submission to the MCA relating to a fishing vessel to include an assessment of these characteristics in a sequence of standard loading conditions loosely representative of a voyage profile.

The following seven loading conditions were compiled for this report to assess the Heather Anne's stability and freeboard characteristics in relation to the requirements:

1. Lightship (non-seagoing)
2. Depart Port, 100% Consumables, 2 Crew
3. Arrive Grounds, 85% Consumables, 2 Crew
4. Depart Grounds, 50% Consumables, 5 Tonnes Catch, 2 Crew
5. Arrival Port, 10% Consumables, 5 Tonnes Catch, 2 Crew
6. Depart Grounds, 25% Consumables, 1 Tonne (20% Catch), 2 Crew
7. Arrival Port, 10% Consumables, 1 Tonne (20% Catch), 2 Crew

Conditions Nos. 4 to 7 are based on a maximum catch weight of 5 tonnes, the original design intention, of which 4 tonnes are assumed to be in the fishroom, 1 tonne on deck.

Appendix 5 is comprised of the deadweight tables and the resultant trim, stability and freeboard data in these conditions. Table 3 below summarises this data - limit values were all derived from MSN 1770(F).

		Condition No.							
Condition data	*Limit value*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*4 'as built'*
Displacement (tonnes)	-	23.986	28.005	27.699	31.985	31.081	27.473	27.169	23.027
LCG about FP (metres)	-	5.710	5.893	5.894	5.505	5.492	5.812	5.813	4.933
VCG_{fluid} about Base Line (metres)	-	1.757	1.806	1.811	1.847	1.856	1.905	1.911	1.755
Draught midships about Base Line (m)	-	1.351	1.454	1.445	1.614	1.588	1.447	1.438	1.376
Freeboard at FP about deck edge (m)	>1.447	1.499	1.501	1.511	1.063	1.085	1.456	1.466	1.025
Freeboard min. about deck edge (m)	>0.256	0.441	0.249	0.260	0.277	0.305	0.300	0.310	0.573
Freeboard at AP about deck edge (m)	>0.513	0.544	0.330	0.338	0.459	0.488	0.392	0.400	0.969
Trim over LBP (metres)	-	0.472 by stern	0.689 by stern	0.691 by stern	0.120 by stern	0.113 by stern	0.582 by stern	0.584 by stern	0.429 by bow

Stability data	*Limit value*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*4 'as built'*
Downflooding angle (degrees)	-	55.9°	44.3°	44.9°	42.5°	44.4°	46.6°	47.2°	68.6°
Area under GZ to 30° (metre.radians)	>0.055	0.077	0.055	0.056	0.039	0.041	0.045	0.045	0.069
Area under GZ to 40° (metre.radians)	>0.090	0.111	0.073	0.074	0.045	0.049	0.054	0.055	0.102
Area under GZ 30°-40° (metre.radians)	>0.030	0.034	0.017	0.018	0.006	0.007	0.010	0.010	0.033
Angle of maximum GZ (degrees)	>25°	26.4°	21.9°	22.1°	18.9°	19.6°	20.6°	20.7°	28.1°
GZ max at >30 degrees (metres)	>0.200	0.217	0.128	0.131	0.069	0.077	0.091	0.093	0.208
GM_{fluid} (metres)	>0.350	0.680	0.547	0.549	0.431	0.434	0.456	0.457	0.582
	Result	***PASS***	***FAIL***	***FAIL***	***FAIL***	***FAIL***	***FAIL***	***FAIL***	***PASS***

Table 3 – Summary of standard loading condition stability and freeboard data

The data in table 3 indicates that equipped as it was at the time of the accident the Heather Anne would fail the stability and freeboard requirements in all but the non-seagoing lightship condition. GM_{fluid} is the only parameter which exceeds the 0.35 metres requirement in all conditions. This voyage cycle data illustrates very clearly the importance of statical stability calculations in highlighting potentially dangerous loading conditions; apart from the much higher catch load, the Heather Anne capsized in a condition somewhere between numbers 4 and 5 which by a significant margin are the worst in terms of stability.

Comparison of the originally intended 5 tonne maximum catch weight with the estimated weight of about 10 tonnes on board when the accident occurred indicate that the boat was probably being worked more intensively in later years. Photographs taken shortly after launch in 1972 and in 2008 before the accident (see diagram 5 below) tend to confirm this, pointing to significant weight gains both loaded and unloaded accompanied by a rise in the centre of gravity.

Heather Anne in 1972 (then named Aquarius II), shortly after launch

Heather Anne in 2008

Diagram 5 – Photographs of Heather Anne in 1972 and 2008

Although no figures are available for the Heather Anne's lightship displacement when first built, the original design intention was that level trim at the datum waterline should represent the Depart Port condition, i.e. with all fishing gear aboard and all tanks pressed full. This corresponds to a lightship displacement of 15.7 tonnes, over a third less than the 23.9 tonnes lightship displacement at the time of the loss. A large part of this increase can probably be attributed to water absorbed by structure and fit-out before and after the accident. Although less in terms of weight, a more significant part lay in equipment additions made during the vessel's life, almost all of which were at or above deck level, thus raising the centre of gravity, and further reducing stability.

Data for the '4 as-built' loading condition (see Appendix 6, summarised in the right hand column of table 3) illustrates the significance of this considerable increase in displacement and centre of gravity height during service. This is the 'as-built' equivalent of the worst condition (No. 4 in table 3) at the lightship displacement originally intended with an estimated lightship centre of gravity height. The boat complies, albeit marginally, with all stability criteria in this condition, and fails only the forward freeboard requirement.

7. *Assessment of the capsize condition*

The standard condition closest in deadweight makeup to the accident condition (see Appendices 5 and 7) is 'Depart Grounds, 50% consumables, 5 tonnes catch, 2 crew' (No. 4 in table 3). As stated above, with the exception of the GM this condition fails all the stability requirements even with the originally intended 5 tonnes of catch. Data for the accident condition forms part of Appendix 7 and is summarised in table 4 on the next page. It should be noted that values for transverse centre of gravity are included in the deadweight table for this condition. This information is included as the vessel had a 6 degree heel to starboard in the lightship condition.

The data for the accident condition indicates that the boat had an estimated 10.5 tonnes of catch (including water entrained with the catch) aboard in 12 catch bins on deck and in the canvas fishroom liner which was full. It was therefore carrying more than double the intended load and had a corresponding displacement of 38.5 tonnes (i.e. about 67% higher than the 'as built' condition) with its vertical centre of gravity 2.05 metres above the Base Line (i.e. approximately 17% higher than the 'as built' condition).

However, on at least one previous occasion in January 2011 a similar catch load had been carried without mishap. In this instance, 10.1 tonnes were landed, but this was made up of proportionately less fish in the hold and more on deck than the accident condition, potentially a more dangerous condition. In an attempt to understand why the boat did not capsize on that occasion a second loading condition representing this incident was modelled - the results are included in Appendix 7 and summarised in table 4 below. A significant change had been made to the boat in November 2011; the canvas fishroom liner was replaced with a larger version which increased the capacity by nearly 48% from 3.4 to 5.02 cubic metres and the free surface moment by some 240% (see tank data in table 1 on page 5).

Condition data	*Limit value*	*January 2011 near-accident condition*	*December 2011 accident condition*
Displacement	-	38.703 tonnes	38.496 tonnes
Estimated catch weight (inc. seawater)	-	10.649 tonnes	10.512 tonnes
Longitudinal CG about FP	-	5.329 metres	5.331 metres
Transverse CG about Centreline	-	0.004 metres to port	0.006 metres to stbd
Vertical CG_{fluid} about Base Line	-	2.025 metres	2.050 metres
Draught midships about Base Line	-	1.828 metres	1.821 metres
Static heel	-	0.94° to port	1.76° to starboard
Freeboard at FP about deck edge	>1.447	0.666 metres	0.664 metres
Freeboard midships about deck edge	-	0.188 metres	0.131 metres
Freeboard at AP about deck edge	>0.513	0.426 metres	0.382 metres
Trim over LBP	-	0.244 metres by bow	0.238 metres by bow

Stability data	*Limit value*	*January 2011 near-accident condition*	*December 2011 accident condition*
Downflooding angle (accomm access)	-	34.36°	34.65°
Area under GZ curve to 30°	>0.055	0.006 metre.radians	0.002 metre.radians
Area under GZ curve to 40°	>0.090	0.006 metre.radians	0.002 metre.radians
Area under GZ between 30° and 40°	>0.030	0.000 metre-radians	0.000 metre.radians
Angle of maximum righting lever (GZ)	>25°	9.16°	8.87°
Maximum righting lever (GZ)	-	0.029 metres	0.016 metres
Positive righting lever (GZ) range	-	17.67°	13.31°
Maximum righting moment	-	1.111 tonne.metres	0.601 tonne.metres
GZ maximum at >30 degrees heel	>0.200	0.000	0.000 metres
GM_{fluid}	>0.350	0.228 metres	0.192 metres
	Result	***Fails requirements***	***Fails requirements***

Table 4 – Summary of accident and near-accident loading condition data

More significantly, in January the deck catch had been loaded with its centre of gravity further to port than in December (see deadweight tables on pages 72 and 75), thereby more effectively balancing the lightship centre of gravity which was 70 millimetres to starboard. As a result, the centre of gravity of the loaded boat in January was only around 4 millimetres to port giving the boat a positive stability range of about 17 degrees, albeit with dangerously low reserves. In the accident condition, the starboard shift in centre of gravity had the effect of reducing the range of positive stability to just over 13 degrees and the areas under the righting lever by 67%.

The righting lever curves for the two conditions are to be found in Appendix 7 and are reproduced in diagram 6 at the head of the next page. For comparison, the righting lever curve from 'As built' Condition No. 4 (see right hand column in table 3) has been superimposed on the plot - this represents marginal compliance with the requirements.

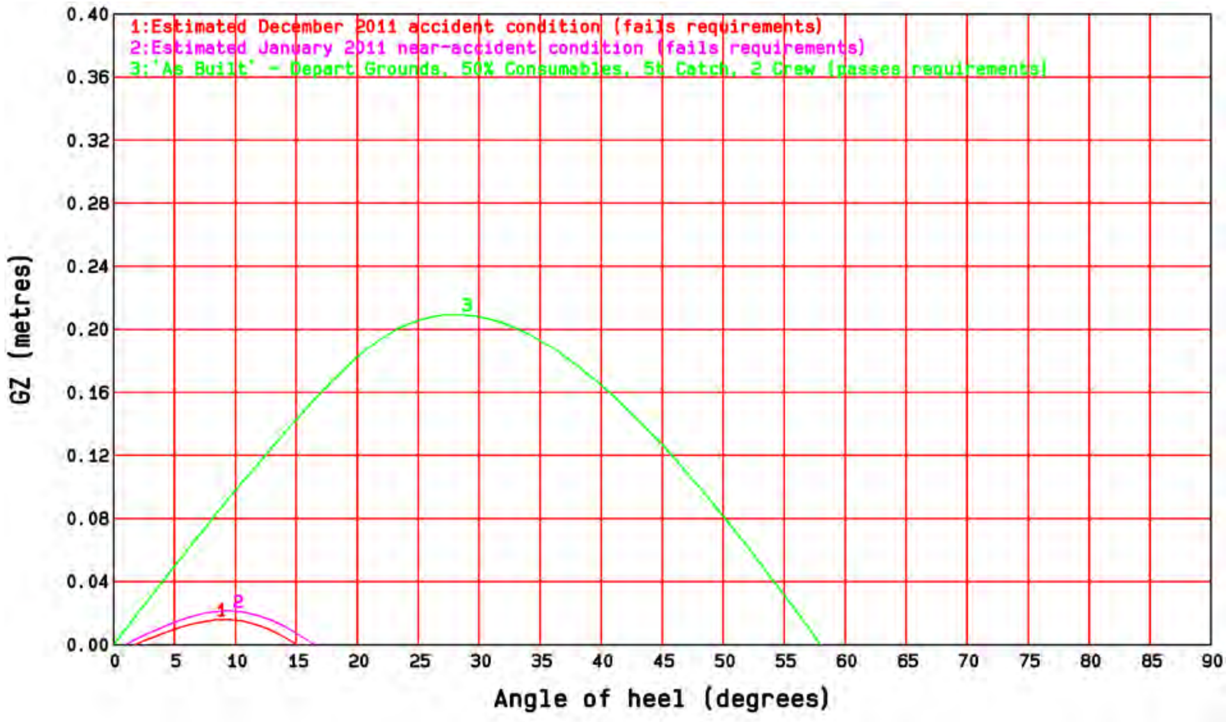


Diagram 6 – Righting lever curves for the 2011 accident, near accident and Depart Grounds 'As built' conditions

As the diagram above indicates, righting levers in the accident condition were very low indeed and capsize was therefore a very real risk in the deteriorating weather conditions. The obvious question is then 'why did Heather Anne not capsize sooner?'. The most likely explanation is the temporary increase in righting lever provided by the immersion of the bulwarks. However, when the lower part of the bulwarks were immersed for more than a few moments, the incoming water onto the deck through the freeing ports would have nullified this increase and capsize would then be almost inevitable.

8. Conclusions

The photograph of the Heather Anne taken in 1972 shortly after it was built (see diagram 5 on page 8) shows a vessel that might have been designed for a different era when fishing techniques were less intensive and catch weights were expected to be lower than today. Originally, with a loaded displacement of about 23 tonnes, the boat's stability probably complied with the requirements introduced in 1975, albeit that compliance was not obligatory.

Over the intervening years, the boat has been considerably altered, with each modification adding to the displacement and raising the centre of gravity, a combination which can only reduce stability reserves. The data in Table 3 on page 7 indicates that by 2011, even with the originally intended 5 tonne catch weight, these reserves had reduced to the point where the vessel would not comply with the stability criteria in any seagoing condition.

In the December 2011 accident condition, the boat had a displacement of over 38 tonnes and was carrying about 5.8 tonnes of catch on deck with a further 4.7 tonnes in the fishroom, although a part of the latter would have been seawater brought aboard with the catch. In other words, this was a fishing boat designed to carry about 5 tonnes in the fishroom and in practice carrying over double that amount, the majority on deck.

As the data in table 4 indicates, the boat had very little positive stability in the accident condition and capsize was imminent, prevented only by the very temporary buoyancy provided by the bulwarks as they became immersed. In such circumstances, the smallest of events can trigger capsize. It may have been increasing quantities of water on deck, shifting of some of the catch boxes, the heeling moment induced by the rudder being put over or heeling in response to waves or a combination of these factors. The key to the accident was that the vessel was carrying a load well in excess of that for which it had been designed and did not have sufficient statical stability to counter even routine heeling moments such as these.

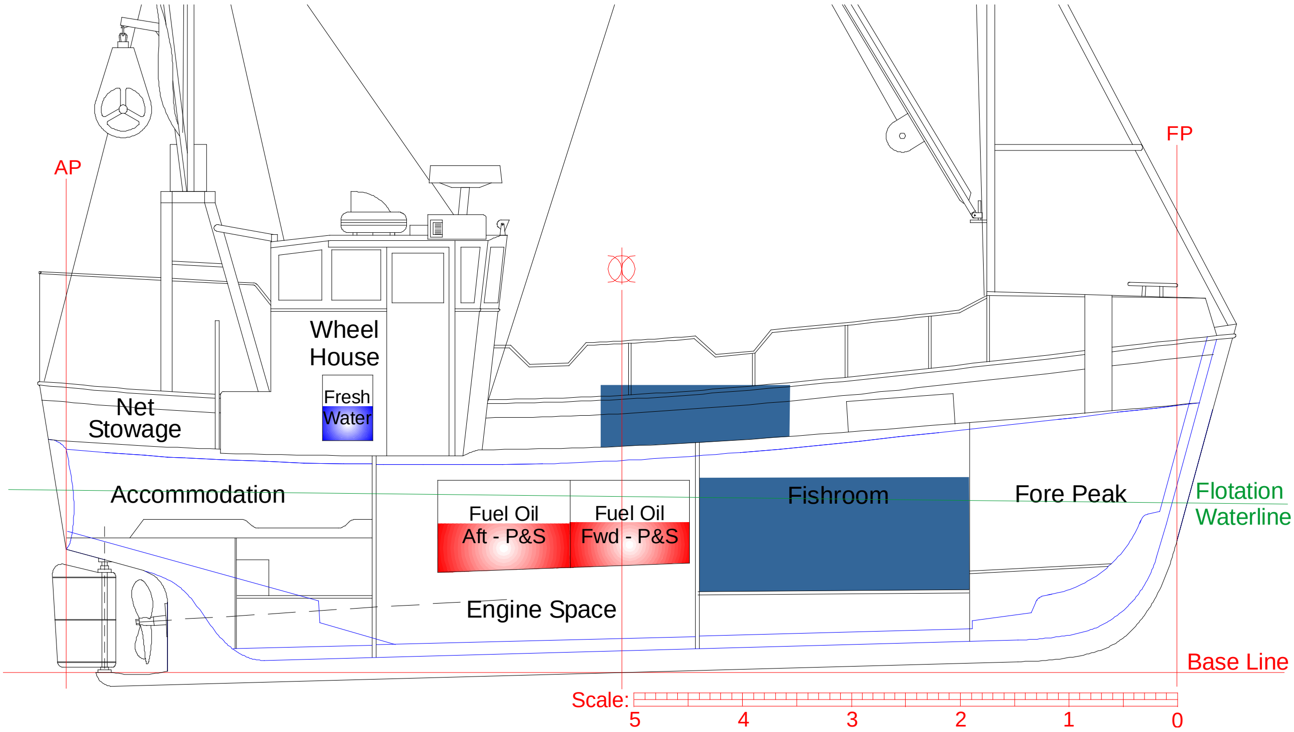
Appendix 5

Standard loading condition data

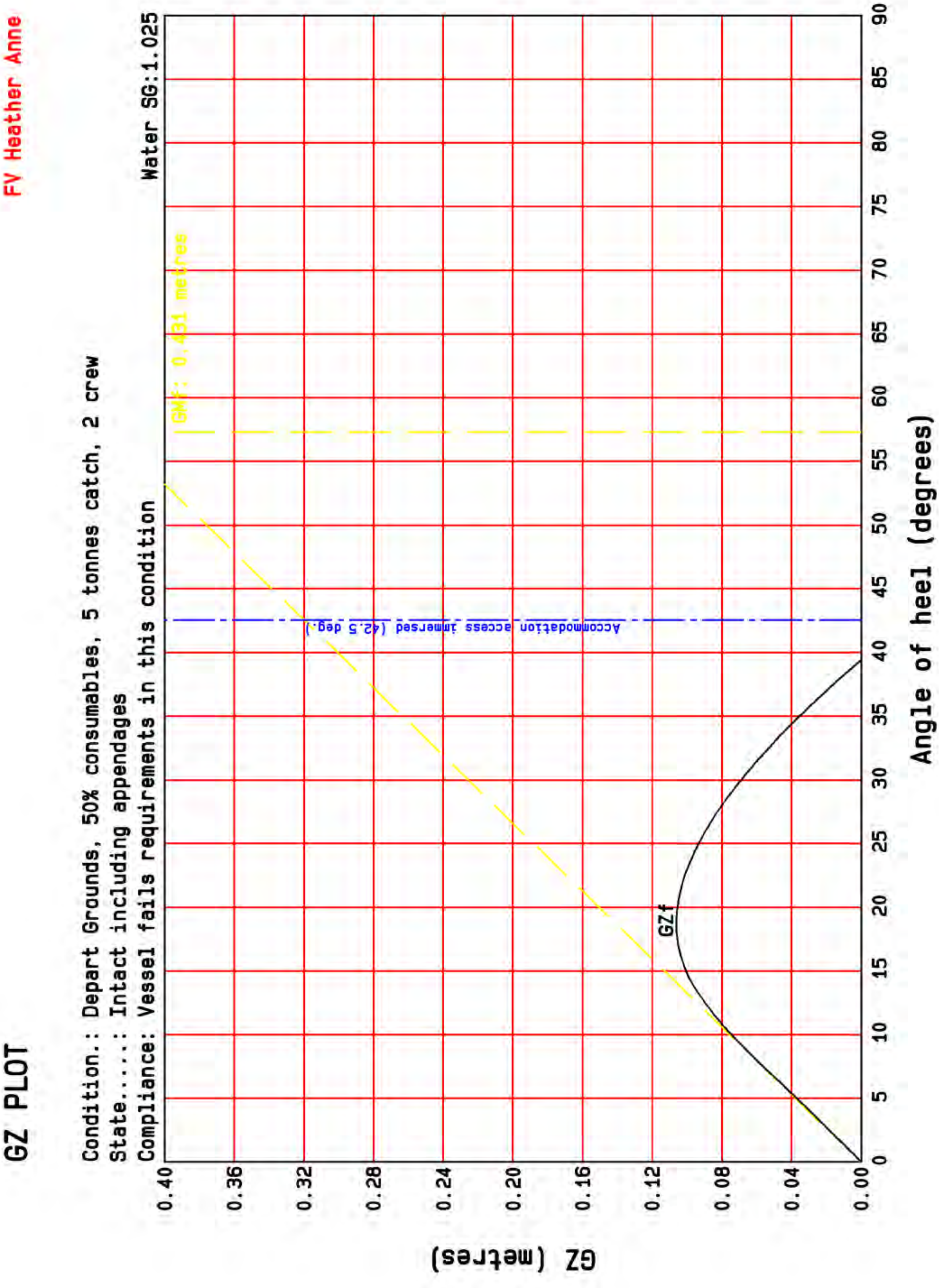
DEADWEIGHT TABLE

Vessel....: FV Heather Anne
Condition.: Depart Grounds, 50% consumables, 5 tonnes catch, 2 crew
State.....: Intact including appendages
Water SG..: 1.025
Compliance: Vessel fails requirements in this condition

Longitudinal dimensions about FP (Stn.1 on lines) (+ve aft, -ve forward)
Vertical dimensions about Base Line USK midships (+ve above, -ve below)



	Deadweight Item	Weight tonnes	LCG metres	Longitudinal moment t.m	VCG metres	Vertical moment t.m	Free Surface moment t.m
1	Fuel Oil Fore - Port	0.228	5.058	1.153	1.397	0.319	0.049
2	Fuel Oil Aft - Port	0.269	6.218	1.673	1.375	0.370	0.049
3	Fuel Oil Fore - Stbd	0.228	5.058	1.153	1.397	0.319	0.060
4	Fuel Oil Aft - Stbd	0.269	6.218	1.673	1.375	0.370	0.060
5	Fresh Water	0.027	7.631	0.206	2.437	0.066	0.000
6	Crew and effects (2)	0.180	7.100	1.278	3.050	0.549	-
7	Consumable stores	0.098	8.000	0.784	2.600	0.255	-
8	Fishing net	1.400	9.400	13.160	2.750	3.850	-
9	Misc. equipment	0.300	3.800	1.140	2.300	0.690	-
10	Bulk catch in fishroom	4.000	3.102	12.408	1.216	4.864	2.272
11	Bulk catch on deck	1.000	4.500	4.500	2.400	2.400	0.400
	Total catch	5.000	3.382	16.908	1.453	7.264	2.672
	DEADWEIGHT TOTAL	7.999	4.892	39.128	1.757	14.050	2.890
	LIGHTSHIP	23.986	5.710	136.960	1.757	42.143	-
	DISPLACEMENT	31.985	5.505	176.088	1.757	56.194	2.890
	Free Surface Correction (Total Free Surface Moment/Displacement)				0.090		
				VCG fluid	1.847		


FV Heather Anne
GZ PLOT
Condition.: Depart Grounds, 50% consumables, 5 tonnes catch, 2 crew
State.....: Intact including appendages
Compliance: Vessel fails requirements in this condition
Water SG:1.025
GMf: 0.431 metres
Accommodation access immersed (42.5 deg.)
GZf
GZ (metres)
0.00
0.04
0.08
0.12
0.16
0.20
0.24
0.28
0.32
0.36
0.40
Angle of heel (degrees)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90

SAILING STATE

Vessel....: FV Heather Anne
Condition.: Depart Grounds, 50% consumables, 5 tonnes catch, 2 crew
State.....: Intact including appendages
Water SG..: 1.025
Compliance: Vessel fails requirements in this condition

DRAFT SUMMARY (DIMENSIONS IN METRES)	Maximum	Actual
Draught at FP about Base Line	-	1.554
Draught at midships on LBP about Base Line	-	1.614
Draught at AP about Base Line	-	1.674

FREEBOARD SUMMARY (DIMENSIONS IN METRES)	Minimum	Actual
Freeboard at FP about deck edge	-	1.063
Freeboard at midships on LBP about deck edge	-	0.403
Freeboard at AP about deck edge	-	0.459

STABILITY DATA

Heel angle degrees	Trim about Base Line metres on LBP	Draft at midships LBP about Base Line	KN metres	KGxSIN(Heel) metres	Righting moment tonne.metres	GZ fluid metres
0	0.120 by stern	1.614	0.000	0.000	0.002	0.000
5	0.116 ''	1.607	0.198	0.161	1.198	0.037
10	0.114 ''	1.585	0.396	0.321	2.396	0.075
15	0.119 ''	1.553	0.579	0.478	3.226	0.101
20	0.142 ''	1.517	0.737	0.632	3.377	0.106
25	0.176 ''	1.477	0.874	0.781	2.990	0.093
30	0.217 ''	1.431	0.993	0.924	2.207	0.069
35	0.261 ''	1.378	1.095	1.060	1.132	0.035
40	0.305 ''	1.318	1.182	1.187	-0.161	-0.005
45	0.350 ''	1.251	1.256	1.306	-1.609	-0.050
50	0.393 ''	1.175	1.316	1.415	-3.162	-0.099
55	0.434 ''	1.092	1.364	1.513	-4.776	-0.149
60	0.472 ''	1.001	1.399	1.600	-6.418	-0.201
65	0.508 ''	0.905	1.422	1.674	-8.056	-0.252
70	0.541 ''	0.802	1.434	1.736	-9.660	-0.302
75	0.570 ''	0.694	1.434	1.784	-11.209	-0.350
80	0.592 ''	0.582	1.423	1.819	-12.680	-0.396
85	0.613 ''	0.466	1.401	1.840	-14.043	-0.439
90	0.625 ''	0.349	1.369	1.847	-15.284	-0.478

STABILITY SUMMARY	Minimum	Actual
Angle of immersion of Accommodation access (degrees)	-	42.531
Area under GZ curve between 0.00 and 30.00 degrees (metre.radians)	0.055	0.039
Area under GZ curve between 0.00 and 40.00 degrees (metre.radians)	0.090	0.045
Area under GZ curve between 30.00 and 40.00 degrees (metre.radians)	0.030	0.006
Maximum GZ (metres)	-	0.106
Angle of heel at which maximum GZ occurs (degrees)	25.000	18.908
Maximum GZ between 30 and 90 degrees (metres)	0.200	0.069
Positive GZ heel range (degrees)	-	39.412
GM solid (metres) (upright)	-	0.521
Free Surface correction (metres)	-	0.090
GM fluid (metres) (upright)	0.350	0.431

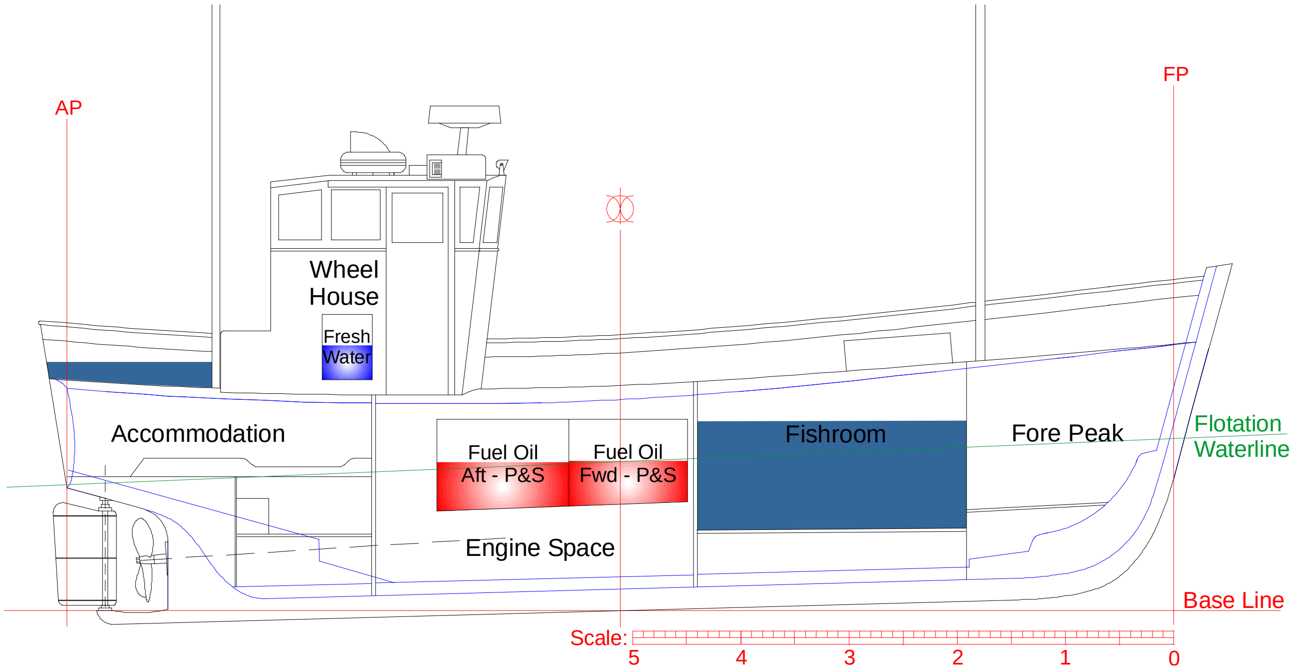
Appendix 6

Loading condition data for worst standard case in 1972 ‘as-built’ configuration

DEADWEIGHT TABLE

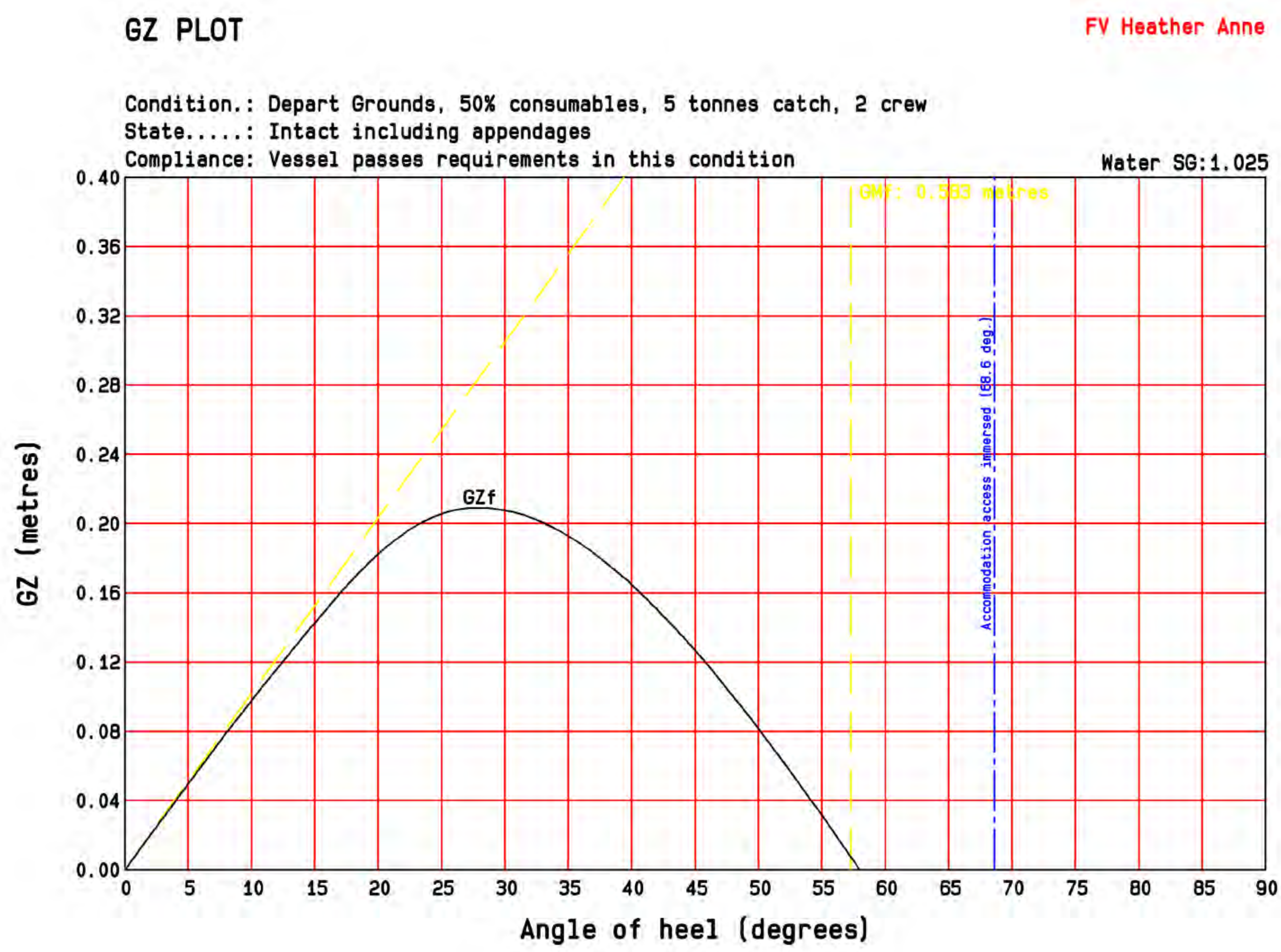
Vessel....: FV Heather Anne
Condition.: Depart Grounds, 50% consumables, 5 tonnes catch, 2 crew
State.....: Intact including appendages
Water SG..: 1.025
Compliance: Vessel passes requirements in this condition

Longitudinal dimensions about FP (Stn.1 on lines) (+ve aft, -ve forward)
Vertical dimensions about Base Line USK midships (+ve above, -ve below)



	Deadweight Item	Weight tonnes	LCG metres	Longitudinal moment t.m	VCG metres	Vertical moment t.m	Free Surface moment t.m
1	Fuel Oil Fore - Port	0.228	5.058	1.153	1.397	0.319	0.032
2	Fuel Oil Aft - Port	0.269	6.218	1.673	1.375	0.370	0.032
3	Fuel Oil Fore - Stbd	0.228	5.058	1.153	1.397	0.319	0.029
4	Fuel Oil Aft - Stbd	0.269	6.218	1.673	1.375	0.370	0.029
5	Fresh Water	0.027	7.631	0.206	2.437	0.066	0.000
6	Crew and effects (2)	0.180	7.100	1.278	3.050	0.549	-
7	Consumable stores	0.098	8.000	0.784	2.600	0.255	-
8	Fishing net	0.700	9.400	6.580	2.750	1.925	-
9	Misc. equipment	0.300	3.800	1.140	2.300	0.690	-
10	Catch -F/R wing pound Port	1.700	3.415	5.806	1.450	2.465	0.220
11	Catch -F/R wing pound Stbd	1.700	3.415	5.806	1.450	2.465	0.220
12	Catch -F/R centre pound	1.200	3.970	4.764	1.350	1.620	0.157
13	Bulk catch on aft deck	0.400	9.600	3.840	2.400	0.960	0.200
	Total catch	5.000	4.043	20.215	1.502	7.510	0.797
	DEADWEIGHT TOTAL	7.299	4.912	35.855	1.695	12.371	0.919
	LIGHTSHIP	15.728	4.942	77.728	1.724	27.115	-
	DISPLACEMENT	23.027	4.933	113.583	1.715	39.486	0.919

Free Surface Correction (Total Free Surface Moment/Displacement)	0.040
VCG fluid	1.755


GZ PLOT
FV Heather Anne
Condition.: Depart Grounds, 50% consumables, 5 tonnes catch, 2 crew
State.....: Intact including appendages
Compliance: Vessel passes requirements in this condition
Water SG:1.025
GMf: 0.583 metres
Accommodation access immersed (68.6 deg.)
GZf
GZ (metres)
0.00
0.04
0.08
0.12
0.16
0.20
0.24
0.28
0.32
0.36
0.40
Angle of heel (degrees)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90

SAILING STATE

Vessel....: FV Heather Anne
Condition.: Depart Grounds, 50% consumables, 5 tonnes catch, 2 crew
State.....: Intact including appendages
Water SG..: 1.025
Compliance: Vessel passes requirements in this condition

DRAFT SUMMARY (DIMENSIONS IN METRES)	Maximum	Actual
Draught at FP about Base Line	-	1.590
Draught at midships on LBP about Base Line	-	1.376
Draught at AP about Base Line	-	1.162

FREEBOARD SUMMARY (DIMENSIONS IN METRES)	Minimum	Actual
Freeboard at FP about deck edge	-	1.025
Freeboard at midships on LBP about deck edge	-	0.639
Freeboard at AP about deck edge	-	0.969

STABILITY DATA

Heel angle degrees	Trim about Base Line metres on LBP	Draft at midships LBP about Base Line	KN metres	KGxSIN(Heel) metres	Righting moment tonne.metres	GZ fluid metres
0	0.429 by bow	1.376	0.000	0.000	0.002	0.000
5	0.438 ''	1.368	0.203	0.153	1.149	0.050
10	0.460 ''	1.344	0.403	0.305	2.257	0.098
15	0.493 ''	1.304	0.597	0.454	3.291	0.143
20	0.534 ''	1.247	0.783	0.600	4.208	0.183
25	0.579 ''	1.179	0.947	0.742	4.740	0.206
30	0.623 ''	1.103	1.085	0.877	4.787	0.208
35	0.667 ''	1.019	1.199	1.006	4.441	0.193
40	0.706 ''	0.929	1.293	1.128	3.791	0.165
45	0.736 ''	0.832	1.367	1.241	2.917	0.127
50	0.761 ''	0.731	1.426	1.344	1.876	0.081
55	0.775 ''	0.626	1.469	1.437	0.723	0.031
60	0.777 ''	0.518	1.498	1.520	-0.495	-0.022
65	0.770 ''	0.408	1.515	1.590	-1.741	-0.076
70	0.748 ''	0.298	1.520	1.649	-2.971	-0.129
75	0.720 ''	0.187	1.513	1.695	-4.181	-0.182
80	0.696 ''	0.075	1.494	1.728	-5.389	-0.234
85	0.681 ''	-0.038	1.462	1.748	-6.587	-0.286
90	0.675 ''	-0.152	1.418	1.755	-7.763	-0.337

STABILITY SUMMARY	Minimum	Actual
Angle of immersion of Accommodation access (degrees)	-	68.618
Area under GZ curve between 0.00 and 30.00 degrees (metre.radians)	0.055	0.069
Area under GZ curve between 0.00 and 40.00 degrees (metre.radians)	0.090	0.102
Area under GZ curve between 30.00 and 40.00 degrees (metre.radians)	0.030	0.033
Maximum GZ (metres)	-	0.209
Angle of heel at which maximum GZ occurs (degrees)	25.000	28.089
Maximum GZ between 30 and 90 degrees (metres)	0.200	0.208
Positive GZ heel range (degrees)	-	57.989
GM solid (metres) (upright)	-	0.622
Free Surface correction (metres)	-	0.040
GM fluid (metres) (upright)	0.350	0.582

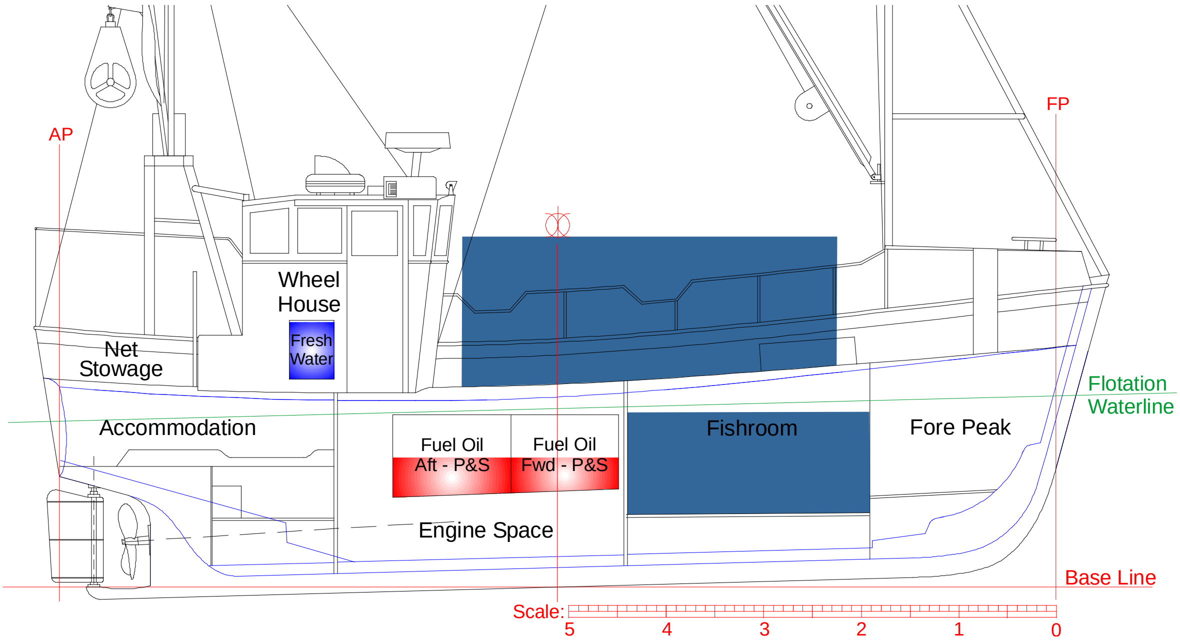
Appendix 7

December 2011 accident and January 2011 near-accident loading condition data

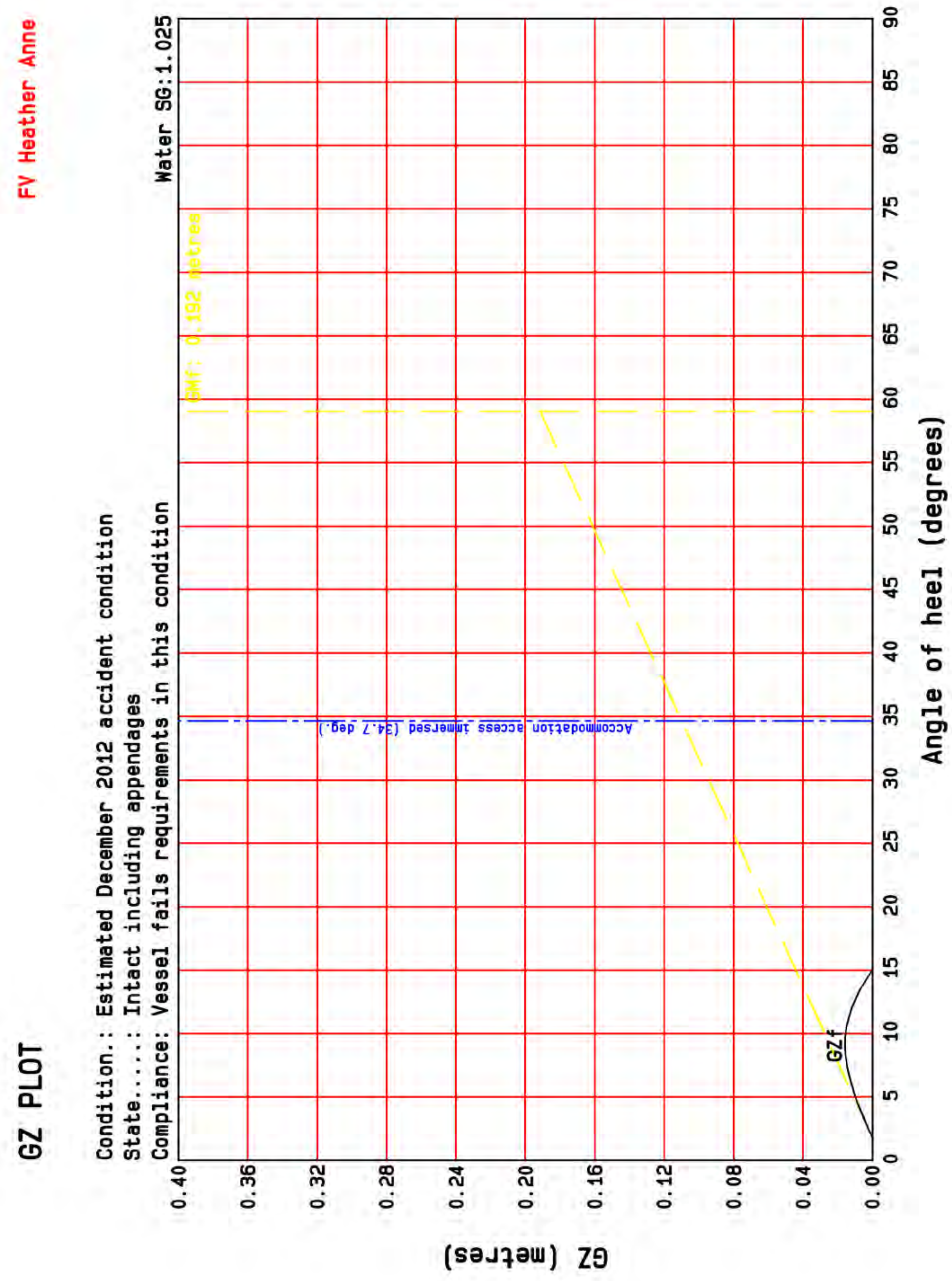
DEADWEIGHT TABLE

Vessel....: FV Heather Anne
Condition.: Estimated December 2011 accident condition
State.....: Intact including appendages
Water SG..: 1.025
Compliance: Vessel fails requirements in this condition

Longitudinal dimensions about FP (Stn.1 on lines) (+ve aft, -ve forward)
Vertical dimensions about Base Line USK midships (+ve above, -ve below)
Transverse dimensions about centreline (+ve Port, -ve Stbd)



	Deadweight Item	Weight tonnes	LCG metres	Longitudinal moment t.m	TCG metres	Transverse moment t.m	VCG metres	Vertical moment t.m	Free Surface moment t.m
1	Fuel Oil - Tanks connected	0.840	5.710	4.796	0.000	0.000	1.156	0.971	4.000
2	Fresh Water	0.053	7.631	0.404	0.956	0.051	2.437	0.129	0.000
3	Crew in W/H (1)	0.132	7.100	0.937	-0.035	-0.005	3.050	0.403	-
4	Crew on deck (1)	0.085	2.500	0.213	-1.100	-0.094	3.000	0.255	-
5	Consumable stores	0.098	8.000	0.784	0.000	0.000	2.600	0.255	-
6	Fishing net	1.500	9.400	14.100	-0.750	-1.125	2.750	4.125	-
7	Misc. equipment - W/H	0.065	8.000	0.520	0.000	0.000	2.800	0.182	-
8	Misc. equipment - Accomm	0.080	8.300	0.664	0.000	0.000	1.100	0.088	-
9	Misc. equipment - Deck	0.100	6.200	0.620	0.000	0.000	2.150	0.215	-
10	Catch in F/R incl. water	4.689	3.070	14.395	0.037	0.173	1.216	5.702	2.272
11	Catch on deck	5.823	4.351	25.336	0.388	2.259	2.568	14.953	0.841
12	Catch bins on deck	0.445	4.351	1.936	0.388	0.173	2.487	1.107	-
13	Bilge water	0.400	5.105	2.042	0.000	0.000	0.283	0.113	0.668
14	Deck water	0.200	7.600	1.520	0.000	0.000	2.060	0.412	0.100
	DEADWEIGHT TOTAL	14.510	4.705	68.268	0.099	1.433	1.992	28.910	7.881
	LIGHTSHIP	23.986	5.710	136.960	-0.070	-1.679	1.757	42.143	-
	DISPLACEMENT	38.496	5.331	205.228	-0.006	-0.246	1.846	71.053	7.881
	Free Surface Correction (Total Free Surface Moment/Displacement)						0.205		
						VCG fluid	2.050		


FV Heather Anne
GZ PLOT
Condition.: Estimated December 2012 accident condition
State.....: Intact including appendages
Compliance: Vessel fails requirements in this condition
Water SG:1.025
GMf: 0.192 metres
Accommodation access immersed (34.7 deg.)
GZf
GZ (metres)
0.00
0.04
0.08
0.12
0.16
0.20
0.24
0.28
0.32
0.36
0.40
Angle of heel (degrees)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90

SAILING STATE

Vessel....: FV Heather Anne
Condition.: Estimated December 2011 accident condition
State.....: Intact including appendages
Water SG..: 1.025
Compliance: Vessel fails requirements in this condition

DRAFT SUMMARY (DIMENSIONS IN METRES)	Maximum	Actual
Draught at FP about Base Line	-	1.941
Draught at midships on LBP about Base Line	-	1.821
Draught at AP about Base Line	-	1.702

FREEBOARD SUMMARY (DIMENSIONS IN METRES)	Minimum	Actual
Freeboard at FP about deck edge	-	0.664
Freeboard at midships on LBP about deck edge	-	0.131
Freeboard at AP about deck edge	-	0.382

STABILITY DATA

Heel angle degrees	Trim about Base Line metres on LBP	Draft at midships LBP about Base Line	KN metres	KGxSIN(Heel) metres	Righting moment tonne.metres	GZ fluid metres
0	0.238 by bow	1.822	-0.006	0.000	-0.232	-0.006
5	0.240 ''	1.814	0.189	0.179	0.380	0.010
10	0.232 ''	1.797	0.372	0.356	0.601	0.016
15	0.210 ''	1.778	0.531	0.531	0.014	0.000
20	0.172 ''	1.759	0.670	0.701	-1.194	-0.031
25	0.124 ''	1.735	0.794	0.867	-2.793	-0.073
30	0.071 ''	1.706	0.905	1.025	-4.633	-0.120
35	0.015 ''	1.671	1.004	1.176	-6.619	-0.172
40	0.042 by stern	1.627	1.093	1.318	-8.679	-0.225
45	0.100 ''	1.574	1.170	1.450	-10.770	-0.280
50	0.157 ''	1.513	1.237	1.571	-12.856	-0.334
55	0.212 ''	1.442	1.293	1.680	-14.902	-0.387
60	0.264 ''	1.363	1.337	1.776	-16.880	-0.438
65	0.311 ''	1.275	1.371	1.858	-18.765	-0.487
70	0.352 ''	1.179	1.393	1.927	-20.535	-0.533
75	0.387 ''	1.076	1.405	1.981	-22.168	-0.576

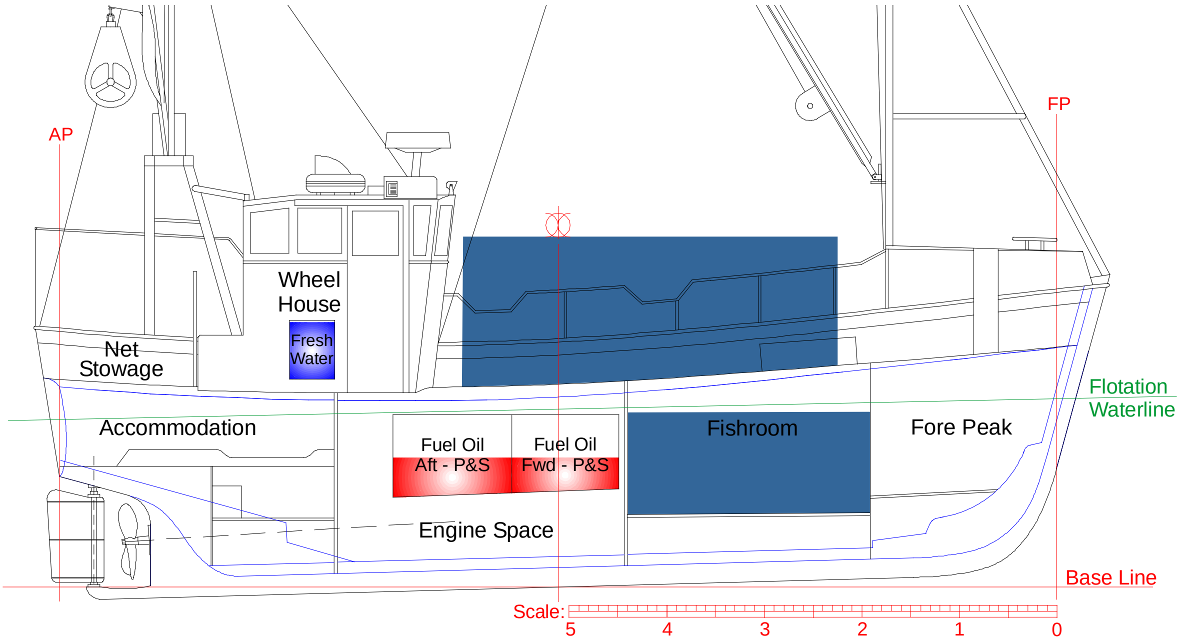
STABILITY SUMMARY	Minimum	Actual
Angle of immersion of Accommodation access (degrees)	-	34.651
Area under GZ curve between 1.76 and 30.00 degrees (metre.radians)	0.055	0.002
Area under GZ curve between 1.76 and 40.00 degrees (metre.radians)	0.090	0.002
Area under GZ curve between 30.00 and 40.00 degrees (metre.radians)	0.030	0.000
Maximum GZ (metres)	-	0.016
Angle of heel at which maximum GZ occurs (degrees)	25.000	8.869
Maximum GZ between 30 and 90 degrees (metres)	0.200	0.000
Positive GZ heel range (degrees)	-	13.312
GM solid (metres) (at angle of equilibrium)	-	0.396
Free Surface correction (metres)	-	0.205
GM fluid (metres) (at angle of equilibrium)	0.350	0.192

STABILITY SUMMARY (CONTINUED)	Maximum	Actual
Angle of equilibrium (degrees)	-	1.757(Stbd)

DEADWEIGHT TABLE

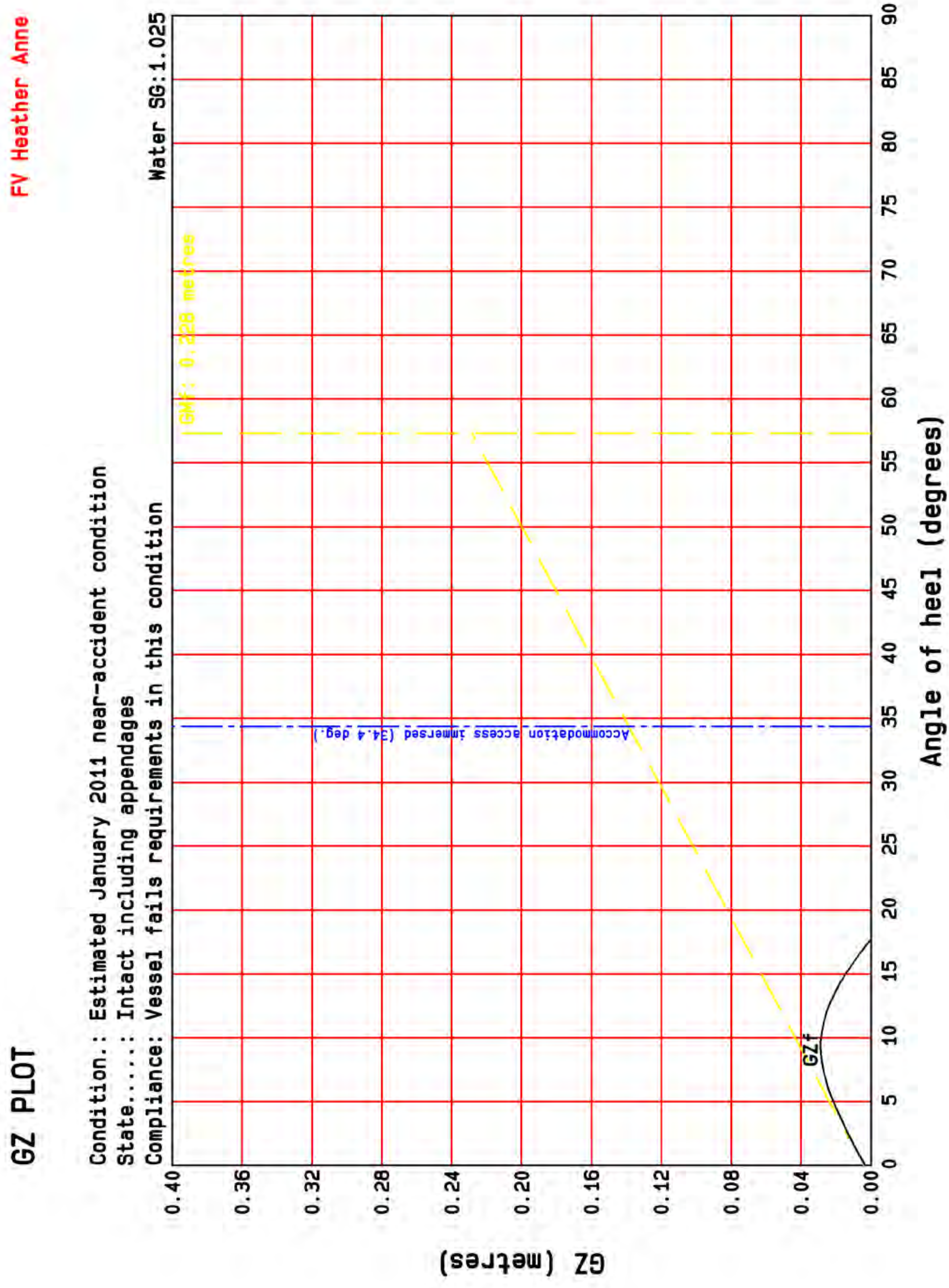
Vessel....: FV Heather Anne
Condition.: Estimated January 2011 near-accident condition
State.....: Intact including appendages
Water SG..: 1.025
Compliance: Vessel fails requirements in this condition

Longitudinal dimensions about FP (Stn.1 on lines) (+ve aft, -ve forward)
Vertical dimensions about Base Line USK midships (+ve above, -ve below)
Transverse dimensions about centreline (+ve Port, -ve Stbd)



	Deadweight Item	Weight tonnes	LCG metres	Longitudinal moment t.m	TCG metres	Transverse moment t.m	VCG metres	Vertical moment t.m	Free Surface moment t.m
1	Fuel Oil - Tanks connected	0.840	5.710	4.796	0.000	0.000	1.156	0.971	2.500
2	Fresh Water	0.053	7.631	0.404	0.956	0.051	2.437	0.129	0.000
3	Crew in W/H (1)	0.132	7.100	0.937	-0.035	-0.005	3.050	0.403	-
4	Crew on deck (1)	0.085	2.500	0.213	-1.100	-0.094	3.000	0.255	-
5	Consumable stores	0.098	8.000	0.784	0.000	0.000	2.600	0.255	-
6	Fishing net	1.500	9.400	14.100	-0.750	-1.125	2.750	4.125	-
7	Misc. equipment - W/H	0.065	8.000	0.520	0.000	0.000	2.800	0.182	-
8	Misc. equipment - Accomm	0.080	8.300	0.664	0.000	0.000	1.100	0.088	-
9	Misc. equipment - Deck	0.100	6.200	0.620	0.000	0.000	2.150	0.215	-
10	Catch in F/R incl. water	3.170	3.213	10.185	0.085	0.269	1.143	3.623	0.634
11	Catch on deck	7.479	4.068	30.425	0.341	2.550	2.588	19.356	0.921
12	Catch bins on deck	0.515	4.068	2.095	0.341	0.176	2.520	1.298	-
13	Bilge water	0.400	5.105	2.042	0.000	0.000	0.283	0.113	0.668
14	Deck water	0.200	7.600	1.520	0.000	0.000	2.060	0.412	0.100
	DEADWEIGHT TOTAL	14.717	4.709	69.305	0.124	1.823	2.135	31.425	4.823
	LIGHTSHIP	23.986	5.710	136.960	-0.070	-1.679	1.757	42.143	-
	DISPLACEMENT	38.703	5.329	206.265	0.004	0.144	1.901	73.568	4.823

Free Surface Correction (Total Free Surface Moment/Displacement)	0.125
VCG fluid	2.025


GZ PLOT
FV Heather Anne
Condition.: Estimated January 2011 near-accident condition
State......: Intact including appendages
Compliance: Vessel fails requirements in this condition
Water SG:1.025
GMt: 0.228 metres
Accommodation access immersed (34.4 deg.)
GZt
GZ (metres)
0.00
0.04
0.08
0.12
0.16
0.20
0.24
0.28
0.32
0.36
0.40
Angle of heel (degrees)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90

SAILING STATE

Vessel....: FV Heather Anne
Condition.: Estimated January 2011 near-accident condition
State.....: Intact including appendages
Water SG..: 1.025
Compliance: Vessel fails requirements in this condition

DRAFT SUMMARY (DIMENSIONS IN METRES)	Maximum	Actual
Draught at FP about Base Line	-	1.951
Draught at midships on LBP about Base Line	-	1.828
Draught at AP about Base Line	-	1.706

FREEBOARD SUMMARY (DIMENSIONS IN METRES)	Minimum	Actual
Freeboard at FP about deck edge	-	0.666
Freeboard at midships on LBP about deck edge	-	0.188
Freeboard at AP about deck edge	-	0.426

STABILITY DATA

Heel angle degrees	Trim about Base Line metres on LBP	Draft at midships LBP about Base Line	KN metres	KGxSIN(Heel) metres	Righting moment tonne.metres	GZ fluid metres
0	0.244 by bow	1.828	0.004	0.000	0.146	0.004
5	0.246 ''	1.821	0.198	0.177	0.839	0.022
10	0.237 ''	1.804	0.380	0.352	1.111	0.029
15	0.214 ''	1.786	0.539	0.524	0.564	0.015
20	0.176 ''	1.767	0.677	0.693	-0.602	-0.016
25	0.128 ''	1.744	0.800	0.856	-2.159	-0.056
30	0.074 ''	1.716	0.910	1.013	-3.957	-0.102
35	0.018 ''	1.681	1.009	1.162	-5.903	-0.153
40	0.040 by stern	1.637	1.097	1.302	-7.926	-0.205
45	0.099 ''	1.585	1.174	1.432	-9.984	-0.258
50	0.156 ''	1.524	1.240	1.552	-12.040	-0.311
55	0.212 ''	1.454	1.296	1.659	-14.062	-0.363
60	0.264 ''	1.375	1.340	1.754	-16.021	-0.414
65	0.311 ''	1.288	1.373	1.836	-17.894	-0.462
70	0.352 ''	1.192	1.395	1.903	-19.658	-0.508
75	0.387 ''	1.089	1.406	1.956	-21.292	-0.550

STABILITY SUMMARY	Minimum	Actual
Angle of immersion of Accommodation access (degrees)	-	34.360
Area under GZ curve between 0.00 and 17.67 degrees (metre.radians)	0.055	0.006
Area under GZ curve between 0.00 and 17.67 degrees (metre.radians)	0.090	0.006
Area under GZ curve between 30.00 and 40.00 degrees (metre.radians)	0.030	0.000
Maximum GZ (metres)	-	0.029
Angle of heel at which maximum GZ occurs (degrees)	25.000	9.158
Maximum GZ between 30 and 90 degrees (metres)	0.200	0.000
Positive GZ heel range (degrees)	-	17.670
GM solid (metres) (upright)	-	0.353
Free Surface correction (metres)	-	0.125
GM fluid (metres) (upright)	0.350	0.228

STABILITY SUMMARY (CONTINUED)	Maximum	Actual
Angle of equilibrium (degrees)	-	0.941(Port)

Appendix 8

Inclining trial report

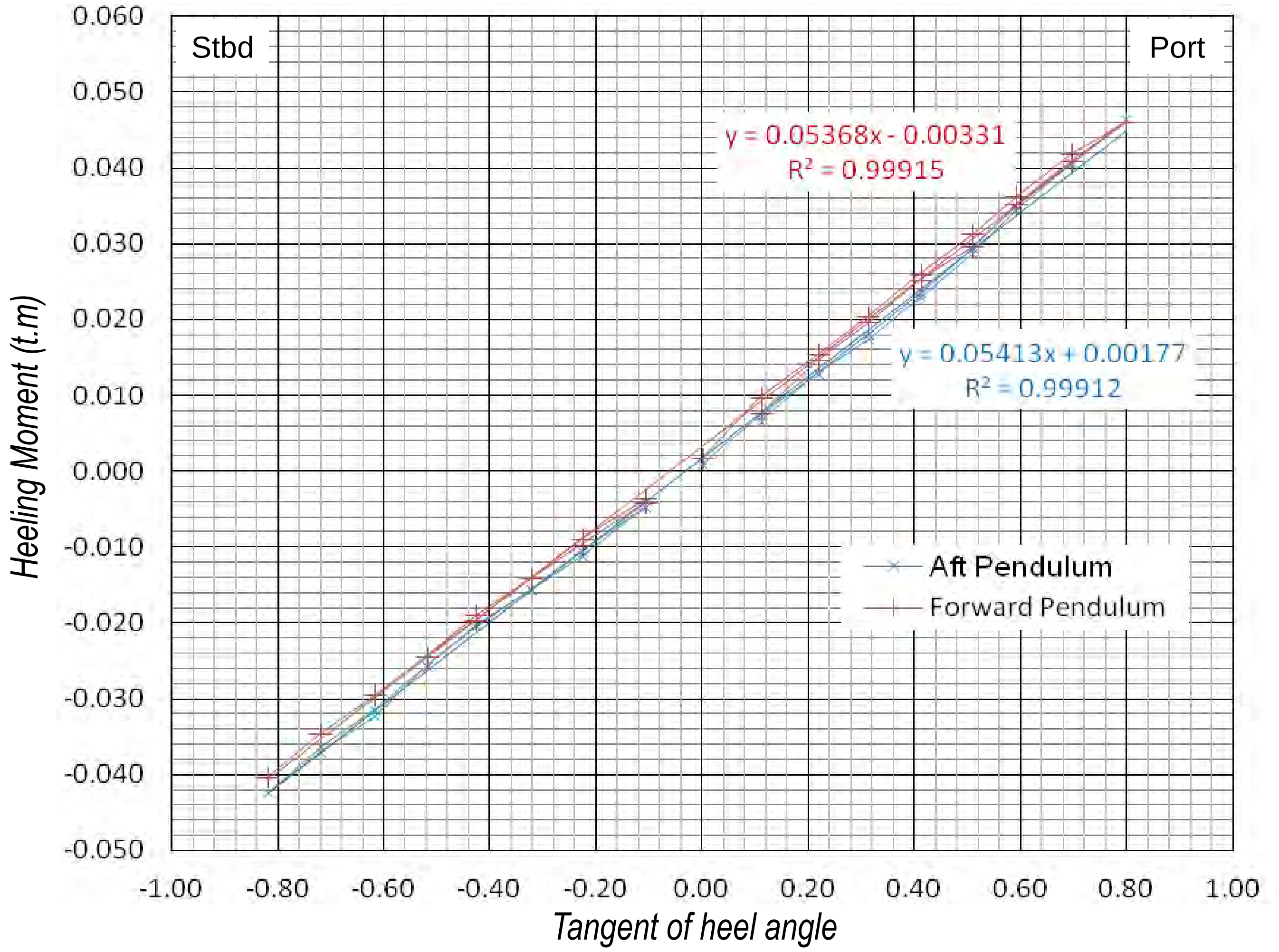
Inclining Trial Report

Vessel name/number.........: Fishing Vessel 'Heather Anne'
Trial location......................: Quayside at Falmouth Docks
Trial time and date.............: 1400 hrs on 18th March, 2012
Weather conditions............: Sheltered from NW Force 2-3 wind by quayside
Sea conditions...................: +/- 15mm wavelets, tide rising (high water at 1430 hrs)
Specific gravity of water.....: 1.0265
Vessel condition.................: Fuel oil and fresh water tanks full, floodwater in E/R, fishroom and accommodation bilges - See table of items to come off and go on
Draught at FP....................: 1.319 metres about Base Line
Draught at AP....................: 1.725 metres about Base Line
Mean draught midships......: 1.522 metres about Base Line
Trim over LBP....................: 0.406 metres by stern
Forward pendulum.............: 3.151 metres long, sited 2.45 metres aft of AP
Aft pendulum.....................: 2.171 metres long, sited 8.15 metres aft of AP
Inclining weights................: 32 in number, total weight 552.56kg
Levelling weights...............: 16 forward, total 277kg, 28 aft, total 477 kg
Personnel.........................[redacted]

Pendulum deflection table

No.	*Weight Shifts Direction*	*Weight Tonnes*	*Distance metres*	*Heeling Moment t.m (+ve Port)*	*Aft Pend'm Deflections mm (+ve Port)*	*Aft Pend'm Tangent of heel angle (+ve Port)*	*Fwd Pend'm Deflections mm (+ve Port)*	*Fwd Pend'm Tangent of heel angle (+ve Port)*
1	Stbd > Port	0.0370	2.980	0.110	14.4	0.0066	24.1	0.0076
2	Stbd > Port	0.0358	2.980	0.217	28.0	0.0129	46.2	0.0147
3	Stbd > Port	0.0320	2.980	0.312	37.9	0.0175	62.0	0.0197
4	Stbd > Port	0.0329	2.980	0.411	49.8	0.0229	79.5	0.0252
5	Stbd > Port	0.0331	2.980	0.509	62.2	0.0287	93.4	0.0296
6	Stbd > Port	0.0278	2.980	0.592	74.9	0.0345	111.2	0.0353
7	Stbd > Port	0.0350	2.980	0.696	88.1	0.0406	129.0	0.0409
8	Stbd > Port	0.0342	2.980	0.798	100.8	0.0464	145.0	0.0460
9	Port > Stbd	0.0342	2.980	0.696	88.1	0.0406	131.9	0.0419
10	Port > Stbd	0.0350	2.980	0.592	76.1	0.0351	114.3	0.0363
11	Port > Stbd	0.0278	2.980	0.509	63.8	0.0294	98.6	0.0313
12	Port > Stbd	0.0331	2.980	0.411	51.0	0.0235	82.0	0.0260
13	Port > Stbd	0.0329	2.980	0.312	39.2	0.0181	64.5	0.0205
14	Port > Stbd	0.0320	2.980	0.217	28.0	0.0129	48.4	0.0154
15	Port > Stbd	0.0358	2.980	0.110	15.9	0.0073	30.8	0.0098
16	Port > Stbd	0.0370	2.980	0.000	2.0	0.0009	5.4	0.0017
17	Port > Stbd	0.0358	2.980	-0.107	-10.1	-0.0047	-11.3	-0.0036
18	Port > Stbd	0.0403	2.980	-0.227	-23.0	-0.0106	-28.1	-0.0089
19	Port > Stbd	0.0319	2.980	-0.322	-33.7	-0.0155	-44.3	-0.0141
20	Port > Stbd	0.0352	2.980	-0.427	-44.3	-0.0204	-59.7	-0.0189
21	Port > Stbd	0.0311	2.980	-0.520	-55.8	-0.0257	-76.9	-0.0244
22	Port > Stbd	0.0329	2.980	-0.618	-68.2	-0.0314	-93.0	-0.0295
23	Port > Stbd	0.0341	2.980	-0.719	-78.9	-0.0363	-109.0	-0.0346
24	Port > Stbd	0.0333	2.980	-0.819	-92.1	-0.0424	-126.9	-0.0403
25	Stbd > Port	0.0333	2.980	-0.719	-80.3	-0.0370	-109.0	-0.0346
26	Stbd > Port	0.0341	2.980	-0.618	-70.0	-0.0322	-93.0	-0.0295
27	Stbd > Port	0.0329	2.980	-0.520	-55.8	-0.0257	-76.9	-0.0244
28	Stbd > Port	0.0311	2.980	-0.427	-44.2	-0.0204	-61.7	-0.0196
29	Stbd > Port	0.0352	2.980	-0.322	-33.7	-0.0155	-44.4	-0.0141
30	Stbd > Port	0.0319	2.980	-0.227	-24.4	-0.0112	-30.4	-0.0096
31	Stbd > Port	0.0403	2.980	-0.107	-10.1	-0.0047	-13.0	-0.0041

Heeling moment/Tangent of heel angle plot



Mean slope (tangent) of aft pendulum = 0.05413 (correlation coefficient 0.99912)
Mean slope (tangent) of forward pendulum = 0.05368 (correlation coefficient 0.99915)
Mean slope of forward and aft pendulums = 0.05391

GMt mean = Heeling moment / (displacement x tangent of heel angle)
Therefore GM_t mean = 1 / mean slope / displacement = 1 / 0.05391 / 29.591 = 0.627 metres

Summary of inclined condition

Displacement : 29.591 tonnes
KMT .... : 2.311 metres
GM_t mean ..... : 0.627 metres
KG_{fluid} .... : 1.684 metres above Base Line
LCB............... : 5.687 metres aft of FP
VCB .... : 1.045 metres above Base Line
LCG .... : 5.662 metres aft of FP

HYDROSTATIC DATA

Includes appendages and repair plywood

Vessel name/number: FV Heather Anne
Longitudinal datum: FP (Stn.1 on lines) (+ve aft, -ve forward of datum)
Vertical datum....: USK (lines midships)
Drafts............: +ve above, -ve below USK (lines midships)
Water SG..........: 1.0265
LBP...............: 10.242 metres
Trim on LBP.......: .406 metres by the stern relative to Base Line

Draft metres	Displacement Ext-tonnes	LCB metres	VCB metres	WPA metres^2	LCF metres	MCT 1cm t.metres	KML metres	KMT metres	TPC tonne/cm	WSA metres^2
1.515	29.354	5.685	1.041	32.917	5.830	0.212	8.426	2.314	0.338	50.275
1.516	29.388	5.686	1.041	32.922	5.830	0.212	8.420	2.314	0.338	50.299
1.517	29.422	5.686	1.042	32.926	5.830	0.212	8.414	2.313	0.338	50.323
1.518	29.456	5.686	1.043	32.930	5.830	0.212	8.408	2.313	0.338	50.347
1.519	29.489	5.686	1.043	32.935	5.829	0.212	8.402	2.312	0.338	50.372
1.520	29.523	5.686	1.044	32.939	5.829	0.212	8.396	2.312	0.338	50.396
1.521	29.557	5.686	1.044	32.943	5.829	0.212	8.391	2.311	0.338	50.420
1.522	29.591	5.687	1.045	32.948	5.829	0.212	8.385	2.311	0.338	50.444
1.523	29.625	5.687	1.045	32.952	5.829	0.212	8.379	2.310	0.338	50.468
1.524	29.658	5.687	1.046	32.956	5.828	0.212	8.373	2.310	0.338	50.492
1.525	29.692	5.687	1.047	32.960	5.828	0.212	8.367	2.309	0.338	50.517
1.526	29.726	5.687	1.047	32.965	5.828	0.212	8.361	2.308	0.338	50.541
1.527	29.760	5.687	1.048	32.969	5.828	0.212	8.355	2.308	0.338	50.565
1.528	29.794	5.688	1.048	32.973	5.827	0.212	8.349	2.307	0.338	50.589
1.529	29.827	5.688	1.049	32.977	5.827	0.212	8.343	2.307	0.339	50.613
1.530	29.861	5.688	1.050	32.982	5.827	0.212	8.337	2.306	0.339	50.637
1.531	29.895	5.688	1.050	32.986	5.827	0.213	8.332	2.306	0.339	50.662
1.532	29.929	5.688	1.051	32.990	5.827	0.213	8.326	2.305	0.339	50.686
1.533	29.963	5.688	1.051	32.994	5.826	0.213	8.320	2.305	0.339	50.710
1.534	29.997	5.688	1.052	32.999	5.826	0.213	8.314	2.304	0.339	50.734
1.535	30.030	5.689	1.052	33.003	5.826	0.213	8.308	2.304	0.339	50.758
1.536	30.064	5.689	1.053	33.007	5.826	0.213	8.303	2.303	0.339	50.782
1.537	30.098	5.689	1.054	33.011	5.825	0.213	8.297	2.303	0.339	50.807
1.538	30.132	5.689	1.054	33.015	5.825	0.213	8.291	2.302	0.339	50.831
1.539	30.166	5.689	1.055	33.020	5.825	0.213	8.285	2.302	0.339	50.855
1.540	30.200	5.689	1.055	33.024	5.825	0.213	8.280	2.301	0.339	50.879
1.541	30.234	5.690	1.056	33.028	5.824	0.213	8.274	2.301	0.339	50.903
1.542	30.268	5.690	1.056	33.032	5.824	0.213	8.268	2.300	0.339	50.927
1.543	30.301	5.690	1.057	33.036	5.824	0.213	8.263	2.300	0.339	50.952
1.544	30.335	5.690	1.058	33.040	5.824	0.213	8.257	2.299	0.339	50.976
1.545	30.369	5.690	1.058	33.044	5.824	0.213	8.251	2.299	0.339	51.000
1.546	30.403	5.690	1.059	33.049	5.823	0.213	8.246	2.298	0.339	51.024
1.547	30.437	5.690	1.059	33.053	5.823	0.213	8.240	2.298	0.339	51.048
1.548	30.471	5.691	1.060	33.057	5.823	0.213	8.234	2.297	0.339	51.072
1.549	30.505	5.691	1.060	33.061	5.823	0.213	8.229	2.297	0.339	51.097
1.550	30.539	5.691	1.061	33.065	5.822	0.214	8.223	2.296	0.339	51.121
1.551	30.573	5.691	1.062	33.069	5.822	0.214	8.217	2.296	0.339	51.145
1.552	30.607	5.691	1.062	33.073	5.822	0.214	8.212	2.295	0.339	51.169
1.553	30.640	5.691	1.063	33.077	5.822	0.214	8.206	2.295	0.340	51.193
1.554	30.674	5.691	1.063	33.081	5.821	0.214	8.200	2.294	0.340	51.217
1.555	30.708	5.692	1.064	33.085	5.821	0.214	8.195	2.294	0.340	51.242
1.556	30.742	5.692	1.064	33.089	5.821	0.214	8.189	2.293	0.340	51.266
1.557	30.776	5.692	1.065	33.093	5.821	0.214	8.184	2.293	0.340	51.290
1.558	30.810	5.692	1.066	33.097	5.820	0.214	8.178	2.292	0.340	51.314

Items to come off to achieve lightship condition

Item	Weight tonnes	LCG - m about FP	Long'l Moment t.m	TCG - m about C/L (+ve Port)	Transv'e moment t.m	VCG - m about Base Line	Vertical Moment t.m	FSM t.m
Fuel Oil - Fore Port 100% (SG 0.95)†	0.516	5.052	2.607	1.390	0.717	1.397	0.721	0.000
Fuel Oil - Aft Port 100% (SG 0.95)†	0.608	6.213	3.778	1.391	0.846	1.375	0.836	0.000
Fuel Oil - Fore Stbd 100% (SG 0.95)†	0.516	5.052	2.607	-1.390	-0.717	-1.397	-0.721	0.000
Fuel Oil - Aft Stbd 100% (SG 0.95)†	0.608	6.213	3.778	-1.391	-0.846	-1.375	-0.836	0.000
Fresh Water (100%)	0.053	7.631	0.404	0.956	0.051	2.437	0.129	0.000
Floodwater (SG 1.025)	1.279	5.748	7.352	0.000	0.000	0.467	0.597	3.290
Concrete - Fishroom bilges	0.438	3.464	1.517	0.000	0.000	0.342	0.150	-
Levelling Weights (16) - Forward	0.277	2.440	0.676	1.233	0.342	2.683	0.743	-
Levelling Weights (28) - Aft	0.477	7.477	3.567	1.520	0.725	2.396	1.143	-
Inclining Weights (32)	0.553	5.402	2.987	0.000	0.000	2.349	1.299	-
Inclining equipment - Fwd pendulum	0.023	2.390	0.055	0.000	0.000	0.680	0.016	-
Inclining equipment - Aft pendulum	0.024	9.490	0.228	0.000	0.000	2.260	0.054	-
1 person - Aft deck	0.076	9.940	0.755	0.000	0.000	2.640	0.201	-
1 person - Fishroom	0.082	2.840	0.233	0.000	0.000	1.120	0.092	-
1 person – Deck forward of w/h	0.060	6.100	0.366	0.000	0.000	3.070	0.184	-
Repair material (ply+bitumen+screws)	0.045	2.840	0.128	-0.520	-0.023	0.425	0.019	-
Portable pump and pipework	0.035	5.600	0.196	-0.400	-0.014	2.340	0.082	-
Spare plywood on deck	0.024	2.900	0.073	-1.300	-0.033	2.540	0.064	-
Misc. equipment under fo'c'sle deck	0.005	1.300	0.007	0.150	0.001	2.600	0.013	-
Total items to come off:	*5.708*	*5.497*	*31.376*	*0.184*	*1.048*	*0.842*	*4.808*	*3.290*

Items to go on to achieve lightship condition

Fishroom hatch	0.015	2.480	0.037	0.000	0.000	2.600	0.039	-
Liferaft	0.025	7.300	0.183	-0.100	-0.003	4.230	0.106	-
Lifejackets	0.002	8.000	0.016	0.000	0.000	2.450	0.005	-
Flares	0.004	8.000	0.032	0.000	0.000	2.450	0.010	-
Fishroom lining	0.018	3.160	0.057	0.240	0.004	1.080	0.019	-
Mattresses and bedding	0.025	8.400	0.210	0.000	0.000	1.050	0.026	-
Foremast lights	0.004	1.840	0.007	0.000	0.000	8.100	0.032	-
R/T mast and antennae	0.006	8.800	0.053	0.000	0.000	8.150	0.049	-
Mast head light on aft mast	0.001	9.000	0.009	0.000	0.000	7.850	0.008	-
Deck floodlights on w/h eyebrow	0.003	6.300	0.019	0.000	0.000	4.200	0.013	-
Total items to go on:	*0.103*	*6.045*	*0.623*	*0.018*	*0.002*	*2.980*	*0.307*	*0.000*

Items to move to achieve lightship condition

Fishroom sole panels in forepeak	0.100	2.100	0.210	0.000	0.000	-0.160	-0.016	-
Main catch landing derrick – raise	0.047	-0.995	-0.047	0.000	0.000	1.770	0.083	-
Gilson derrick – relocate	0.003	0.000	0.000	-2.500	-0.008	1.700	0.005	-
Foremast above tripod – relocate	0.007	0.100	0.001	-0.300	-0.002	5.425	0.038	-
Total items to move:	*0.157*	*1.044*	*0.164*	*-0.061*	*-0.010*	*0.702*	*0.110*	*0.000*

Lightship Summary

Condition at inclining trial	29.591	5.662	167.544	-0.021	-0.621	1.684	49.831	3.290
Total items to come off	-5.708	5.497	-31.376	0.184	-1.048	0.842	-4.808	-3.290
Total items to go on	0.103	6.045	0.623	0.018	0.002	2.980	0.307	0.000
Total items to move	-	-	0.164	-	-0.010	-	0.110	-
2012 Lightship:	*23.986*	*5.710*	*136.955*	*-0.070*	*-1.677*	*1.894*	*45.440*	
						FSM:	*-3.290*	
	VCG corrected for free surface moments:					*1.757*	*42.150*	

† Estimated SG of fuel oil plus seawater

Annex C

MGN 427(F) - Stability Guidance for Fishing Vessels of under 15m Overall Length

MARINE GUIDANCE NOTE

Maritime and Coastguard Agency

MGN 427 (F)

Stability Guidance for Fishing Vessels of under 15m Overall Length

Notice to all Shipyards, Boatbuilders, Fishing Vessel Operators, Skippers, Fishermen, Designers and Consultants

Summary

This Notice:

- Provides guidance for stability assessment to help fishermen make decisions.
- Strongly recommends owners and skippers to commission and purchase new vessels which have had a stability assessment and stability information supplied.
- Re-iterates that full stability requirements for the 12m registered length – 15m overall length fishing vessels will be re-introduced in the near future.
- Indicates that at the present time there is no intention to introduce compulsory stability criteria to fishing vessels under 12m registered length.
- Vessels over 12m registered length which have historically been roll tested may continue to do so.
- Skippers and owners are reminded that beam trawlers have a 20% uplift with the full stability criteria and their own formula for a roll test (only applicable to existing vessels which have previously been on a roll test).

1. Introduction

1.1 Vessels under 15 metres LOA are not currently required to have approved stability that is compliant with statutory requirements. There is presently no intention to introduce statutory requirements for vessels under 12 metres registered length.

1.2 Any vessel must be stable for its intended purpose and it is reasonable to expect that naval architectural skills will be employed during the design and construction process to ensure that the vessel is safe for use. MCA recommends that all purchasers ask for stability information from builders.

1.3 No vessel can be designed to be inherently safe; this depends upon the way it is operated. Therefore a vessel must be operated in such a manner that keeps it stable and provide a safe working platform for those onboard, whatever the purpose of the vessel or the operational circumstances.

1.4 Unfortunately it is not possible to make an assessment of stability and hence the safety of the vessel by simple inspection; however, various tools and assessment methods can be used to provide a degree of confidence and assurance.

2. Legal Responsibilities

2.1 While no specific statutory requirements currently exist for the stability of small fishing vessels, the owner, skipper and others do have legal responsibilities as detailed under the Merchant Shipping and Fishing Vessels (Health and Safety at Work) Regulations 1997.

For example their duties include ensuring, as far as is reasonably practicable:

- Systems of work that are, so far as reasonably practicable, safe and without risk to health,
- Safe arrangements for the use, handling, and stowage and transportation of articles and substances,
- there is provision of information, instruction, training and supervision necessary to ensure health and safety of workers and other persons.

2.2 In the absence of specific statutory requirements for stability and its subsequent approval of stability, owners may use other methods to assess stability and support skippers and fishermen to meet their health and safety general duties and responsibilities. It is not acceptable to do nothing and assume the vessel's stability is satisfactory. It is always better to assess the situation or obtain professional advice and this notice helps by providing additional information for this process. In short, MCA is providing a number of methods you may find helpful. MCA Fishing Vessel Surveyors cannot decide which method of stability assessment is best for your vessel (that is for owners/ skippers and crews to decide), but they are available to discuss the pros and cons of each method and may be able to identify specific risks/ similar vessels/ fishing methods which may assist owners/skippers and crews in coming to a decision on which stability assessment method best fits their vessel.

3. Some factors to consider and some myths

3.1 A number of factors can affect a vessel's stability, for example its length and breadth, the freeboard, the centre of gravity of the ship and equipment, distribution of weights such as in the fish hold, on deck, in hoppers, in nets, fuel, water and stores etc. Research has shown the importance and effect on stability of maintaining adequate freeboard. The weathertight deck, hatches and doors should be kept closed and decks should be kept clear of water and other movable weights. While a vessel may appear very 'stiff' because of her large beam, if the freeboard is small there may be little reserve of stability when the vessel heels or is in large waves due to the dangers of downflooding. Also a vessel which appears very sea-kindly and comfortable with a slow roll period can actually be potentially unsafe in terms of stability. Keeping water off the deck by closing scuppers or freeing ports may seem sensible and safe, but does have the opposite effect if a wave comes onboard and causes instability because of the trapped water and its free surface effect. It is also vital that the catch is not stored on deck, it should be stored as low as possible in the vessel as soon as is practicable.

4 Available Stability Methods

4.1 The following methods are considered:

- Full stability information, inclining experiment and calculation.
- Small Commercial Vessel Code standard.
- A modified small passenger vessel standard.
- IMO Roll Period Approximation.
- Wolfson Guidance.

5 Full Stability Method

5.1 This requirement will apply to all vessels over 12 metres and is widely used.

5.2 The method requires the lightship weight and centres of gravity both vertical and longitudinal to be ascertained (e.g. inclining experiment) and that the stability for a series of loading conditions be calculated.

5.3 The properties of the GZ Curves are then compared with the criteria reproduced here at Annex 1 and Appendix 1 to that Annex.

5.4 Many Naval Architects consider that the established criteria are good for vessels above 7m registered length.

5.5 Vessels which have previously been on a roll test, if they have had no structural modifications, may continue on the roll test until modified. Should they have been modified or wish to modify they must contact the MCA and prepare for hull stability assessment.

6 Small Commercial Vessel Code Standard (heel test)

6.1 This method requires checking the heel, resultant from the application of the maximum load on the maindeck at the maximum outboard position, is within 7°, together with sufficient freeboard.

6.2 The method may only be used for vessels carrying up to 1000 kg of cargo, in this case fish, and may not be most suited for cockle/mussel dredgers bagging the catch.

6.3 This method has distances from port as limits of operation.

6.4 For further details see Annex 2.

7 Small Passenger Vessel Heel Test

7.1 As an alternative to the Small Commercial Vessel Code heel test standard, an equivalent test can be used to that on small passenger vessels, which allows for weights in excess of 1000 kg.

7.2 It considers a shift in passenger, or in this case landed fish weight, with an assumed distribution of 2/3 : 1/3 on each side of the vessel. This gives a simple formula of WB/12 (see Annex 3, paragraph 6.0) as a heeling moment which when applied should not exceed a vessel heel of 7^o, plus a minimum freeboard requirement.

7.3 This method can be repeated to check for changes over time.

7.4 For further details see Annex 3.

8 Roll period Approximation (IMO)

8.1 This is an operational comparative method to determine whether the vessel is stiff or tender.

8.2 Because of its simplicity it can be used operationally by the skipper.

8.3 This method is particularly useful to assess changes which can affect stability during the life of the vessel (if the roll period increases the vessel is becoming less stable).

8.4 Refer to Annex 4 for further information.

9 Wolfson Guidance

9.1 Overview

9.1.1 During 2003 to 2006, the Maritime & Coastguard Agency in response to the Marine Accident Investigation Branch (MAIB) Recommendations, sponsored a number of initiatives aimed at reducing the number of stability associated accidents onboard United Kingdom fishing vessels.

9.1.2 These initiatives included earlier work on identifying the use of a stability model for increasing "stability awareness" and the commissioning of research into a system which would inform the skipper concerning his management of stability.

9.1.3 The research was conducted by the Wolfson Unit of the University of Southampton.

9.2 Deliverable

9.2.1 Deliverables from the research included;

9.2.2 To produce a "traffic light" system which would inform the user of the level of risk associated with a particular operation, and;

9.2.3 to provide a baseline which could be used over time to recognise degradation of stability due to the acquisition of lightship by growth or the retention of equipment, stores or supplies.

9.3 Research Results

9.3.1 The research results have been published and are available on the Wolfson website, at www.wumtia.soton.ac.uk.

9.3.2 The Method has been publicised during recent United Kingdom "FISHING" Exhibitions and presented academically.

9.4 Making the Method available

9.4.1 The FISG Stability Sub Group decided that the Document, "Preparation of Guidance Information for Fishing Vessels – Instructions for Consultants", prepared by the Wolfson Unit should be published for information and guidance. This is attached at Annex 4.

9.4.2 Fishing vessels load their cargo at sea. It should always be remembered that no matter how inherently stable the vessel may be, that if the net snags on an obstruction, the vessel may be overwhelmed. Due regard should always ensure that the towing point is as low as possible. To save the ship, the fishing gear may have to be buoyed and jettisoned to recover later, possibly using a bigger vessel.

9.4.3 The attachment of fishing wire to the trawl winches should always be arranged for quick removal. The rope type of attachment is most effective and allows the wire to be parted from the winch drum quickly.

10 Notes on Maintaining Stability

10.1 A notice containing simple and effective methods for maintaining stability should be posted on the vessel in a prominent position, where crew members will see it.

10.2 The notice should include notes entitled "Simple Efforts for Maintaining Stability" or similar. These notes should be relevant to the vessel, its gear and catch handling arrangements and the fishing method. Suggestions for notes follow, and relevant ones might be selected from, or based on, this list but it is not intended to be exclusive.

- To maintain the approved stability, ensure that external doors and hatches are not left open at sea. (Those assumed to be closed in preparation of the Notice should be identified clearly here).
- Ensure that scuppers and freeing ports are open and clear of obstructions to allow water to drain quickly from the deck.
- Before attempting a heavy lift, or freeing snagging gear, inform the coastguard, bring the warp as far inboard and as low as possible, close all the doors and hatches and ensure that all crew are on deck, wearing lifejackets.
- If the maximum recommended lift from the vessel's side is exceeded, abandon the lift immediately. The position of the gear should be marked for retrieval by a larger vessel.
- The vessel may become unsafe if heavy items are moved up, heavier gear is fitted or lifting points are moved.
- Secure all gear and the catch against shifting.

11 Training

11.1 Skippers and crew should attend the Seafish 1-day Intermediate Stability Awareness course. Contact your nearest Seafish Approved Training Provider for details or call Seafish on 01472 252302. See MGN 411 for further details on fishermen's training.

More Information

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ANNEX 1

STABILITY CRITERIA (Becoming mandatory for vessels over 12m registered length and considered useful for vessels down to 7m registered length)

1. Vessels shall, for the operating conditions and circumstances set out in Appendix 1 to Annex 1 including icing allowances when applicable, and in all foreseeable operating conditions, satisfy the following stability criteria after due correction for the free surface effects of liquids in tanks:

i) the area under the curve of righting levers (GZ curve) shall not be less than:

(a) 0.055 metre-radians up to an angle of 30 degrees;

(b) 0.090 metre-radians up to an angle of 40 degrees or such lesser angle of heel at which the lower edges of any openings in the hull, superstructures, deckhouses or companionways, being openings that cannot be closed weathertight, are immersed;

(c) 0.030 metre-radians between the angles of heel of 30 degrees and 40 degrees or such lesser angle as defined in (ii) above;

ii) the righting lever (GZ) shall be at least 200 millimetres at an angle of heel equal to or greater than 30 degrees;

iii) the maximum righting lever (GZ) shall occur at an angle of heel not less than 25 degrees;

iv) in the upright position the transverse metacentric height (GM) shall not be less than 350 millimetres;

2. For vessels engaged on single or twin boom fishing the values of dynamic stability, righting lever and metacentric height given in sections 1 i), ii) and iv) respectively shall be increased by 20%.

LIGHTSHIP PARTICULARS

3. The vessel's lightship particulars shall be determined by inclining on completion of building to the satisfaction of the Certifying Authority.

4. Weight growth should be monitored carefully and the vessel's lightship details shall be verified at certificate renewal to the satisfaction of the Certifying Authority.

5. The carriage of unnecessary spare gear, stores and parts, the accumulation of debris and the cumulative effects of minor modifications over time can adversely affect the vessel's lightship weight and centre of gravity. Attention shall be made to limiting these effects if lightship growth and the possibility of adverse effects on the vessel's stability are to be avoided.

APPENDIX 1 to ANNEX 1

INFORMATION AS TO STABILITY OF FISHING VESSELS (FOR VESSELS UP TO 15M REGISTERED LENGTH. NAVAL ARCHITECTS CONSIDER THESE CRITERIA APPROPRIATE FOR VESSELS DOWN TO 7M REGISTERED LENGTH)

The book to be kept on board the vessel pursuant to the requirements of the Code (MSN 1813 (F) - The Fishing Vessels Code of Practice for the Safety of Small Fishing Vessels), shall contain the following information:

1. A statement of the vessel's name, port of registry, official number, registration letters, principal dimensions, date and place of build, gross and net tonnage, displacement and minimum freeboard in the deepest foreseeable operating condition.

2. A profile plan of the vessel drawn to scale showing the names of all compartments, tanks, storerooms, crew accommodation spaces and the position of the mid-point of the length between perpendiculars (LBP).

3. A tabular statement of the capacities and position of the centres of gravity, longitudinally and vertically for every compartment available for the carriage of cargo, fuel, stores, domestic water, water ballast, crew and effects. The free surface function defined in paragraph 9 below shall also be included for each tank designed to carry liquid. Details of the centroid of the total internal volume of the fish-hold(s) shall be included in such information. The calculation may take into account the effect of assuming a void space between the top of the catch and the underside of the deckhead provided that under normal operating conditions, control of loading in the hold is such that the actual void space above the catch will always be equal to or greater than that assumed in such a calculation.

4. Where deck cargo and/or stores is carried by a vessel the estimated maximum weight and disposition of such deck cargo shall be included in the information in the appropriate operating conditions, and show compliance with the stability criteria set out in the Code.

5. A diagram or tabular statement shall be provided showing for a suitable range of mean draughts and at the trim stated, the following hydrostatic particulars of the vessel:

(i) the heights of the transverse metacentres;

(ii) moments to change trim one centimetre;

(iii) tonnes per centimetre immersion;

(iv) longitudinal position of the centre of flotation;

(v) vertical and longitudinal positions of the centre of buoyancy;

(vi) displacement in tonnes.

Where a vessel has a raked keel, the same datum (a horizontal line through the intersection of the hull moulded line with the vessel centreline, amidships) shall be used for the hydrostatics as employed in determining the information required in paragraph 3 above. In such cases full information shall be included in respect of the rake and dimensions of the keel and may be given in the form of a diagram. The positioning of the draft marks relative to this datum shall be included on such a diagram.

6. A diagram or table shall be provided showing cross curves of stability indicating the assumed position of the axis from which the righting levers are measured and the trim which has been assumed. Where a vessel has a raked keel a horizontal datum through the intersection of the hull moulded line with the vessel centreline, amidships, shall be used.

7. The information provided under paragraphs 5 and 6 above shall be at such a nominal trim that represents accurately the vessel in all normal operating trims. Where calculations show that there are significant numerical variations in these operating trims the information provided under paragraphs 5 and 6 above shall be repeated over such a range of trims to allow an accurate interpolation of such information at any normal operating trim.

8. Superstructure deckhouses, companionways located on the freeboard deck, including hatchway structures may be taken into account in deriving such cross-curves of stability provided that their location, integrity and means of closure will effectively contribute to the buoyancy.

9. An example shall be included in such information to show the corrections applied to the transverse metacentric height and righting levers (GZ) for the effects of the free surfaces of liquids in tanks and shall be calculated and taken into account as follows:

(i) the metacentric height in metres shall be reduced by an amount equal to the total of the free surface functions for each tank divided by the vessel's displacement in tonnes. For each tank the free surface function is given by:

1.025 x ρi where ρ = specific gravity of the liquid;
i = transverse moment of inertia of the surface
(i = $\frac{LB^3}{12}$ where L=length and B=breadth of the free surface in metres)

i.e. correction = $\frac{\text{Sum of } \rho i}{\text{Displacement}}$

(ii) the righting lever (GZ) curves shall be corrected by either:

(a) adding the free surface correction calculated under (i) above to the value in metres of the calculated height of centre of gravity of the vessel above datum; or

(b) making direct calculations of the heeling moment due to the liquid surface being inclined at the selected angle of heel where such calculations take proper account of the position of liquid surface in relation to the geometric configuration of the tank. The correction to the righting lever (GZ) at any selected angle of heel shall then be the summation of the individual heeling moments of the tanks considered, divided by the vessel's displacement.

10. A stability statement and diagram shall be provided for the usual condition of the vessel:

(i) in the lightship condition:

the vessel shall be assumed to be empty except for liquids in machinery and in piping systems including header tanks. The weight and position of the centre of gravity of any permanent ballast or fishing gear shall be indicated;

(ii) in each of the following circumstances so far as they may be applicable to the vessel in its foreseeable operating conditions:

(a) on departure from port:

the vessel shall be assumed to be loaded with the necessary equipment, materials and supplies including ice, fuel, stores and water;

(b) on arrival at fishing grounds:

as sub-paragraph (a) above but account taken of the consumption of fuel and stores;

(c) on arrival at fishing grounds:

as sub-paragraph (b) above but the appropriate icing-up allowance as set out in paragraph 14 below shall be taken into account;

(d) on departure from fishing grounds:

the vessel shall be assumed to be loaded with its maximum catch but account taken of the consumption of fuel and stores;

(e) on departure from fishing grounds:

as sub-paragraph (d) above but the appropriate icing-up allowance as set out in paragraph 14 below shall be taken into account;

(f) on departure from fishing grounds:

the vessel shall be assumed to be loaded with 20% of its maximum catch but account taken of the consumption of fuel and stores;

(g) on departure from fishing grounds:

as sub-paragraph (f) above but the appropriate icing-up allowance as set out in paragraph 14 below shall be taken into account;

(h) on arrival at port with maximum catch:

account shall be taken of the consumption of fuel and stores;

(i) on arrival at port with 20% maximum catch:

account shall be taken of the consumption of fuel and stores;

(j) if any part of the catch normally remains on deck, further statements and diagrams appertaining to that condition in all the appropriate circumstances set out in subparagraphs (d) to (i) inclusive shall be provided;

The total free surface correction for the effect of liquid in tanks shall be applied to each loading condition set out in the foregoing provisions of this paragraph. The free surface correction shall take into account the amounts of fuel, lubricating oil, feed and fresh water in the vessel in each such loading condition.

(iii) Working instructions, specifying in detail the manner in which the vessel is to be loaded and ballasted, shall be included within the Trim and Stability Manual. The instructions shall generally be based upon the conditions that are specified in paragraph (ii) above. For vessels in which no provision has been made for the carriage of deck cargo, the working instructions shall also contain the following statement:

"Provision has not been made within the vessel's stability for deck stowage of catch.

Catch landed on deck shall be stowed below as soon as is possible and prior to landing further catch"

11. Where provision is made in a particular area of the vessel for the washing and cleaning of the catch which could lead to an accumulation of loose water a further statement and diagram shall be provided appropriate to that condition which takes into account the adverse effects of such loose water, it being assumed that:

i) the amount of loose water on deck is determined by the size and disposition of the retaining devices; and

ii) in all other respects the vessel is loaded in accordance with (d) or (f) of paragraph 10 above, whichever is the less favourable with regard to the vessel's stability.

12. Each stability statement shall consist of:

(i) a profile drawn to a suitable scale showing the disposition of the deadweight components;

(ii) a tabular statement of all the components of the displacement including weights, positions of centres of gravity, transverse metacentric height corrected for free surface effects, trim and draughts;

(iii) a diagram showing a curve of righting levers (GZ), corrected for free surface effects and derived from the cross-curves of stability, showing, if appropriate, the angle at which the lower edges of any opening which cannot be closed watertight will be immersed. The diagram shall also show the corresponding numerical values of the stability parameters defined in section 3.1.2 of the 15-24m Code (as reproduced in Annex 1 above).

13. The information provided under sub-paragraph (iii) of paragraph 12 above shall be supplemented by a graph or tabular statement showing the maximum permissible deadweight moment over a range of draughts which shall cover foreseeable operating conditions. At any given draught this maximum permissible deadweight moment value is the total vertical moment about a convenient base line, of all the component weights of the total deadweight which, at that draught, will ensure compliance with the minimum stability criteria requirements of the Code. If an allowance for the weight due to icing-up is required, this shall be taken into account by a suitable reduction in the permissible moment. Where the stability information is supplied in accordance with the requirements of this paragraph the tabular statement required in accordance with sub-paragraph 12(ii) above shall include the deadweight moment appropriate to each condition and an example shall be added to the stability information to demonstrate the assessment of the stability.

14. The icing-up allowance which represents the added weight due to ice accretion on the exposed surfaces of the hull, superstructure, deck, deckhouses and companionways shall be calculated as follows:

(i) full icing allowance:

all exposed horizontal surfaces (decks, house tops, etc.) shall be assumed to carry an ice weight of 30 kilogrammes per square metre. The projected lateral area of the vessel above the waterline (a silhouette) shall be assumed to carry an ice weight of 15 kilogrammes per square metre. The height of the centre of gravity shall be calculated according to the heights of the respective areas and in the case of the projected lateral area the effect of sundry booms, rails, wires, etc., which will not have been included in the area calculated shall be taken into account by increasing by 5% the weight due to the lateral area and the moment of this weight by 10%. This allowance shall apply in winter (1st November to 30th April inclusive in the northern hemisphere) to vessels which operate in the following areas:

(a) the area north of latitude 66°30'N. between longitude 10ºW. and the Norwegian Coast;

(b) the area north of latitude 63°N. between longitude 28ºW. and 10ºW.;

(c) the area north of latitude 45°N. between the North American continent and longitude 28°W.;

(d) all sea areas north of the European, Asian and North American continents east and west of the areas defined in (a), (b) and (c) above;

(e) Bering and Okhotsk seas and Tatar Strait;

(f) South of latitude 60°S.

(ii) Half of the full icing allowance:

this shall be taken as one half of that calculated under sub-paragraph (i) of this paragraph and shall apply in winter to vessels which operate in all areas north of latitude 61°N. between longitude 28°W. and the Norwegian Coast and south of the areas defined as the lower limit for the full icing allowance between longitude 28°W. and the Norwegian Coast.

15. Information shall be provided in respect of the assumptions made in calculating the condition of the vessel in each of the circumstances set out in paragraph 10 above for the following:

(i) duration of the voyage in terms of days spent in reaching the fishing grounds, on the grounds and returning to port;

(ii) the weight and disposition of the ice in the hold at departure from port including the heights of stowage;

(iii) consumption rates during the voyage for fuel, water, stores and other consumables;

(iv) ratio by weight of the ice packed with the catch in the fish hold;

(v) melting rates for each part of the voyage of the ice packed with the catch and the ice remaining unused in the hold.

16. A copy of a report of an inclining test of the vessel and the derivation there from of the lightship particulars shall be provided.

17. A statement shall be given by or on behalf of the owner of the vessel that the statements and diagrams supplied with respect to the operating conditions set out in paragraph 10 above are based on the worst foreseeable service conditions in respect of the weights and disposition of fish carried in the hold or on deck, ice in the hold, fuel, water and other consumables.

ANNEX 2 – THE CRITERIA FOR SMALL (UNDER 24M) COMMERCIAL VESSELS

A vessel should be tested in the fully loaded conditions (which should correspond to the freeboard assigned) to ascertain the angle of heel and the position of the waterline which results when all persons which the vessel is to be certificated to carry are assembled along one side of the vessel. (The helmsman may be assumed to be at the helm.) Each person may be substituted by a mass of 75kg for the purpose of the test. Please note that 75kg may be increased in the foreseeable future.

The vessel will be judged to have an acceptable standard of stability if the test shows that:-

.1 the angle of heel does not exceed 7 degrees; and

.2 in the case of a vessel with a watertight weather deck extending from stem to stern, as described in Section 4.1.1 (of MGN 280, see below), the freeboard to deck is not less than 75mm at any point.

.3 The angle of heel may exceed 7 degrees, but should not exceed 10 degrees, if the freeboard in the heeled condition is in accordance with that required by Section 12 (of MGN 280, see below) in the upright condition.

This method considers areas of operation from the point of view of distances from port.

MGN 280 states

4. Construction and Structural Strength

4.1 General Requirements

4.1.1 A vessel which operates in Area Category 0, 1, or 2 should be fitted with a watertight weather deck over the length of the vessel, satisfying the requirements of Section 4.3.1, and be of adequate structural strength to withstand the sea and weather conditions likely to be encountered in the intended area of operation.

4.1.2 A vessel which is not fitted with a watertight weather deck in accordance with Section 4.1.1 should normally be restricted to Area Category 3, 4, 5 or 6 and be provided with adequate reserves of buoyancy and stability for the vessel with its full complement of persons to survive the consequences of swamping. An open boat should normally be restricted to service in area categories 4, 5 and 6. A sailing vessel which is not fitted with a watertight weather deck should be limited to Area Category 6.

11.3.9 Permitted areas of operation (not presently applying to fishing vessels)

Permitted Area of Operation	MCA Code Category	ISO 12217 Design Category
Unrestricted	0	A
Up to 150 miles from a safe haven	1	A
Up to 60 miles from a safe haven	2	B
Up to 20 miles from a safe haven	3	B
Up to 20 miles from a safe haven in favourable weather and daylight	4	C
Up to 20 miles from a nominated departure point in favourable weather and daylight	5	C
Up to 3 miles from a nominated departure point in favourable weather and daylight	6	C

12.2 Motor Vessels

12.2.1 General

Section 12.2.2 defines the requirements for minimum freeboard for a motor vessel whose stability has not been assessed using ISO 12217 'Small craft - Stability and buoyancy assessment and categorisation' Part 1. Section 12.2.3 defines how and when the freeboard mark, and deck line, should be applied. Requirements for an inflatable boat or boat fitted with a buoyant collar, not requiring an approved Stability Information Booklet, are contained within Section 12.2.4.

It should be noted that for vessels whose freeboard is not determined using Section 12.2.2.2, and are not provided with an approved stability information booklet, although requirements exist for minimum freeboard, such vessels are not required to be marked with a freeboard mark. In such cases the loading of the vessel is governed the maximum permissible weight, in accordance with Section 11, as identified on the vessel's certificate.

12.2.2 Minimum freeboard

The freeboard , for a motor vessel whose stability has not been assessed in conjunction with Sections 11.3.8 or 11.4.5, should be not less than that determined by the following requirements:-

12.2.2.1 Vessels which carry cargo or a combination of passengers and cargo for which the cargo element does not exceed 1000kg.

A vessel, other than an inflatable or rigid inflatable boat covered by Section 12.2.4, when fully loaded with cargo and non-cargo deadweight items certificated to be carried (each person taken as 75kg) should be upright and:-

.1 in the case of a vessel with a continuous watertight weather deck in accordance with Section 4.3.1.1, which is neither stepped or recessed or raised, have a freeboard measured down from the lowest point of the weather deck of not less than 300 mm for vessels of 7 metres in length or under and not less than 750 mm for vessels of 18 metres in length or over. For a vessel of intermediate length the freeboard should be determined by linear interpolation;

.2 in the case of a vessel with a continuous watertight weather deck in accordance with Section 4.3.1.2, which may be stepped, recessed, or raised, have a freeboard measured down from the lowest point of the weather deck, of not less than 200 mm for vessels of 7 metres in length or under and not less than 400 mm for vessels of 18 metres in length or over. For a vessel of intermediate length the freeboard should be determined by linear interpolation. The raised portion(s) of the watertight weather deck should extend across the full breadth of the vessel and the average freeboard over the length of the vessel should comply with .1 above for a vessel with a continuous watertight weather deck;

.3 in the case of an open boat, have a clear height of side (i.e. the distance between the waterline and the lowest point of the gunwale*) of not less than 400mm for vessels 7 metres in length or under and not less than 800mm for vessels 18 metres in length or over. For a vessel of intermediate length the clear height should be determined by linear interpolation;

*(The clear height of the side should be measured to the top of the gunwale or capping or to the top of the wash strake if one is fitted above the capping.)

12.2.2.2 Vessels which carry cargo or a combination of passengers and cargo for which the cargo element exceeds 1000kg, or those that cannot comply with Section 12.2.2.1.

Freeboard should be assigned in accordance with the Merchant Shipping (Load Line) Regulations 1998.

Such vessels should have a scale of draught marks marked clearly at the bow and stern.

12.2.2.3 A vessel required to be provided with an approved Stability Information Booklet should be assigned a freeboard which corresponds to the draught of the vessel in sea water when fully loaded (each person taken as 75kg), but which in no case should be less than the freeboard required by Section 12.2.2.1 or 12.2.2.2, nor that corresponding to the scantling draught.

12.2.3 Freeboard mark and loading

12.2.3.1 A vessel assigned a freeboard in accordance with Section 12.2.2.2 should be marked with a freeboard mark in accordance with the Merchant Shipping (Load Line) Regulations 1998 and have a scale of draught marks marked clearly at the bow and stern, on both sides of the vessel. The longitudinal position of the draught marks, relative to the longitudinal datum for the hydrostatic data, should be recorded in the Stability Information Booklet, where provided.

Where it is considered that the addition of a scale of draught marks is neither practicable nor meaningful, for example, due to restricted loading variations, application for special consideration should be made to the Administration.

Additionally, where the line of the deck is not immediately discernable, a vessel should be provided with a deck line. The deck line and freeboard mark should be permanent and painted on a contrasting background.

The freeboard mark shall consist of a ring 300 millimetres in outside diameter and 25 millimetres wide, intersected by a horizontal line 450 millimetres long and 25 millimetres wide the upper edge of which passes through the centre of the ring. The top of the intersecting line should be positioned at the waterline corresponding to the assigned freeboard to deck edge at amidships.

No mark should be applied for fresh water allowance.

The assigning letter marking on the bar of the ring and bar should be D on the left and T on the right when the MCA is the Certifying Authority. In the case of any other Certifying Authority, the assigning letters should be U on the left and K on the right.

12.2.3.2 The freeboard mark for a vessel required to be provided with an approved Stability Information Booklet, other than a vessel complying with Section 12.2.3.1 should be a bar of 300mm in length and 25mm in depth.

The marking should be permanent and painted black on a light background or in white or yellow on a dark background. (No assigning letter marking should be placed on the bar marking.)

The top of the mark should be positioned at the waterline corresponding to the draught referred to in Section 12.2.2.3, at amidships.

Additionally, where the line of the deck is not immediately discernable, a vessel should be provided with a deck line. The deck-line shall be marked amidships on each side of the ship so as to indicate the position of the freeboard deck. The mark need not be of contrasting colour to the surrounding hull.

Where the design of the vessel, or other circumstances, render it impracticable to mark the deck line, the Certifying Authority may direct that it be marked by reference to another fixed point as near as practicable to the position described above.

12.2.3.3 A vessel should not operate in a condition which will result in its freeboard marks being totally submerged when it is at rest and upright in calm sea water.

ANNEX 3 – SMALL PASSENGER VESSEL HEEL TEST

The Heeling Test and Freeboard Measurements

1.0 Condition of Ship:

The heeling test shall be conducted with fuel and water tanks full. If this is not possible, extra weights shall be added at approximately the same longitudinal centre of gravity to simulate the additional fuel or water required. Any ballast present on the ship shall be recorded for reference at future stability verifications. Photographs of the ship should be taken to aid recording of the condition of the ship during the test.

2.0 Weights:

Any form of weights may be used where the mass is known or can be checked using a suitable weighing device. Care shall be taken when using sandbags or similar where moisture ingress may have a significant effect on their weight. The use of people for performing heeling tests is not permitted due to safety and accuracy considerations.

3.0 Movement of weights:

The total heeling moment of WB/12 shall be imposed in 3 shifts of approximately WB/36, with the angle of heel being recorded at each stage. This staged heeling allows for subsequent analysis in borderline cases, helps avoid experimental errors and reduces the risk of excessive heel angles being achieved on newly considered ships. The process shall be performed for shifts both to port and to starboard. It is not necessary to utilise all the weights on board to produce the required heeling moment; the amount of weight used to provide the heeling moment will depend upon the distance it is able to be shifted. The type of weights, distribution and movement shall be agreed with the owner or representative prior to the test.

4.0 Measurement of Angle of Heel:

The angle of heel may be measured using battens pre-marked with freeboard corresponding to 5° and 7° of heel. In most cases, however, it is considered easier to calculate the angle of heel by use of a pendulum, calibrated inclinometer, water tube or by freeboard measurements. The angles of heel shall be measured by two separate methods where practicable to provide a means of verification. For example, this could be two pendulums (forward and aft), a pendulum and freeboard measurements or pendulum and inclinometer. When a pendulum is used to measure the heel angle the pendulum shall ideally be of sufficient length to produce a deflection of 35 mm for each weight shift. The angle of heel shall be recorded. Care shall be taken to ensure the ship is floating freely and avoid the influence of wash from passing ships, wind heeling and mooring line tension on heel angle measurements.

5.0 Assumed Centre of Gravity of Fish Landed on Deck:

The vertical centre of gravity of fish landed shall be assumed to be 500 mm above the deck.

6.0 Heeling Moment:

The two thirds – one third weight distribution equates to the standard heeling moment of WB/12. W is the weight of landed fish and B is the extreme breadth to the outside of the hull plating (excluding any fendering or rubbing strakes). This heeling moment may be applied using any weight and shift distance combination, provided it produces the required heeling moment (heeling moment = weight x distance moved).

7.0 Freeboard measurements:

7.1 Loaded freeboard measurements shall be taken at the heeling test with all weights onboard to represent the maximum capacity of fish in the fully loaded condition. Freeboard measurements shall be taken at positions forward, aft and amidships; with the location of the measurement points being recorded for future reference. Freeboard measurements shall generally be taken to the deck edge at side; any exception to this shall be noted to avoid any misinterpretation. The minimum freeboard and its location shall also be recorded. The mean loaded freeboard shall not be less than the minimum freeboard permitted for the ship. The minimum freeboard for ships of waterline length 6 m or less is 380mm. The minimum freeboard for ships with a waterline length of 18.3 m or more is 760mm. For intermediate lengths the minimum freeboard shall be calculated by linear interpolation.

7.2 The mean loaded freeboard measured at the amidships point from the deckline shall be the loaded freeboard of the ship and shall be the freeboard to be marked. The freeboard shall be the distance between the position of assumed minimum freeboard to the waterline.

7.3 Ships may take the minimum freeboard to the lowest point of downflooding rather than to the deck edge, providing that the upstands or superstructure raising the point of downflooding above the level of the deck are of a similar standard of watertight structural efficiency to the ship's topsides.

7.4 In the case of ships heeling less than 7° but not meeting the minimum freeboard requirement, a reduced minimum freeboard may be accepted provided that the actual freeboard in the heel test condition is not less than the residual freeboard would have been, had the prescribed minimum freeboard criteria been complied with and the ship had heeled to the full 7°.

7.5 At the heeling test, freeboard measurements shall also be taken in the 'light' condition with no landed fish weight onboard. This may be done before or after the heeling test is conducted. The tank states shall be as per the heeling test condition (full or compensated using weights). Freeboard measurements shall be taken forward, aft and amidships; with the location of the measurement points being recorded for future reference. Details of any bar stock, changes in normal furniture and equipment, and number of personnel onboard shall also be noted.

8.0 Subsequent Stability Verifications:

The ship shall be placed in the same "light" condition as recorded. The upright freeboards shall be re-recorded and compared with the previous values. Should the result be the same then the ship is deemed to be unchanged and the stability is accepted for a further five years. Due to measurement errors freeboards are considered unchanged if within 2 cm of the original figures at the bow and stern and 1 cm at the amidships measuring point. Slightly larger figures may be accepted if reasons for the change can be accounted for. However, if the change in freeboard exceeds these margins and cannot be accounted for (thereby indicating an increase in the lightship displacement) then the heeling test must be undertaken.

ANNEX 4

THE APPROXIMATE ROLL METHOD

Method

Measure the beam of the vessel in metres (eg 4.6m).

Induce the vessel to roll and time 5 complete rolls (A complete roll is from one side to the other and back to the beginning). After the initial force has been applied, the vessel should be allowed to roll freely. Times should be recorded as accurately as possible. It is also more accurate to take the time from the upright rather than the maximum roll angle, due to the speed of movement at that position.

Repeat this exercise twice more. From the fifteen rolls determine the average time of one complete roll.

If the time for one roll in seconds is greater than the beam in metres, the vessel can be said to be tender. Similarly if the time in seconds is less than “the figure” for beam, she may be said to be stiff.

Figures should be retained for future comparison and ideally a photograph taken and dated at the time of the roll.

ANNEX 5 – THE WOLFSON METHOD

THIS ANNEX REPRODUCES THE DOCUMENT "PREPARATION OF GUIDANCE INFORMATION FOR FISHING VESSELS" ISSUED BY THE WOLFSON UNIT

THE WOLFSON METHOD HAS BEEN DEVELOPED FROM A MCA RESEARCH PROJECT. SKIPPERS AND OWNERS MAY FIND IT USEFUL.

For additional guidance to calculate the size of freeboard marks for vessels without stability data and further examples of stability notices see Appendix 1 to Annex 4.

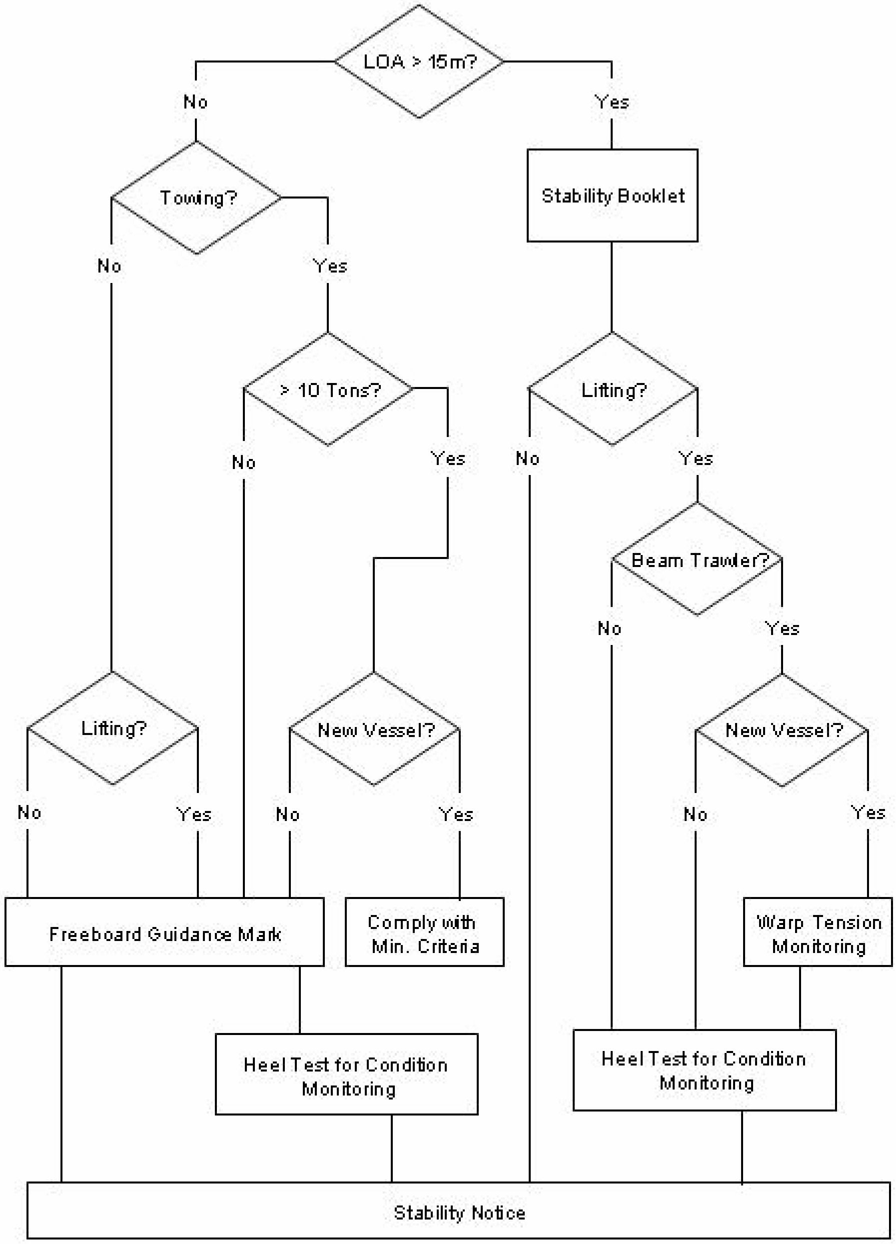
CONTENTS

1. INTRODUCTION

This document summarises the methods used to prepare Stability Notices for fishing vessels. It is based on the recommendations of Research Projects 559 and 560 carried out by the Wolfson Unit of Southampton University. The researchers recommend that each vessel display a Stability Notice in a prominent position in the wheelhouse. This notice would provide guidance on how certain loading or lifting operations will reduce the safety of the vessel, and on the limiting seastates in which such operations should be conducted. Three safety zones are defined, and assigned the colours green, amber and red on the Stability Notice to represent the relative levels of safety.

Figure 1 presents a simplified summary of the proposals for stability assessment and documentation for fishing vessels, depending on their age, size, and whether they are equipped for towing or lifting. Vessels over 15m LOA are required to carry stability books. For these vessels, and any smaller vessels that have a full stability analysis, the method of providing safety guidance is based on an assessment of the residual stability when loaded or lifting. For vessels with no stability information the guidance is based on the residual freeboard when loaded or lifting.

Figure 1. Flow Chart of the system of assessment and guidance for fishing vessels



2. CALCULATION OF THE SAFETY ZONE DEFINITIONS

Three safety zones are defined:

Green: "Safe" in all but extreme sea states
Amber: "Low level of safety" and should be restricted to low sea states
Red: "Unsafe, and danger of capsize" unless restricted to calm conditions and with extreme Caution

The safety of a vessel is dependent on its size and stability in relation to the sea state. For a vessel of a given size and stability, the lowest, or critical, sea state that could result in capsize can be estimated. The safety zone boundaries are defined by the significant waves heights Hs_{amber} and Hs_{red} as follows:

Green/amber boundary: $Hs_{amber} = \sqrt{1+0.4LOA}-1$

Amber/red boundary: $Hs_{red} = (Hs_{amber})/2$

The loading and lifting cases that are most likely to occur, and which reduce the stability to these values, should be presented on the Stability Notice.

3. CALCULATION OF THE CRITICAL LOADING AND LIFTING CASES

3.1 Minimum stability for vessels with full stability analysis:

The critical loading or lifting cases that correspond to the green/amber and amber/red safety zone boundaries are defined by the residual range of stability and righting moment:

Green/amber boundary: $\text{Range}\sqrt{RM\max} = 20B(Hs_{amber})$

Amber/red boundary zone: $\text{Range}\sqrt{RM\max} = 20B(Hs_{red})$

Where
Range is the residual range of positive stability in degrees
RMmax is the maximum residual righting moment, having taken account of any heeling moments due to offset weights, lifting or wind, in tonne.metres
B is the maximum beam in metres

The potential for significant downflooding should be considered, and the stability curve terminated at the downflooding angle.

3.2 Minimum freeboard for vessels with no stability data:

For vessels with no stability data, the critical loading or lifting cases that correspond to the safety zone boundaries are defined by the residual minimum freeboard. That is the minimum height of the lowest part of the weather deck above the waterline. The only vessel dimensions required are the overall length and beam.

Decked Vessels

Green/amber zone boundary: $\text{Min.Freeboard} = \frac{B}{L}(Hs_{amber})$

Amber/Red zone boundary: $\text{Min.Freeboard} = \frac{B}{L}(Hs_{red})$

Undecked Vessels

Because of the increased risk of swamping by wave action, no green safety zone is defined for undecked vessels.

Amber/red zone boundary Min.Freeboard = $\frac{2.6B}{L}$ (Hs_{red})

4. INFORMATION TO BE PRESENTED

The following information should be included for each case presented on the Stability Notice:-

- The significant wave height of the maximum recommended sea state for the amber and red zones.
- The range of minimum residual freeboards appropriate for each zone.
- For loading cases, definitions of the critical loadings that are identifiable on board.
- For lifting cases, the range of heel angles appropriate to each zone, and, or
- Where a load cell is fitted, the range of lifting loads appropriate to each zone.

5. CALCULATION METHODS FOR VESSELS WITH FULL STABILITY ANALYSIS

5.1 Loading cases

It is preferable for consultants to use software that automates the calculation to such a degree that it can be based on all of the standard loading conditions, in the same way as a maximum allowable KG calculation might be performed. It should be possible then to identify the worst conditions as those with the lowest loads at the safety zone boundaries.

If it is not practical to consider all loading conditions, care should be taken to ensure that the worst condition is selected. The condition with the lowest stability might have the highest freeboard, and it is not always possible to identify by inspection which condition might have the lowest level of safety when additional loads are applied, particularly when lifting. Conventional assessment does not consider righting moment, and the condition with the lowest GZ values might not be the condition with the lowest righting moment.

It is necessary to consider all possible loading cases that might be hazardous to the vessel. These might include overloading holds, filling hoppers, holding catch on deck, and lifting from all blocks with capacity. Example lifting cases for a beam trawler are presented in Figure 3.

It may be necessary to consider combinations of loading and lifting, particularly where it is likely that a combination of the two will take place, or where normal operations will result in very large variations of loading condition and stability. Examples of possible presentations are shown in Figure 4 and Figure 5. Figure 3 is preferred because it identifies the increased danger of lifting when adversely loaded.

It is anticipated that, in most cases, such a study will provide redundant information, and every effort should be made to simplify the Stability Notice by minimising the number of loading cases presented. Redundant information will occur if maximum possible loads or lifts do not result in a reduction of stability to the amber zone. Simplification of the information may also be possible where different loading cases have similar critical loads, and therefore may be groups together with a common value.

6. ACCURACY OF DATA

When operating with minimal stability, small changes to the loading case can result in large changes to the predicted value of the critical seastate. This is because the range of stability, which is the dominant parameter, can reduce rapidly, particularly with asymmetric loading, or lifting, cases. Whilst accuracy of the calculations is necessary to ensure that reliable information is provided, it should be borne in mind that the information is based on estimates of vulnerability which depend on many variables. This method does not offer a precise prediction of capsize, and so presentation of information to a high degree of accuracy is not appropriate.

Calculated values should be rounded to levels that are reasonable, bearing in mind the instrumentation or observations to which they relate. As a general rule of thumb, rounding of values to within 10% should be appropriate. The following examples are offered for guidance:

Parameter	Units	Decimal Places
Seastate	metres	0 or 1
Load	tonnes	0 or 1
Freeboard	metres	1
Heel angle	degrees	0

7. VESSEL ILLUSTRATIONS

Simple illustrations should be incorporated to clarify the nature of the information provided. These may be simple diagrammatic line drawings of the profile or cross section of the vessel, as appropriate to identify each loading case considered. Whilst it is not necessary for these to be scale drawings of the vessel, the fishermen will be more likely to relate to them if they bear a close resemblance to the vessel.

8. NOTES ON MAINTAINING STABILITY

The notice should include notes entitled “Simple Efforts for Maintaining Stability” or similar. These notes should be relevant to the vessel, its gear and catch handling arrangements and the fishing method. Suggestions for notes follow, and relevant ones might be selected from, or based on, this list but it is not intended to be exclusive.

- To maintain the approved stability, ensure that external doors and hatches are not left open at sea. (Those assumed to be closed in preparation of the Notice should be identified clearly here).
- Ensure that scuppers and freeing ports are open and clear of obstructions to allow water to drain quickly from the deck.
- Before attempting a heavy lift, or freeing snagging gear, inform the Coastguard, bring the warp as far inboard and as low as possible, close all the doors and hatches and ensure that all crew are on deck, wearing lifejackets.
- If the maximum recommended lift from the vessel’s side is exceeded, abandon the lift immediately. The position of the gear should be marked for retrieval by a larger vessel.
- The vessel may become unsafe if heavy items are moved up, heavier gear is fitted or lifting points are moved.
- Secure all gear and the catch against shifting.

9. PHOTOGRAPH

A photograph of the full profile of the vessel should be included, and labelled with the date it was taken. The date should correspond with the preparation of the Stability Notice.

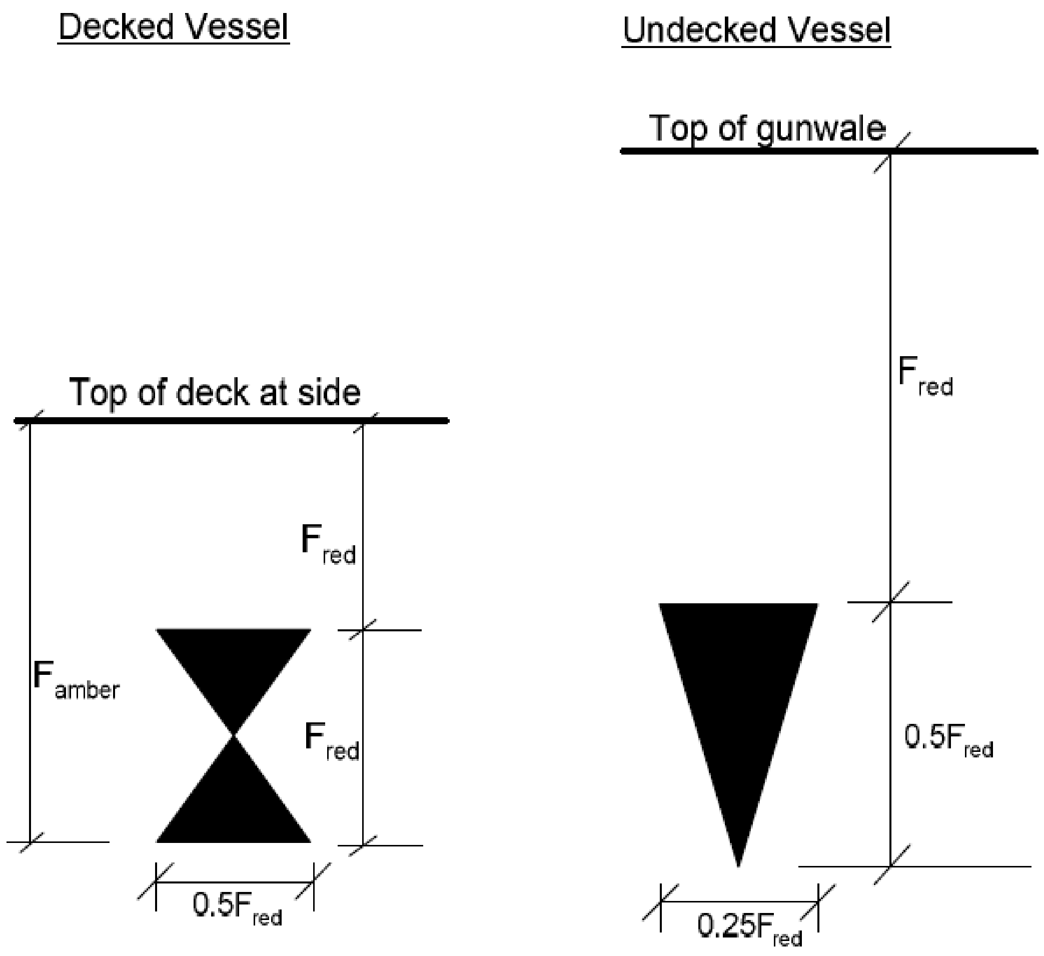
10. FREEBOARD MARKS

The researchers propose that Freeboard marks are applied on all vessels for which the guidance information has been based on minimum freeboards rather than on a full stability analysis.

The marks should be placed on both sides of the vessel. In selecting the location, the most likely reason for reduced freeboard should be borne in mind. If a large load is added well forward of aft, or is lifted from a point that is well forward of aft, the load might induce a large trim, resulting in the minimum freeboard being at a different longitudinal location compared with the upright case. While the research is based on the minimum freeboard it is not possible to calculate the exact location of minimum freeboard because freeboard might be reduced with a number of different load configurations. A consistently useful position is 25% LOA (forward from the aft end i.e. 75% abaft the fore end).

The marks should be applied in a colour that contrasts with the surrounding topsides.

The size and shape of the marks should conform to the dimensions shown in Figure 2.



11. HEELING TEST

The aim of the heeling test is to indicate whether significant modifications have been made to the vessel, its gear or gear handling arrangement. Significant modifications will require revision of the Stability Notice, and perhaps the stability booklet, in which case an inclining experiment will be required.

It is preferable to use components of the actual gear, lifted from a block in its highest or furthest outboard location, to give a measurable heel angle. Such a heeling test will relate directly to the fishing operation. More importantly, it will enable the fishermen to relate their operation to their vessels stability.

For a beam trawler, this is straightforward because one beam trawl from the horizontal derrick on one side, typically, will result in a heel angle of about 10 degrees. Any increase in the trawl weight or derrick length, or decrease in the stability, will result in a larger angle. Small differences are not important because they are inevitable with wear of the gear and small variations in the loading condition. It is not considered necessary to specify the vessel loading condition precisely but some level of repeatability in the righting moment is required. Because the righting moment is proportional to the product of displacement and GM, and both tend to increase with increased tank contents, variations of around 30% are to be expected between the depart port and arrival conditions. A convenient loading condition, such as a nominal depart port condition, should be selected. Empty hold, no ice and full tanks might be a practical condition for example. Preferably this should be agreed by the skipper and surveyor well in advance of the first test. The vessel should be trimmed upright by movement of loose gear or tank contents, or the heel test may be conducted on both sides, and a mean value recorded to eliminate the effects of any initial list.

The heel angle can be measured with a simple inclinometer, provided it enables a suitable level of accuracy. If the heeling test is conducted at the same time as an inclining experiment it may be convenient to use a damped pendulum. If the heel angle is significantly greater than that recorded when the Stability Notice or stability booklet were prepared, it will be necessary to determine the reason for the increase. It is suggested that a suitable criterion for acceptability, or margin of variation, in the measured heel angle is within 10% of the original value. It should be noted that such an increase in the heel angle may be gradual, so that successive heeling tests might be within the acceptable margin of each other, while the cumulative effect results in an increase from the original that is unacceptable.

There are three possible reasons for an increase in heel angle, and each one that applies will require appropriate revision of the stability documents for the vessel. In some cases a combination of reasons will apply.

Reason for increase in heel angle	Revisions required
Increased weight of fishing gear	Stability booklet – gear details and loading conditions
Longer derricks, or a higher lifting point	Stability booklet – derrick details Stability Notice – maximum recommended lifting loads
Reduced vessel stability	Conduct new inclining experiment Stability booklet – loading conditions Stability Notice – all data

12. INSTRUMENTATION

12.1 Load cells and warp tension monitoring systems

Where load cells are fitted to the lifting blocks, or the vessel has warp tension monitoring equipment, the lifting loads corresponding to the safety zone boundaries should be presented on the Stability Notice, unless they exceed the capacity of the lifting equipment.

12.2 Inclinometers

An inclinometer enables the heel angle due to lifting to be monitored, and compared with heel angle information on the Stability Notice. Whilst it is unlikely to be as accurate as lifting load monitoring instrumentation, it has the advantage that measurement of heel angle incorporates any reduction in the stability of the vessel or movement of the lifting point. If the stability has been adversely affected by unreported modifications to the vessel, poor loading or flooding, the heel angle resulting from a given moment will be greater than predicted in the stability calculations conducted when preparing the Stability Notice. If the lifting point has been relocated, the lifting guidance presented on the Stability Notice may be invalid, but the heel angle is unlikely to be affected.

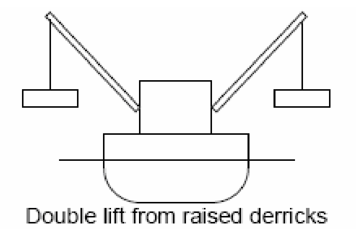
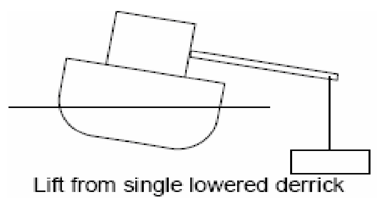
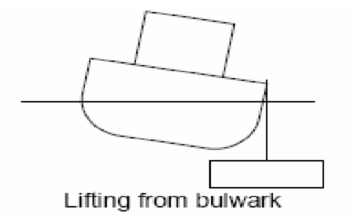
Inclinometers come in a variety of forms and levels of complexity. It would be advantageous to have a display with an efficient averaging system to eliminate the roll motion and present the mean heel angle, but even a simple device will provide valuable information. A bead in a fluid filled tube is perhaps the simplest type, obtainable at yacht chandlers for a few pounds, Whilst it will not give a steady reading on a rolling vessel, the observer can obtain a mean reading with reasonable accuracy, and such a device would enable the fishermen to become familiar with the feel of their vessel at different heel angles. They would then be better able to relate to the information on the Stability Notice.

A permanent inclinometer would facilitate conducting a heel test to monitor the stability.

Because simple instruments are cheap, readily available, and trivial to fit, the researchers propose that all fishing vessels should be equipped with some form of inclinometer, mounted athwartships to measure the heel angle.

Figure 3 Example Stability Notice for a 24m beam trawler

STABILITY NOTICE

	Lifting Guidance		
BONNIE LASS AB123 **LOA: 24M** **Owner; John Fisher**	**Good margin of Stability**	**Low level of safety** Max recommended seastate 2.2 metres	**Danger of Capsize** Max recommended seastate 1.1 metres
	Less than 4.5 tonnes each side	4.5 – 7-5 each side	More than 7.5 tonnes each side
	Less than 5.5 tonnes Deck edge above waterline Heel angle less than 12°	5.5 - 7.5 tonnes Deck edge immersion less than 20 cm Heel angle 12° - 17°	More than 7.5 tonnes Deck edge immersion more than 20 cm Heel angle more than 17°
	Less than 10 tonnes Deck edge above waterline Heel angle less than 10°	10 - 15 tonnes Deck edge immersion less than 20 cm Heel angle 10° - 16°	More than 15 tonnes Deck edge immersion more than 20 cm Heel angle more than 16°

Simple efforts for maintaining stability

- Before attempting a heavy lift the coastguard should be informed, the warp should be brought to the vessel's side, all hatches should be closed and all crew should be on deck, wearing lifejackets.
- If maximum recommended lift from the bulwark is exceeded the list must be abandoned immediately. Position of gear should be marked and noted for retrieval by a larger vessel.
- Ensure scuppers are open and clear of obstructions to allow water to drain from the deck.
- Vessel may become unsafe if longer derricks or larger beams are fitted.

Heel Monitoring Test

This vessel heeled 9 degrees with starboard gear on lowered derrick, port derrick topped and port gear on deck. The residual freeboard was 33cm. 5 February 2006.

Photograph of Vessel
Dated 5th February 2006

Figure 4 Example of the loading guidance for the Stability Notice on a pelagic trawler. Preferred format for combined lifting and loading

STABILITY NOTICE

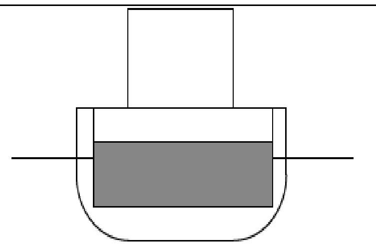
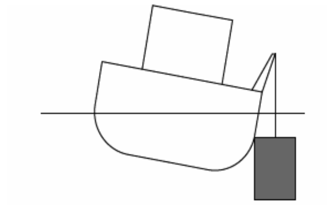
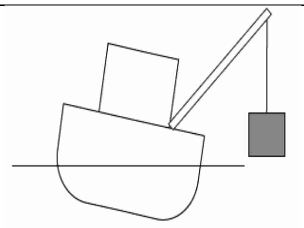
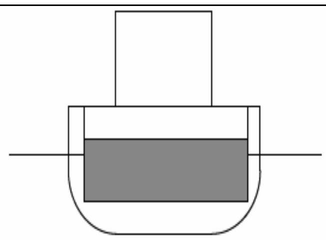
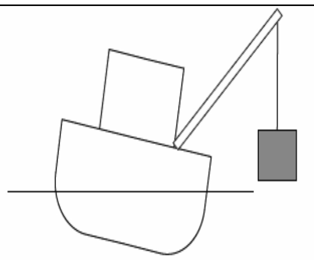
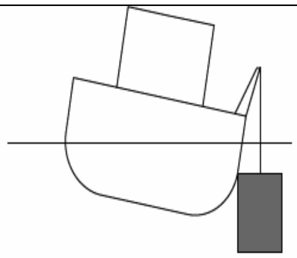
BONNIE LASS AB456 **LOA: 32M** **Owner: Mike Fisher**		 Loading bulk fish in hold		
		Less than half depth of hold	½ - ¾ depth of hold	More than ¾ depth of hold
 Lifting from towing blocks	Less than 6 tonnes	Min freeboard at least 40cm	Min freeboard 20-40cm Max seastate 3.5m	Min freeboard Less than 20cm Max seastate 1.5m
	6 – 10 tonnes	Min freeboard 20-40cm Max seastate 3.5m	Min freeboard Less than 20cm Max seastate 1.5m	
	More than 10 tonnes	Min freeboard Less than 20cm Max seastate 1.5m		
 Lifting from derrick	Less than 2 tonnes	Min freeboard at least 40cm	Min freeboard 20-40cm Max seastate 3.5m	Min freeboard Less than 20cm Max seastate 1.5m
	2 -4 tonnes	Min freeboard 20-40cm Max seastate 3.5m	Min freeboard Less than 20cm Max seastate 1.5m	
	More than 4 tonnes	Min freeboard Less than 20cm Max seastate 1.5m		
		Good margin of safety	Low level of safety	Danger of capsize

Figure 5 Example of the loading guidance for the Stability Notice on a pelagic trawler. Alternative format for independent loading and lifting.

STABILITY NOTICE			
BONNIE LASS AB456 **LOA: 32M** **Owner: Mike Fisher**	Loading and Lifting Guidance		
	Good margin of Stability	**Low level of safety** Max recommended seastate 3.5 metres	**Danger of Capsize** Max recommended seastate 1.5 metres
 Loading bulk fish in hold	Less than half depth of hold Min freeboard at least 50cm	½ - ¾ depth of hold Min freeboard 25-50cm	More than ¾ depth of hold Min freeboard less than 25cm
 Lifting from derrick	Less than 2 tonnes Min freeboard at least 40cm	2 – 4 tonnes Min freeboard 20-40cm	More than 4 tonnes Min freeboard Less than 20cm
 Lifting from towing blocks	Less than 6 tonnes Min freeboard at least 30cm	6 – 10 tonnes Min freeboard 15 – 30 cm	More than 10 tonnes Min freeboard Less than 15cm

APPENDIX 1 TO ANNEX 4

STEP-BY-STEP GUIDE TO CALCULATE SIZE OF FREEBOARD MARKS FOR VESSELS WITHOUT STABILITY DATA

To calculate the size of the marks for a vessel, Beam (B) and Length Overall (LOA) of the vessel is needed. The shape and size of the mark varies between Decked and Undecked vessels.

The safety zone boundaries are based on Significant Wave Heights, Hs_{amber} and Hs_{red} which need to be calculated in the first instance using the equations below.

Hs_{amber} (metres) = $\sqrt{(1+0.4 \times LOA)} - 1$

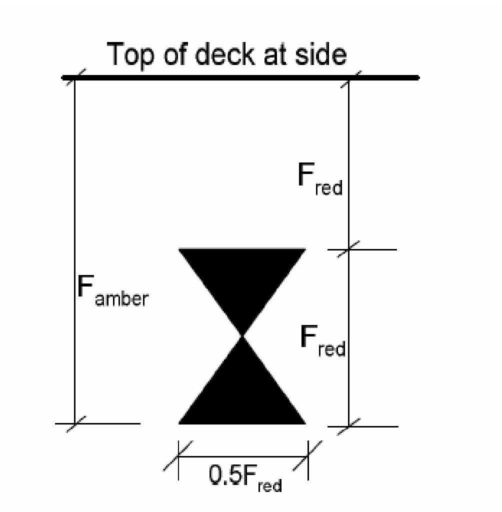
Hs_{red} (metres) = $(Hs_{amber})/2$

Once this has been calculated, the green/amber boundary (F_{amber}) and the amber/red boundary (F_{red}) of the mark need be calculated as shown below, which will then indicate the size of the mark.

<u>Decked Vessels</u>

F_{amber} (cm) = $100 \times HS_{amber} \times \left(\frac{B(metres)}{LOA(metres)} \right)$

F_{red} (cm) = $\frac{(F_{amber})}{2}$

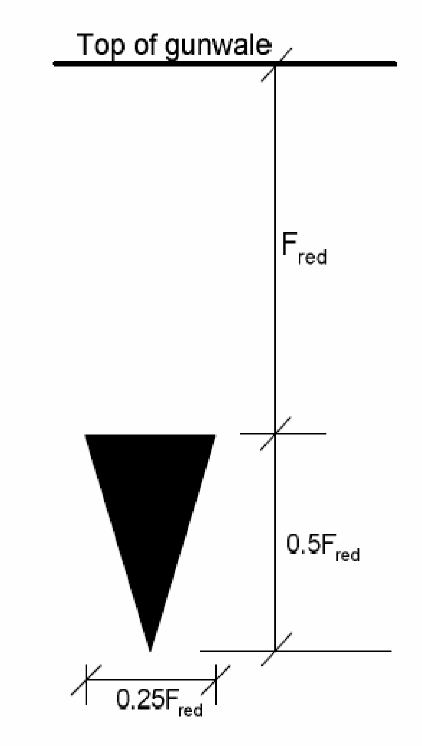


Undecked Vessels

F_{red} (cm) = $2.6 \times B \times HS_{red} \; / LOA \times 100$

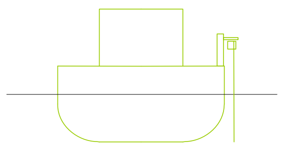
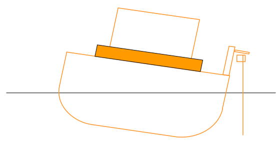
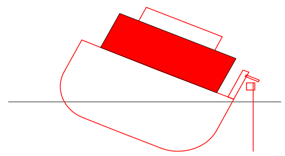
Height of the Mark (cm) = 0.5 x F_{red}

Width of the Mark (cm) = 0.25 x F_{red}

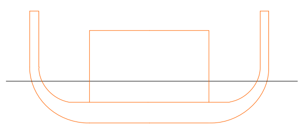
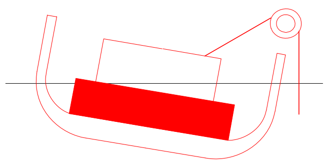


EXAMPLE STABILITY NOTICES

13.91m Decked Vessel

STABILITY NOTICE				
Name **A Vessel** No. **0** Owner **Mr Smith** Length **13.91 metres** Beam **4.89 metres**	**Loading & Lifting Guidance**	**Safety Zone**	**Minimum Freeboard**	**Maximum Recommended Seastate**
	Good margin of residual freeboard	**Good margin of safety**	At least 55 cm	
	Loading or lifting reduces minimum freeboard to less than 55 cm	**Low level of safety**	27 to 55 cm	1.6 metres
	Excessive loading or lifting reduces minimum freeboard to less than 27 cm	**Danger of capsize**	Less than 27 cm	0.8 metres

6.44m Open Vessel

STABILITY NOTICE				
Name **Noname** No. **0** Owner **Mrs Potter** Length **6.44 metres** Beam **2.66 metres**	**Loading & Lifting Guidance**	**Safety Zone**	**Minimum Freeboard**	**Maximum Recommended Seastate**
	Even with a freeboard of at least 48 cm, swamping may be a hazard	**Low level of safety**	At least 48 cm	
	Excessive loading or lifting reduces minimum freeboard to less than 48 cm	**Danger of capsize**	Less than 48 cm	0.4 metres