

Report on the investigation of the
capsize and foundering of the fishing vessel

Nancy Glen (TT100)

with the loss of two lives

Lower Loch Fyne, Scotland

18 January 2018



Extract from
The United Kingdom Merchant Shipping
(Accident Reporting and Investigation)
Regulations 2012 – Regulation 5:

“The sole objective of the investigation of an accident under the Merchant Shipping (Accident Reporting and Investigation) Regulations 2012 shall be the prevention of future accidents through the ascertainment of its causes and circumstances. It shall not be the purpose of an investigation to determine liability nor, except so far as is necessary to achieve its objective, to apportion blame.”

NOTE

This report is not written with litigation in mind and, pursuant to Regulation 14(14) of the Merchant Shipping (Accident Reporting and Investigation) Regulations 2012, shall be inadmissible in any judicial proceedings whose purpose, or one of whose purposes is to attribute or apportion liability or blame.

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GLOSSARY OF ABBREVIATIONS AND ACRONYMS

ALB	-	All weather lifeboat
C	-	Celsius
CGOC	-	Coastguard Operations Centre
CoC	-	Certificate of Competency
CRT	-	Coastguard rescue team
DSC	-	Digital selective calling
FISG	-	Fishing Industry Safety Group
GM	-	Metacentric height
GZ	-	Heel righting lever
IBC	-	Intermediate bulk container
ILB	-	Inshore lifeboat
IMO	-	International Maritime Organization
kg	-	kilogramme
kW	-	kilowatt
l	-	litre
L	-	Registered length
LOA	-	Length overall
LOLER	-	The Merchant Shipping and Fishing Vessels (Lifting Operations and Lifting Equipment) Regulations 2006
m	-	metre
MCA	-	Maritime and Coastguard Agency
MGN	-	Marine Guidance Note
MSN	-	Merchant Shipping Notice
NATO	-	North Atlantic Treaty Organization
NLB	-	Northern Lighthouse Board

NLV	-	Northern Lighthouse Vessel
nm	-	nautical miles
RNLI	-	Royal National Lifeboat Institution
ROV	-	Remotely Operated Vehicle
Seafish	-	Sea Fish Industry Authority
SI	-	Statutory Instrument
t	-	tonne
UTC	-	Universal Co-ordinated Time
VCB	-	Vertical centre of buoyancy
VCG	-	Vertical centre of gravity
VHF	-	Very High Frequency

TIMES: all times used in this report are UTC unless otherwise stated

SYNOPSIS

At about 1750 on 18 January 2018, the prawn trawler *Nancy Glen* capsized and later sank in Lower Loch Fyne, Scotland; only one of the three crew survived.

Nancy Glen was trawling when its starboard net became fouled with mud and debris from the seabed during a turn to starboard, and the vessel capsized rapidly. One of the crew escaped but the skipper and the other crewman were trapped inside. The missing crewmen's bodies were recovered when the wreck was salvaged.

The MAIB's investigation established that through life modifications to *Nancy Glen*, culminating in the replacement of the crane with a heavier model, had reduced the vessel's stability, significantly increasing its vulnerability to capsize. Despite the skipper's attempt to bring the situation under control, the combined effect of the increased towing load from the fouled net, the turn to starboard and the limited stability meant that *Nancy Glen* was unable to recover from the rapid heel to starboard.

Evidence from small fishing vessel capsizes, coupled with the limited adoption of the Wolfson Mark, suggests that owners and skippers are unaware of the risks of not conducting stability assessments. The case for introducing stability criteria for small fishing vessels has been made by the Marine Accident Investigation Branch and accepted by the Maritime and Coastguard Agency. Nevertheless, until such criteria have been implemented, the risk of capsize resulting from unknown stability conditions will endure.

A safety recommendation has been made in this report to the Maritime and Coastguard Agency to ensure that the stability of small fishing vessels is regularly assessed.

SECTION 1 - FACTUAL INFORMATION

1.1 PARTICULARS OF NANCY GLEN AND ACCIDENT

SHIP PARTICULARS	
Vessel's name	<i>Nancy Glen</i>
Flag	United Kingdom
Classification society	Not applicable
IMO number/fishing numbers	TT100
Type	Twin rig prawn trawler
Registered owner	Privately owned
Manager(s)	Not applicable
Construction	Steel
Year of build	1991
Length overall	12.98m
Registered length	11.98m
Gross tonnage	19.55t
Minimum safe manning	Not applicable
Authorised cargo	Not applicable
VOYAGE PARTICULARS	
Port of departure	Tarbert
Port of arrival	Tarbert (intended)
Type of voyage	Coastal
Cargo information	Prawns
Manning	3
MARINE CASUALTY INFORMATION	
Date and time	18 January 2018, about 1750
Type of marine casualty or incident	Very Serious Marine Casualty
Location of incident	55 53.80N 005 22.65W
Place on board	Over side
Injuries/fatalities	Two fatalities
Damage/environmental impact	Vessel lost, no environmental damage
Ship operation	Trawling
Voyage segment	Mid-water
External & internal environment	Air temperature 2°C, occasional snow showers, sea temperature 6°C, sea state calm.
Persons on board	3



Nancy Glen

1.2 BACKGROUND

Nancy Glen was a prawn trawler that operated from its home port of Tarbert, Scotland. Trawling was usually confined to Lower Loch Fyne and, due to the confines of the loch, normally carried out on northerly or southerly headings with short easterly or westerly passages as the vessel turned. Hauling and re-shooting the nets took 20 to 30 minutes, then each tow lasted up to 5 hours with the skipper and crew taking turns to rest during the towing periods.

The crew's routine comprised daily voyages on weekdays, usually departing in the late evening and returning early the following evening to land the catch and rest before returning to the fishing grounds. On completion of fishing on a Friday, the fuel tanks were refilled in preparation for the following week. The local fish market had been closed over the Christmas to New Year period and had re-opened on Monday 8 January 2018.

1.3 NARRATIVE

1.3.1 The accident

Nancy Glen sailed from Tarbert Harbour at about 2230 on 17 January and trawling commenced soon after. Sunset on 18 January was at 1626, and at about 1750 with the loch in darkness, the skipper was at the wheel part-way through the last tow of the day. He was turning *Nancy Glen* to starboard onto a southerly heading (**Figure 1**) in preparation for hauling the nets prior to heading back to Tarbert. The two crewmen had completed washing down and tidying the deck and were in the accommodation waiting to be called to assist with the final haul. Weather conditions were relatively benign, with calm sea and very little wind. There had been occasional snow flurries with an air temperature of 2°C and sea temperature of 6°C.

During the turn, *Nancy Glen* began to list to starboard. The list rapidly increased and caused loose items in the cabin to fall and the refrigerator door to fly open. Initially the two crewmen were unconcerned as the vessel normally listed during turns. However, as the list continued to increase, they became increasingly worried. One of the crewmen shouted to his colleague to get out, then made his way up into the wheelhouse. There, he noted that the skipper was at the wheel and that the vessel was listing at such a severe angle that the main deck guardrails were starting to become immersed. He heard the skipper shout that he did not know what was happening; the crewman then repeated his call to get off the vessel.

To escape from the wheelhouse the crewman had to climb over the trawl winch, travel along the main deck and climb onto the side of the net drum. He then jumped off the net drum and over the stern into the sea. He swam away from *Nancy Glen* to avoid becoming trapped if it sank. Once aware that the vessel had not sunk, the crewman swam back to the upturned hull to try to find his colleagues. After realising that he could not access the upturned hull, the crewman saw the liferaft canister that had floated free from the vessel; he attempted to inflate the liferaft by pulling on the painter, but this was not successful. Shortly after this, a searchlight illuminated *Nancy Glen* and the crewman was able to attract the attention of the crew on board a local fish farm vessel. The crewman was rescued from the water and, following a search around the upturned *Nancy Glen* (**Figure 2**) for other survivors, he was transferred to another fishing vessel and taken ashore for medical assessment and treatment.

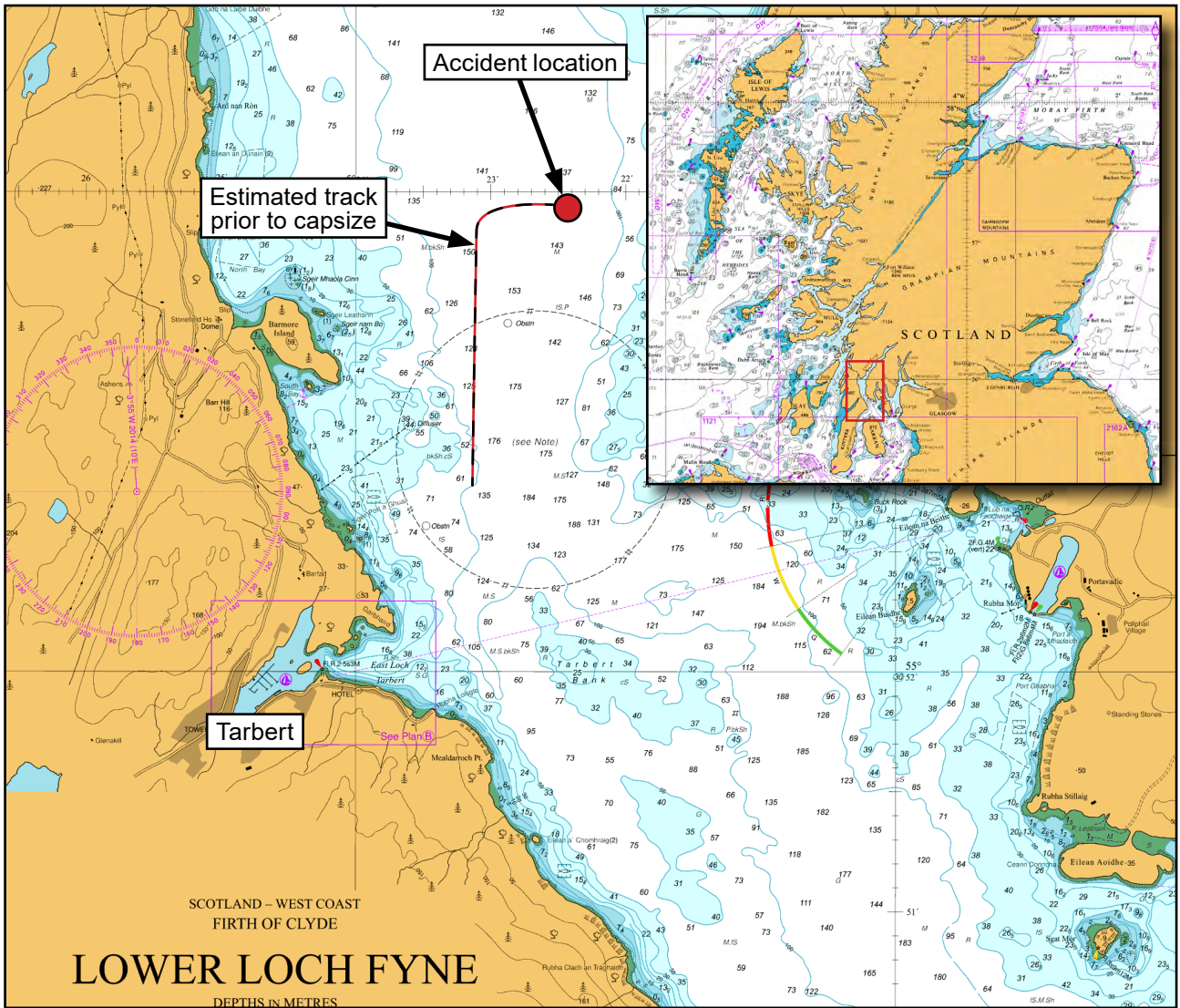


Figure 1: Chart showing *Nancy Glen's* estimated track and the capsizing position with overview inset



Figure 2: *Nancy Glen's* upturned hull

1.3.2 Search and rescue

At 1800, Coastguard Operations Centre (CGOC) Belfast received a '999' call reporting the capsizing of *Nancy Glen*. This was supported by a digital selective calling (DSC) alert raised by the crew of the fish farm vessel *Lady Inger*. CGOC Belfast broadcast a 'Mayday Relay' at 1819 reporting that the fishing vessel *Nancy Glen* had capsized 1.2nm north-east of Barmore Island (**Figure 1**) with two persons missing.

A number of fishing vessels and small boats from Tarbert immediately joined *Lady Inger* in the search area. The ferry *Loch Riddon* and the research vessel *SD Northern River* also responded to the 'Mayday Relay' and, at the request of CGOC Belfast, proceeded towards the scene.

The RNLI all weather lifeboat (ALB) from Campbeltown and inshore lifeboats (ILB) from Campbeltown, Arran and Tighnabruaich were all launched. Once on site, co-ordination of the local search and rescue effort was undertaken by the ALB. The search and rescue (SAR) helicopter, R199, from Prestwick, was also involved in the search.

By 1845 *Loch Riddon* had arrived on scene and attached a mooring rope to *Nancy Glen*'s Kort nozzle¹. At 1915 *Loch Riddon*'s crew reported that *Nancy Glen*'s stern was, by then, below the surface with only 1 metre (m) of the bow remaining visible. Shortly after this a local dive boat arrived and a diver entered the water and attached an additional line from *Loch Riddon* to *Nancy Glen*'s crane pedestal. *SD Northern River* stood by, clear of *Nancy Glen*, awaiting further direction.

It was then decided to attempt to use the deck crane on *SD Northern River* to support *Nancy Glen*. Two local divers took strops and shackles from *SD Northern River* and attempted to assemble a suitable lifting rig around the fishing vessel's wheelhouse.

At 2033 the mooring rope attaching *Nancy Glen* to *Loch Riddon* parted as the fishing vessel sank; the two divers were safely recovered from the water.

The liferaft painter remained attached to *Nancy Glen* and the action of the vessel sinking resulted in the liferaft inflating; the weak link then broke, allowing the liferaft to ascend to the surface.

Shoreline searches were co-ordinated by Tarbert Coastguard Rescue Team (CRT).

1.4 CREW

Nancy Glen had sailed from Tarbert Harbour with a crew of three comprising the skipper and two crewmen.

The 46 year old skipper, Duncan MacDougall, was a part owner of the vessel, the other shareholders being his father and his uncle. He was an experienced fisherman and skipper and had worked on fishing vessels since leaving school at the age of 16. Duncan had completed the mandatory Sea Fish Industry Authority (Seafish²) safety

¹ The Kort nozzle was around *Nancy Glen*'s propeller – see Section 1.5.2.

² Seafish is a non-departmental public body with a mission to support a profitable, sustainable and socially responsible future for the seafood industry.

training courses³ comprising Basic Sea Survival, Basic Fire Fighting and Prevention, Basic First Aid, and Safety Awareness and Risk Assessment, that were sufficient for him to act as skipper of *Nancy Glen*. There is no record of him having completed any training relating to stability awareness and he did not hold the voluntary under 16.5m Skipper's Certificate.

Przemyslaw Krawczyk was a 38 year old Polish national who had lived in Tarbert for a number of years. He was considered to be an experienced fisherman and had previously skippered another vessel operating from Tarbert. Seafish training records indicate that he had completed only Safety Awareness and Risk Assessment training. He held no STCW (F) 95⁴ or equivalent certificates issued in Poland.

The third member of the crew was a 34 year old local fisherman who had been a crewman on *Nancy Glen* since leaving school. He had completed the four mandatory fishing safety training courses.

1.5 NANCY GLEN

1.5.1 General description

Nancy Glen was originally named *La Hai Roi*, side number LH18. It was designed and built by Coastal Marine Boatbuilders of Eyemouth and its keel was laid in 1991. The owners at the time of the accident had purchased and renamed the vessel in 1995.

Nancy Glen had been designed as a twin rig stern trawler with the wheelhouse at the forward end of the main deck. The accommodation - a four-berth cabin - forward of the wheelhouse was above the engine room. There was a small ventilation hatch in the deckhead of the cabin. The working deck with the main trawl winch and net drums was aft of the wheelhouse. There was an insulated but not refrigerated fish hold aft of the engine room. Access to the wheelhouse was from the main deck via a short companionway. The cabin was accessed from the wheelhouse using a similar companionway and there was a shelter over the main deck, which extended just aft of midships. *Nancy Glen's* original layout is at **Figure 3**. A crane, located at the aft end of the shelter deck, was used for moving nets and catch when the vessel was in harbour.

Lifejackets were stored in a locker in the accommodation, and a float free liferaft was located in a frame on top of the wheelhouse.

Nancy Glen was fitted with a 201 kilowatt (kW) Cummins NT855M main engine with a twin disc 5:1 reduction gearbox that supplied propulsion, with a power take-off for hydraulic power. There was a 2000 litre (l) capacity fuel tank located on the port side of the engine room and a 2600l capacity tank on the starboard side. The tanks were alternated daily with fuel spill returns going back to the tank in use. The engine typically consumed 300 to 350l/day during normal fishing operations.

The owners and previous skippers of *Nancy Glen* considered the vessel to be a 'good sea boat'.

³ Fishermen who work in the UK are required to complete basic safety training courses in sea survival, first-aid, fire-fighting and prevention, and health and safety. Fishermen with over 2 years' experience are also required to complete a Seafish safety awareness and risk assessment course.

⁴ International Convention on Standards of Training, Certification and Watchkeeping for Fishing Vessel Personnel, 1995.

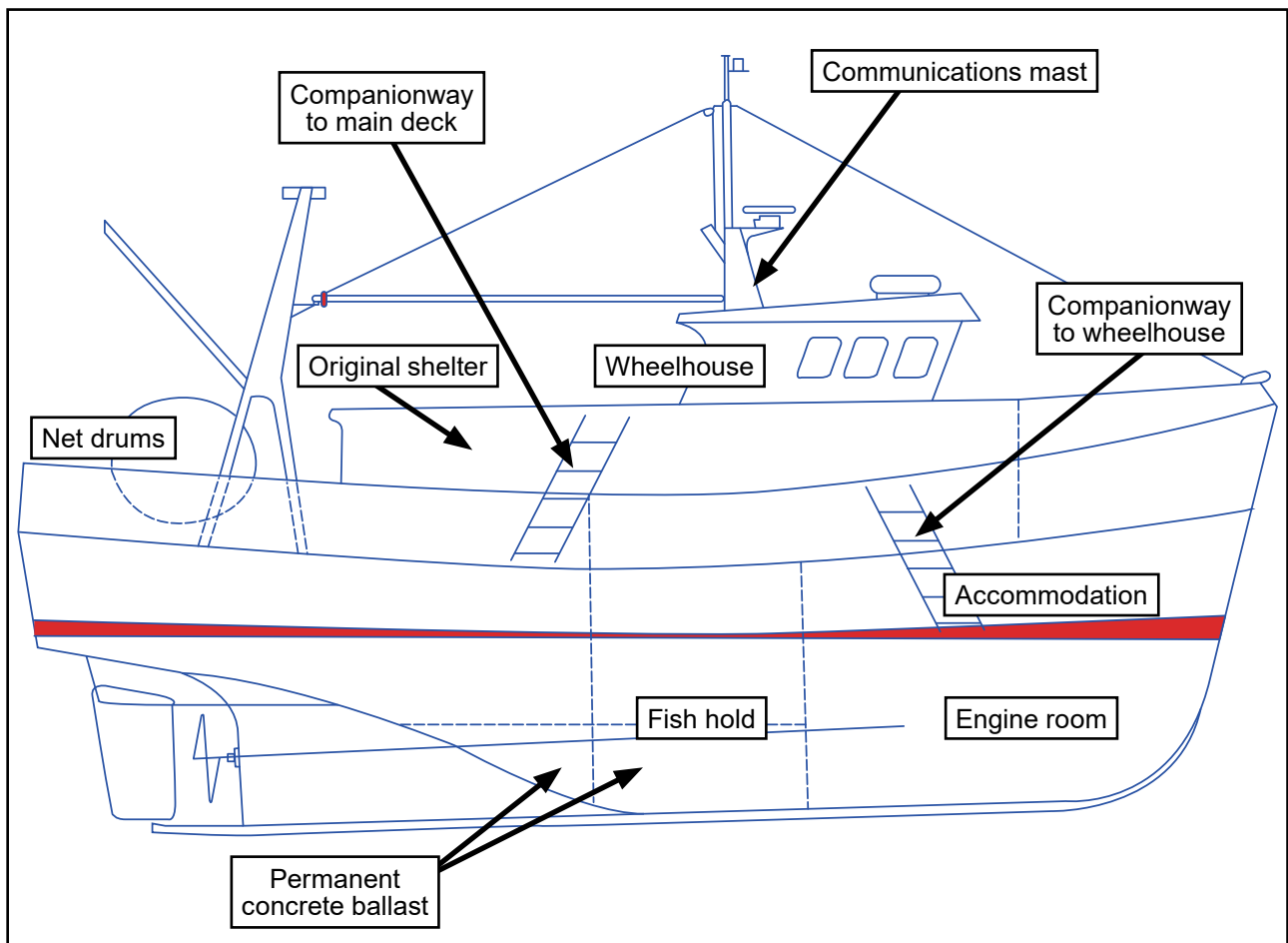


Figure 3: *Nancy Glen* – general arrangement before modifications

1.5.2 Modifications

In 2002 *Nancy Glen*'s owners contracted a boat designer and naval architect to prepare a specification for modifications to be carried out, which included extending the shelter deck aft to the gantry position. It also included replacing the existing crane (a Palfinger crane that had insufficient reach for operating on Tarbert Harbour fishing berths), locating it on the shelter deck, replacing the net drum with a split drum, and fitting a new Gilson winch to the shelter deck. The work also required relocating an access hatch from the shelter deck to the main deck, removal of the trawl gallows and resiting of the lifting pole. Prior to the work being agreed, intact stability calculations were carried out by the naval architect (Section 1.9.1).

The work package was confirmed as feasible following stability calculations, and the work was completed in late 2002.

In 2012 the owners decided to replace the propeller and fit a Kort nozzle (**Figures 4a-c**). This comprised a fixed, annular forward extending duct around the propeller. The propeller operated with a small gap between blade tips and the nozzle internal wall. The nozzle ring had a cross-section shaped as a hydrofoil (**Figure 4c**) that improved propeller efficiency and helped to reduce fuel consumption.

In order to fit the nozzle, enhancements to the internal supporting structure were required. This involved fitting longitudinal members to supplement the original transverse frames. Although additional weight was added in respect of the nozzle and supporting structure, no changes were made to the concrete ballast located in

the fish hold. The additions to the supporting structure were carried out following informal advice from a naval architect and a boatyard engineer. Although no stability calculations were carried out in respect of the effect of these modifications, the forward fresh water tank was kept full as ballast to counter the stern trim caused by the Kort nozzle.

Photographs courtesy of www.trawlerpictures.net



Figure 4a: *Nancy Glen* with original propeller arrangement



Figure 4b and c: *Nancy Glen* after Kort nozzle fitting

In 2016, consideration was given to raising the height of the wheelhouse to improve visibility, and to relocating the net drums. However, following further investigation, including advice from a naval architect, it was decided to refurbish the existing arrangements instead. At this time the vessel's wiring was completely renewed and the steel communication mast was replaced with a lighter aluminium structure.

Later in 2016 and following the decision not to raise the height of the wheelhouse, some of the concrete ballast was removed to reduce *Nancy Glen's* stern trim, which had increased as a result of the additional weight from the Kort nozzle installation.

In September 2016, the owners realised that a better return could be achieved in winter by marketing live catch. To facilitate this, they placed an aluminium tank in the fish hold to store the tubed prawns. The tank needed to be regularly flushed with sea water in order to maintain the condition of the prawns.

The tank was removed around April 2017 when the owners reverted to keeping the catch on ice in the fish hold for the summer season. In September 2017, to improve utility for the 2017/18 winter season, the aluminium tank was divided into two and relocated on the shelter deck either side of the wheelhouse (**Figure 5b**). The storage arrangements were supplemented with a 1 tonne (t) intermediate bulk container (IBC) located on the main deck aft of the fish hold hatch, and filled as required.

During the 2017/18 Christmas layover, the crane (a Guerra MC 40.55A1) was replaced with a Thistle Marine MKB7 Crane (**Figures 5a** and **5b**). The Guerra crane had a dry weight of 700 kilogramme (kg) while the replacement was more than double the weight, at 1500kg. To compensate for the additional weight the steel cod end lifting post was replaced with an aluminium structure. Although the weight difference was considered, no empirical assessment regarding the effect on the vessel's stability was carried out prior to completing these modifications.

1.6 FISHING GEAR AND FISHING GROUNDS

1.6.1 Fishing gear

Nancy Glen was configured as a twin rigged prawn trawler with port and starboard nets stored on a split net drum. The Harkness prawn nets had approximately 7.6m of rockhopper disc ground gear connected to rubber covered link chain, giving an overall ground gear length of 17.7m. The nets were connected to 2m Dunbar trawl doors and a 400kg clump weight (**Figure 6**). The towing gear comprised 400m of 14mm rubber covered wire warps.

Once deployed, each of the three warps (two towing warps and the clump weight) was connected to the single towing point on the banana bar using a chain stopper (**Figure 7**). This arrangement allowed the vessel to turn more quickly as the load and the effective towing point was free to move along the bar as the vessel manoeuvred. For trawling in Lower Loch Fyne, approximately 400m of warps were deployed.

On completion of each tow, the nets were recovered using the trawl winch. The cod ends were then lifted using a Gilson winch, which allowed the catch to be discharged through the access hatch in the shelter deck and deposited on the main deck.

Photograph courtesy of David McAllister



Figure 5a: *Nancy Glen* – previous Guerra crane

Photograph courtesy of John MacDougall



Figure 5b: *Nancy Glen* – replacement Thistle crane

Image courtesy of Seafish

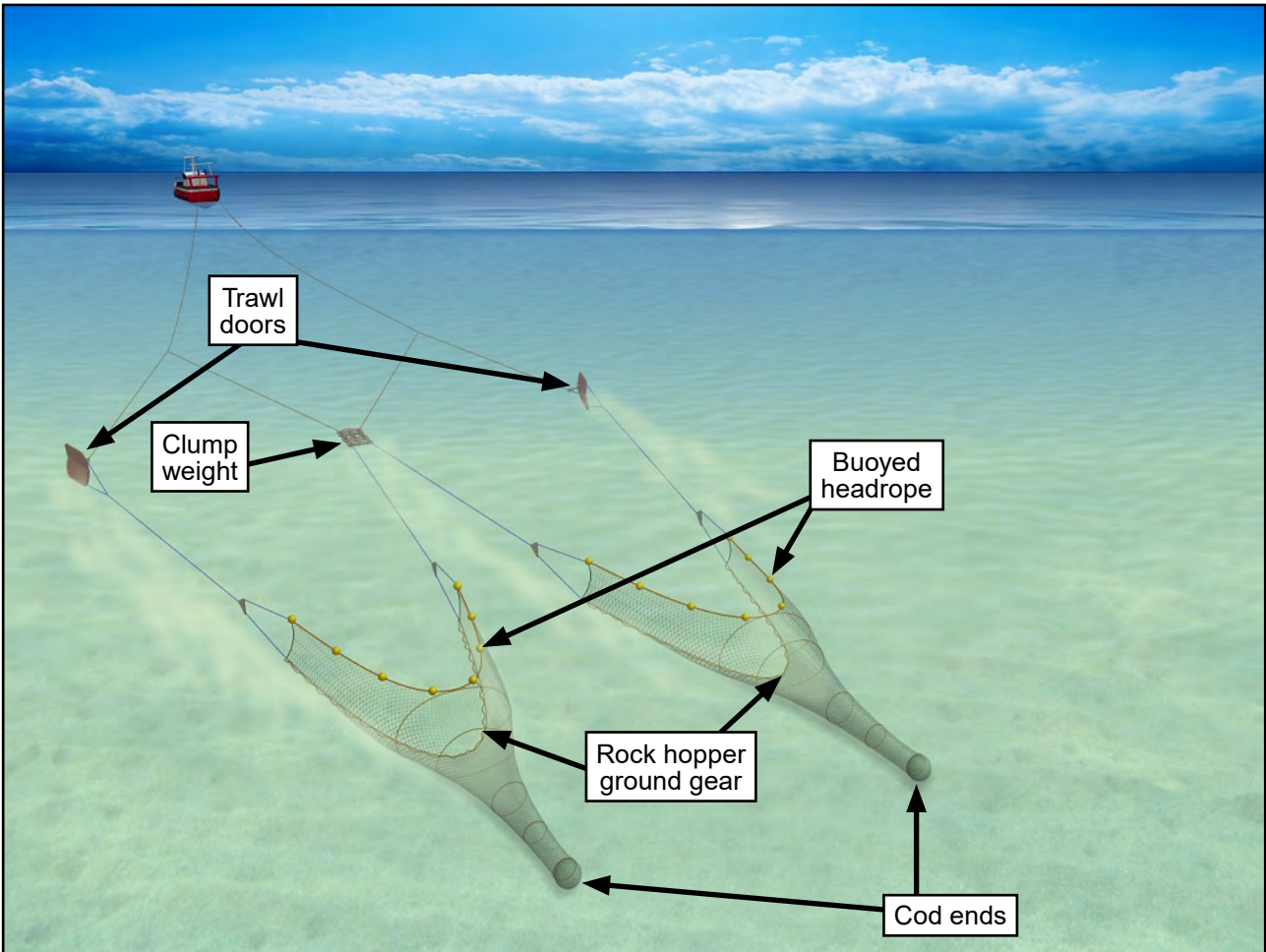


Figure 6: General arrangement of twin rigged prawn trawling



Figure 7: *Nancy Glen's* trawling arrangement showing the net drums, towing chains and banana bar

1.6.2 Lower Loch Fyne seabed

Admiralty charts for *Nancy Glen's* regular fishing grounds indicate that the seabed consists of mud and broken shells. They also identify a permanent obstruction (known locally as 'the anchor') approximately 0.5nm south of the accident location.

Trawlers operating in the area, including *Nancy Glen*, had reported instances of 'muddied doors'⁵ and choked nets.

1.7 UNDERWATER SURVEY

1.7.1 *SD Northern River*

Immediately following the foundering of *Nancy Glen*, *SD Northern River* deployed a remotely operated vehicle (ROV) to locate the wreck and to ascertain whether further rescue attempts could be initiated. The ROV was operated by a team from JFD⁶, who were on board *SD Northern River* and had been training with the NATO Submarine Rescue System.

⁵ A phenomenon whereby a trawl door collapses and becomes buried in the seabed, causing a sudden load to come onto the fishing gear. This usually occurs as the vessel is turning, and can be countered by applying astern propulsion and coming back over the trawl gear.

⁶ Part of James Fisher and Sons plc, JFD incorporates Divex, James Fisher Defence and the National Hyperbaric Centre (NHC). JFD operates in a number of different market sectors including offshore, inshore and onshore commercial diving, defence diving, submarine rescue, hyperbaric medical and renewable energy.

Despite poor visibility the ROV operators located the wreck of *Nancy Glen* and positioned a locator beacon close to it on the seabed. Attempts to map the wreck site using sonar were unsuccessful due to obstructions that ultimately resulted in damage to the ROV.

1.7.2 Northern Lighthouse Board

The MAIB requested NLV *Pharos*, a lighthouse tender operated by the Northern Lighthouse Board (NLB), to survey the seabed around the wreck site using multi-beam sonar. However, due to the depth of water no usable imagery was gathered from the survey attempt.

1.7.3 MAIB survey

After an initial case review, the MAIB decided to carry out an underwater survey to gather evidence from *Nancy Glen*'s location; specifically the condition of the vessel and its trawling equipment. It was decided that side scan sonar imagery, coupled with underwater video footage, could be analysed to determine whether to consider raising the wreck in order to support the investigation.

1.7.4 Side scan and ROV survey

Following a commercial tendering process, the MAIB awarded Keynvor MorLift Ltd a contract to carry out an underwater survey of the wreck site. The site was initially mapped using a 'towed fish' side scan sonar. This was followed by the deployment of an ROV fitted with video and multi-beam sonar.

The side scan sonar survey showed two distinct debris fields on the seabed: one below the position where *Nancy Glen* capsized, and a second in the vicinity of its final location on the seabed. Identifiable items included one of the shelter deck prawn storage tanks and a number of tubed prawn boxes (**Figure 8**).

The ROV survey showed that the ventilation hatch in the deckhead of the accommodation was closed and the access hatch from the shelter deck to the main deck was open.

Sonar images revealed that the trawl nets were lying in an east/west direction on the seabed⁷. The images showed that the port net was on top of the seabed with the buoyed headrope floating and the mouth of the net open. The starboard net was buried with the buoyed headrope close to the seabed (**Figure 8**).

Although the video survey was hampered by poor visibility, images confirmed that the port net was open with the rockhopper ground gear on the seabed and the buoyed headrope floating free. The starboard net was found to be buried with the buoyed headrope lying on the seabed. Further examination indicated that the main body of the starboard net was filled with mud from the seabed (**Figure 9**).

1.7.5 Wreck recovery

As directed by the Scottish Government, on 13 April 2018 the wreck of *Nancy Glen* was raised from the seabed and taken to a secure location ashore. The bodies of both missing fishermen were recovered from inside the wreck.

⁷ The trawl gear was lying east/west but the nets had been disturbed through the action of local trawlers assisting in the search post-accident and before the sonar survey was conducted.

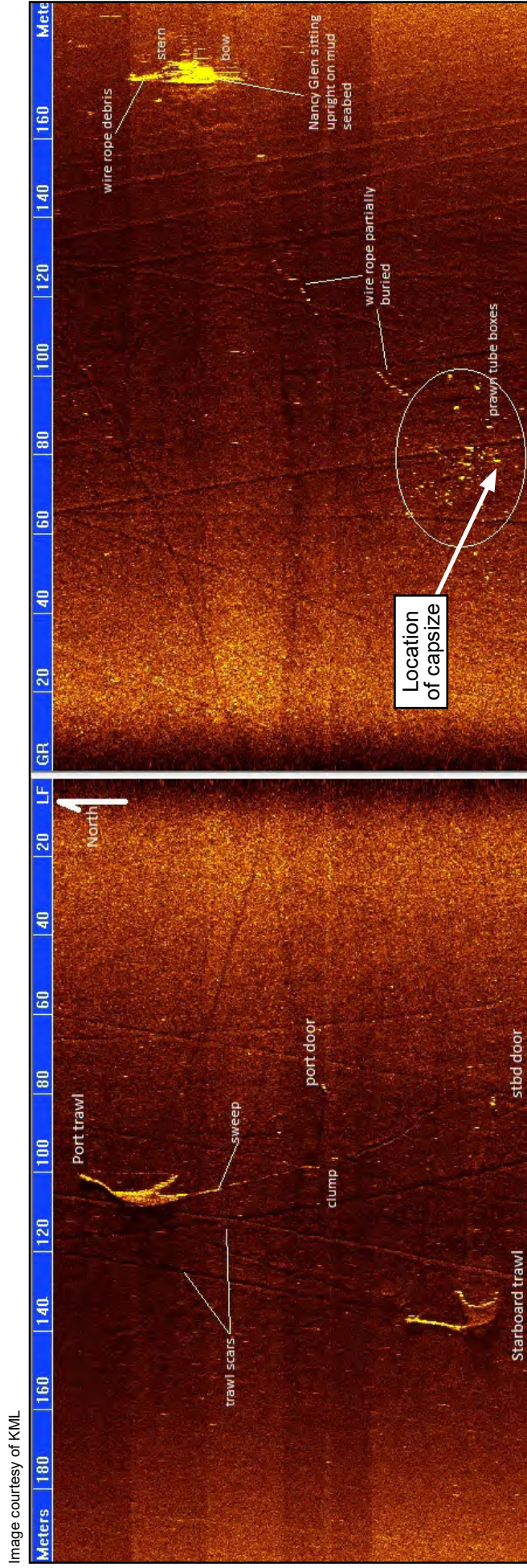


Figure 8: Sonar imagery of seabed showing the debris field, *Nancy Glen* and configuration of the nets



Figure 9: ROV imagery showing *Nancy Glen*'s starboard net

1.8 STABILITY

Stability is the capacity of a vessel to return to an upright condition following a heel. Stability is dependent on the vessel's weight and buoyancy and is determined by the relationship between the vertical centre of gravity (VCG)⁸ and the vertical centre of buoyancy (VCB)⁹.

A vessel's metacentric height (GM) is a measurement of its initial static stability. GM is calculated as the distance between the vessel's VCG and its metacentre¹⁰. A larger GM implies greater initial stability against overturning. As well as GM, reserve of buoyancy and righting levers are important.

With positive stability, as a vessel heels, a righting lever (GZ) is created between the forces acting from the VCB and VCG as the shape of its underwater volume changes. This righting lever creates a restoring moment to bring the vessel upright.

⁸ The centre of gravity is the point where the mass of a vessel is acting downward. It is affected by the construction and layout of the vessel and the weight and location of equipment. The centre of gravity will alter if weights are moved, added or removed, but is not affected by the vessel's motion.

⁹ Buoyancy is a vessel's ability to float. All of the hull below the waterline contributes to a vessel's total buoyancy. The centre of buoyancy moves depending on draught, trim and heel.

¹⁰ Metacentre is a point through which the force of buoyancy acts on a vessel. If a line of buoyancy force is extended it will meet the line of gravitational force. This point of intersection is called the metacentre.

The righting lever increases to a maximum when the angle of heel corresponds to deck edge immersion, thereafter it reduces as the vessel heels further and water floods the deck.

A vessel's original VCG can be altered by modifications involving the addition, removal and/or relocation of weight, and changes to its freeboard¹¹.

1.9 STABILITY ASSESSMENTS

1.9.1 Assessment in 2002

Prior to undertaking the 2002 modifications to *Nancy Glen*, a naval architect, who was contracted by the owners to develop the work package, undertook a simplified intact stability calculation with the aim of confirming that the proposed modifications would provide a safe level of stability.

No stability information was required under the extant regulations when *Nancy Glen* was constructed in 1991. In addition, there were no build drawings (line plans etc.) available to the naval architect. He therefore based his calculations using the hydrostatics from a similar vessel, FV *Aeolus*, in the 'depart port' condition for which his company had produced a stability book.

Vessel	Waterline length	Beam
FV <i>Aeolus</i>	13.1	5.25
FV <i>Nancy Glen</i>	12.7	5.0

The naval architect carried out an inclining experiment on *Nancy Glen* in April 2002 and calculated that its GM was approximately 0.37m. The minimum requirement stated in The Fishing Vessels (Safety Provisions) Rules 1975 for GM for vessels of 12m or more registered length (L) was 0.35m. He then calculated the effect of the proposed modifications (including a margin of error) and concluded that post-modification the GM would be reduced to 0.35m.

In addition, the naval architect used the information collected from the inclining experiment to derive a factor of safety as recommended in the Seafish Construction Standards issued in 2001. The calculated safety factor of 1.23 exceeded the minimum recommended factor of 1.0. The factor of safety method was not retained when the Seafish Construction Standards were updated in 2004.

As a result of his calculations, the naval architect wrote to *Nancy Glen*'s owners suggesting that the modifications could be carried out but that top weight should be kept to a minimum.

1.9.2 MAIB calculations

Nancy Glen was not inclined, or lightship checked during the 16 years of its life prior to the accident on 18 January 2018. Unlike vessels of 15m or more length overall (LOA), *Nancy Glen* was required neither to satisfy intact stability criteria nor to be assessed at least every 5 years to ensure the vessel had not sustained weight growth, which could have invalidated the stability information¹².

¹¹ Freeboard is a measure of the height of a vessel's side between the waterline and the highest watertight deck.

¹² Built in 1991, with a length overall of 12.98m, *Nancy Glen*'s registered length was 11.98m, which meant that stability criteria for fishing vessels under 12m registered length did not apply.

The MAIB has identified the following modifications made to *Nancy Glen* since 2002:

- installation of the Kort nozzle and subsequent ballast adjustment;
- replacement of the steel communications mast with a lighter aluminium structure;
- use of the aluminium prawn storage tanks;
- use of the IBC container, and;
- replacement of the crane on the shelter deck.

When using the prawn storage tanks, *Nancy Glen* no longer carried ice in the fish hold. Concurrent with the crane replacement, the cod end lifting arrangement was also modified, replacing steel with aluminium to reduce top weight. The weight of equipment taken off and the equipment added were not recorded (**Figure 10**).

Image courtesy of John MacDougall

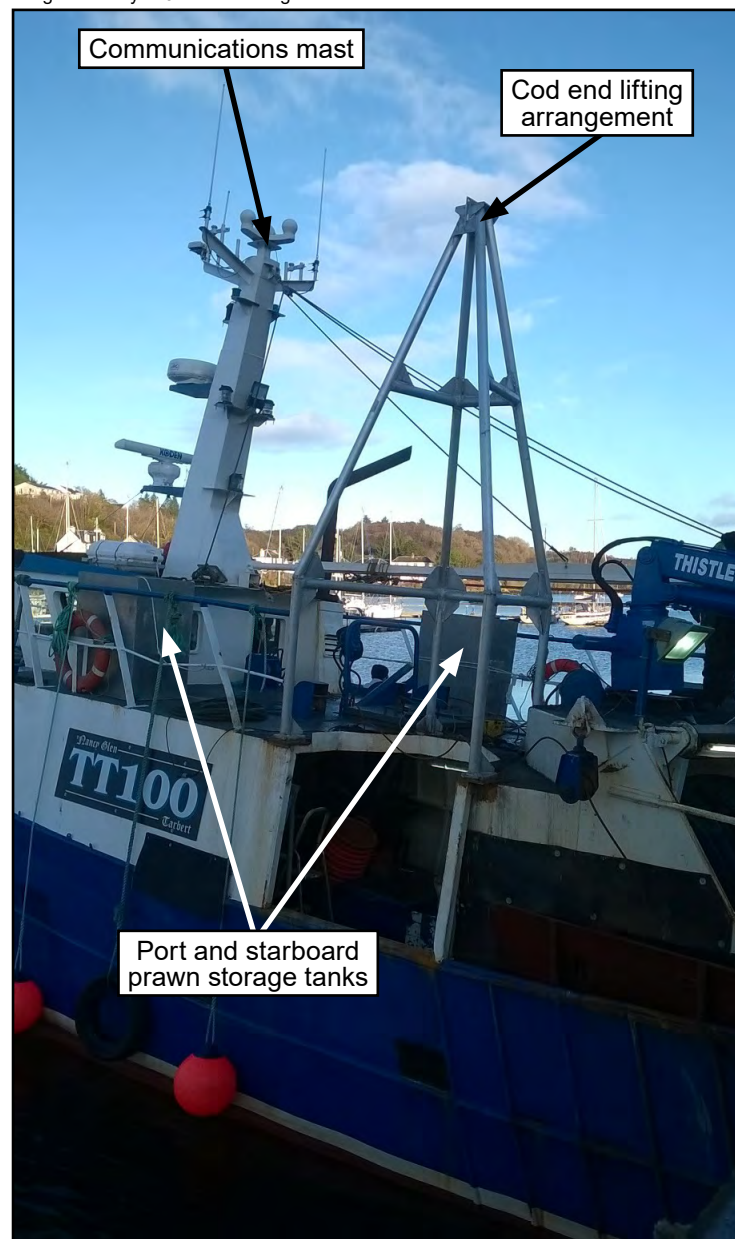


Figure 10: *Nancy Glen* – aluminium prawn storage tanks and lifting arrangement

Following the recovery of *Nancy Glen*, a team of marine consultants was engaged to develop a computer model of the vessel, using 3D imaging and laser scanning. The model was subsequently used to carry out stability calculations.

Nancy Glen was inclined by the consultants with an MAIB naval architect in attendance. The results of the inclining trial and the 3D model were used by the MAIB to enable an assessment of the vessel's stability.

All available evidence, including approximate figures for modifications through the vessel's life, were assessed and used to estimate *Nancy Glen*'s stability at the time of loss. By reviewing the modifications undertaken to the vessel it was also possible to estimate *Nancy Glen*'s stability in 2002.

Calculations indicate that following the modifications made in 2002, and although the regulations did not apply, *Nancy Glen* would not have satisfied the intact stability criteria¹³ for fishing vessels over 15m length overall, and it is also unlikely that the vessel would have satisfied these criteria at build. **Table 1** summarises the vessel's through life stability, based on the depart port condition, i.e. 100% fuel, water, lubricating oil, with fishing gear and 1t of ice in the fish hold.

	Displacement (t)	Trim by stern (m)	GM (m)	Max GZ (m)
2002 after modifications	70.45	0.46	0.281	0.099 @ 24°
2012 fitting Kort nozzle	71.45	0.55	0.299	0.101 @ 23°
2016 removal of ballast	70.45	0.47	0.292	0.103 @ 24°
2018 after crane renewal	71.44	0.59	0.232	0.075 @ 20°

Table 1 - *Nancy Glen* - estimated stability through life

The table only includes the modifications for which figures can be estimated. Other modifications¹⁴ have not been accounted for as no weights of equipment, added or removed, were recorded.

Nancy Glen's condition at the time of loss was estimated with fuel at 70%, two prawn tanks on the upper deck and the IBC container on the main deck (all filled with seawater/catch), and the fishing gear deployed over the stern.

1.9.3 Vertical load

The vertical load for which the vessel just achieved a positive righting lever with the load suspended from the banana bar towing point, at its maximum starboard extent, was then estimated both before and after replacing the crane on the shelter deck.

With the original Guerra crane, *Nancy Glen* nominally had positive stability with a 6t vertical load offset on the banana bar. After replacing the crane with the heavier Thistle Marine Crane this load dropped to 4t, a 33% reduction in the load the trawl gear could experience before *Nancy Glen*'s stability became negligible.

¹³ The over 15m intact stability criteria would require a minimum GM of 0.35m and a minimum righting lever (GZ) of 0.2 at 30° or greater with the maximum GZ occurring at not less than 25°.

¹⁴ Other modifications included replacing a steel communications mast with an aluminum structure and fitting a lighter stern roller.

1.10 DEVELOPMENT OF REGULATIONS AND GUIDANCE RELATING TO STABILITY

1.10.1 2001 Code of Practice

A wide range of safety standards, including stability criteria for fishing vessels, was introduced in The Fishing Vessels (Safety Provisions) Rules 1975 (known as the 1975 Rules). These rules first introduced mandatory intact stability criteria for all vessels of 12m registered length (L) and over. The 1975 Rules were amended with the introduction of The Fishing Vessels (Code of Practice for the Safety of Small Fishing Vessels) Regulations 2001. The full text of the Code was set out in the Maritime and Coastguard Agency's (MCA) Merchant Shipping Notice (MSN) 1756 (F) – The Fishing Vessels Code of Practice for the Safety of Small Fishing Vessels under 12 metres in length. Amendment 1 to MSN 1756 (F) was introduced in 2002 and stated that *all previous references to under 12m registered length will now read under 15m length overall and apply to the whole Code*. This amendment effectively removed the requirement for stability criteria to be applied to any fishing vessel under 15m LOA.

There was no requirement in the 2001 Regulations, nor in MSN 1756 (F), either to assess a vessel's stability or to advise or record equipment or material changes to existing vessels. New vessels, defined as those whose keel was laid or construction or lay-up was started after 1 April 2001, were required to comply with construction standards issued by Seafish or to an equivalent standard. Notwithstanding this, the construction standards did not require a formal stability assessment.

1.10.2 Wolfson guidance

In May 2006, the University of Southampton's Wolfson Unit completed a research project commissioned by the MCA aimed at developing loading guidance for small fishing vessels (nominally under 15m LOA).

The project's report proposed a method of generating simplified stability guidance linked to recommended maximum wave heights through the application of a freeboard mark on the hull referenced to a stability notice displayed in the wheelhouse. The guidance derived from the Wolfson stability notice and mark is intended to provide fishermen with a basic indication of safety based on a vessel's residual freeboard when loading and lifting, and the sea state.

For decked vessels with no stability data, only a vessel's LOA and breadth are required to calculate where to position the freeboard guidance marks, and the corresponding safety zones. The safety zones are:

- **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 capsizing' unless restricted to calm conditions and used with extreme caution.

The report recommended:

'That guidance freeboard marks be placed on fishing vessels for which the guidance information is based on freeboard alone. These will enable the fishermen to relate the guidance information to his vessel directly.' [sic]

1.10.3 MGN 332 (M+F)

The MCA's Marine Guidance Notice (MGN) 332 (M+F) - The Merchant Shipping and Fishing Vessels (Lifting Operations and Lifting Equipment) Regulations 2006 (LOLER), provided requirements for the fitting and operation of lifting equipment. Guidance for the implementation of Regulation 6 stated the following:

'In addition to the vessel's structure, consideration must be given to the effect upon stability, angle of heel and consequent down-flooding from the use of a crane, derrick or other lifting device fitted on any vessel. This is especially important where cranes are fitted on work boats and other small vessels and MCA would strongly recommend that advice is sought from the crane manufacturer where it is proposed to fit cranes on such vessels. In addition it is recommended that prior to installation a check of the vessel's stability should be carried out by a suitably qualified person to ensure that the vessel is capable of operating safely with the crane fitted and in use. Failure to do this could have serious consequences. Information and instruction on these effects as well as maximum safe working loads, including variable maximum safe working loads where these vary with the crane configuration, must be given to the master or skipper of the vessel.'

1.10.4 2007 Code of Practice

In 2007, the 2001 Code was revised (and annexed to MSN 1813 (F) - The Fishing Vessels Code of Practice for the Safety of Small Fishing Vessels). The stated aim of the revised Code was to improve the safety of fishing vessels of less than 15m LOA. MSN 1813 (F) included a recommendation that stability information be provided for fishing vessels of 12m L to 15m LOA (**Annex A**), and the Code recommended that owners arrange for a lightship check at intervals not exceeding 5 years to verify that their vessel's stability information remained valid.

The stability information recommended by MSN 1813 (F) referred to that contained in sections 16 and 74 of The Fishing Vessels (Safety Provisions) Rules 1975 (**Annex B**).

1.10.5 MGN 427 (F)

In December 2010, the MCA published MGN 427 (F) – Stability Guidance for Fishing Vessels of under 15m Overall Length (**Annex C**).

The MGN stated that full stability requirements for 12m L to 15m LOA fishing vessels would be reintroduced in the near future, and indicated that there was no intention to introduce compulsory stability criteria to fishing vessels under 12m L.

The MGN stated that while no specific requirements existed for the stability of small fishing vessels, the owner, skipper and others had legal responsibilities as detailed in The Merchant Shipping and Fishing Vessels (Health and Safety at Work) Regulations 1997, and that it was not acceptable to do nothing and assume

the vessel's stability was satisfactory. It further stated that it was better to assess the situation or obtain professional advice, and offered five methods of stability assessment:

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

MGN 427 (F) also stated that a notice entitled 'Simple Efforts for Maintaining Stability' or similar should be posted in a prominent position on board a fishing vessel, and that skippers and crew should attend Seafish stability awareness training (Section 1.11.1).

1.10.6 MGN 502 (F)

In April 2014, MGN 502 (F) - The Code of Practice for the Safety of Small Fishing Vessels - Standards which can be used to prepare for your MCA Inspection, was published. This MGN provided a voluntary small fishing vessel code of practice that was based on MSN 1813 (F) and considered the findings of a number of MAIB investigations (Section 1.13). Its recommendations included:

- Substantial modifications or alterations to be notified to the MCA prior to work taking place.
- Stability requirements for vessels of 12m L to less than 15m LOA.

1.10.7 MGN 503 (F)

Also issued in April 2014 was MGN 503 (F) – Procedure for Carrying out a Roll or Heel Test to Assess Stability for Fishing Vessel Owners and Skippers. This was intended to allow owners/skippers of small fishing vessels to assess whether their vessel was tender or stiff in a particular condition (**Annex D**).

1.10.8 Fishermen's Safety Guide

In May 2015, the MCA published an updated version of the Fishermen's Safety Guide – A guide to safe working practices and emergency procedures for fishermen. As in previous versions, the guide provided advice on a wide range of operating practices on board fishing vessels. A section on stability explained the effect on a vessel's centre of gravity of: lifting a load from a high point, loose water or fish on deck, loading and unloading, and freeboard (**Annex E**).

1.10.9 2017 Code of Practice

On 23 October 2017, Statutory Instrument 2017 No. 943 (SI 943), The Fishing Vessels (Codes of Practice) Regulations 2017 came into force. Article 7(1) of SI 943 placed an obligation on the owner of a UK registered fishing vessel to notify the MCA¹⁵ *'of the details of any proposal to alter or modify the structure of that vessel, remove or reposition engines or machinery or change the mode of fishing'*.

Following publication of SI 943, the MCA withdrew MSN 1813 (F) and MGN 502 (F) and replaced them with MSN 1871 (F), The Code of Practice for the Safety of Small Fishing Vessels of less than 15m LOA. MSN 1871 (F) included a statement that *'...substantial modifications or alterations affecting the vessel's dimensions, structure or stability, the removal or repositioning of machinery or engines, changes in the vessel's mode of fishing and/or its gear or the fitting of additional equipment shall only be undertaken after consultation and with the MCA's approval to ensure it complies with the requirements of the Code, as applicable to a new vessel, to the satisfaction of the MCA.'*

MSN 1871 (F) also required new fishing vessels of 12m L to less than 15m LOA, and vessels that were built before 2007 and coming on to the UK fishing register for the first time, to have approved stability information relevant to their intended method of operation.

1.11 STABILITY AWARENESS

1.11.1 Training

Seafish provided stability awareness training for fishermen at 'new entry' 'experienced' and 'advanced' levels. The courses were provided free of charge and completion of stability training was a prerequisite for award of the Seafish voluntary under 16.5m Skipper's Certificate.

The courses, which used a series of visual animations and a model boat, were specifically designed to explain key aspects of stability and to provide skippers and crew with a greater understanding of the issues involved. The model boat featured an interchangeable structure to simulate a range of different fishing vessel types and, in conjunction with a water tank and a variety of weights, a range of operating conditions could be tested to reflect the dangers of additional top weight, free surface effect, catch on deck etc.

The stability awareness training included:

- The principles of flotation as they apply to fishing vessels.
- The terms used to describe basic vessel stability.
- How the movement of weight can influence a vessel's stability.
- The different states of vessel equilibrium.
- How the hauling of gear and landing of catch influence a vessel's stability.

¹⁵ The wording used in the SI is 'Secretary of State', which in practice is the MCA.

- Free surface effect.
- Roll periods.
- Weight 'creep' or growth.

To further impress upon fishermen the importance of these issues, specific MAIB accident investigations were highlighted. An end of course multiple-choice assessment required a pass mark of 70%.

1.11.2 RNLI campaign

In January 2015, the RNLI initiated a campaign aimed at improving the stability awareness of commercial fishermen, specifically targeting vessels of less than 15m LOA.

The campaign was entitled 'Keep it Stable, Bring it Home', and featured five short videos giving practical advice on the hazards associated with:

- Vessel modifications.
- Free surface effect.
- Hauling operations.
- Overloading.
- Watertight integrity.

The videos were distributed to fishermen via social media.

1.12 MCA INSPECTIONS

Under MSN 1813 (F) The Code of Practice for the Safety of Small Fishing Vessels, the owners of under 12m L fishing vessels were required to present their vessels for inspection by the MCA every 5 years and to carry out annual self-certification to confirm that the vessel complied with the Code. Records show that *Nancy Glen* was inspected by the MCA in 2005, 2010 and most recently on 24 July 2015. During the 2015 inspection a number of deficiencies were noted. These included:

- No fire detection in machinery spaces.
- Smoke alarm not fitted in accommodation.
- Fish hold bilge alarm not fitted.
- Engine room bilge pipe holed and heavily corroded.

These defects were promptly rectified, and the MCA was notified. A Small Fishing Vessel Inspection Certificate (MSF 1316) was then issued in December 2015 with an expiry date of 23 July 2020.

1.13 PREVIOUS ACCIDENTS

1.13.1 *Stella Maris*

On 28 July 2014, the 9.96m LOA trawler *Stella Maris* capsized and sank while hauling fishing gear. The vessel's two crew were uninjured. *Stella Maris* had been significantly modified prior to its loss, including the fitting of an 'A' frame gantry and a winch for lifting the cod end. No calculations had been required or carried out regarding the effects of this work on the vessel's stability.

The subsequent MAIB investigation report¹⁶ identified that *Stella Maris* capsized as a result of insufficient stability due to an overly high gantry supporting a heavy cod end lifted by a winch with excessive power. *Stella Maris* had a sister vessel that had been similarly modified.

The report highlighted a number of small fishing vessel losses (*Heather Anne, Sally Jane, Charisma, Kirsteen Anne, Amber* and *Auriga*) that had resulted from insufficient stability. It also identified countries that required intact stability criteria for small fishing vessels, including: Norway, New Zealand, the Republic of Ireland, Denmark, Greenland, Canada, Poland and Russia.

Following the accident, the MCA undertook to:

*'Include a requirement for fishing vessel owners to notify and seek approval from the agency prior to carrying out substantial modifications in MGN 502.'*¹⁷

The MCA was also recommended (MAIB recommendation 2015/165) to:

'Introduce intact stability criteria for all new and significantly modified decked fishing vessels of under 15m in length.'

This recommendation was accepted by the MCA, which stated that:

'...as part of our work to progressively align the standards of the Small Fishing Vessel Code with the Workboat Code, the MCA will consider the application of suitable stability standards for new and significantly modified vessels of under 15m.'

The MCA's target date for the completion of this action is 31 December 2020.

1.13.2 *JMT*

During the afternoon of 9 July 2015, routine contact was lost with the skipper and crewman on board the 11.4m LOA scallop dredger *JMT*, which was fishing off Plymouth, England. A search and rescue operation was initiated the following morning when the vessel did not return alongside as expected. The body of the crewman was found floating in a life-ring; he was not wearing a lifejacket. The wreck of the vessel was located 3.8 miles off Rame Head in a depth of 51m but its skipper was not found. There was no pollution and *JMT* was recovered from the seabed the following month.

¹⁶ MAIB report no 29/2015.

¹⁷ This was included in the voluntary code introduced through MGN 502 (F) and subsequently became a mandatory requirement following the introduction of MSN 1871 (F).

The MAIB investigation¹⁸ identified that:

- *JMT* had only 25% of the reserve of stability required for larger fishing vessels.
- The vessel's stability had been adversely affected by structural modifications and by aspects of its operation.
- Capsize was possibly triggered by the release of the contents of the starboard dredges while the port dredges and their contents remained suspended.

The MCA was recommended (MAIB recommendations 2016/130 and 2016/131) to:

'Include in its intended new legislation introducing stability criteria for all new and significantly modified decked fishing vessels of under 15m in length a requirement for the stability of new open-decked vessels, and all existing vessels of under 15m to be marked using the Wolfson Method or assessed by use of another acceptable method.'

'Require skippers of under 16.5m fishing vessels to complete stability awareness training.'

The MCA's target date for implementing appropriate action in response to both of the above recommendations is 31 December 2020.

¹⁸ MAIB report no 15/2016

SECTION 2 - ANALYSIS

2.1 AIM

The purpose of the analysis is to determine the contributory causes and circumstances of the accident as a basis for making recommendations to prevent similar accidents occurring in the future.

2.2 FATIGUE

There is insufficient evidence to conclude with certainty that fatigue contributed to this accident. However, the cumulative effect of long working days (routinely 20 hours from port departure to arrival for 5 days each week) could have impacted on the crew's ability to react to an emergency. Long hours with limited breaks remain a common feature of commercial fishing.

2.3 THE ACCIDENT

Evidence gathered during the investigation indicates that unexpected weight came onto the starboard trawl, causing *Nancy Glen* to heel heavily to starboard. The heel was exacerbated as the vessel turned to starboard. *Nancy Glen* was unable to recover from the heel and rapidly capsized; it initially remained inverted on the loch surface.

As *Nancy Glen* rolled over, one crewman was able to escape from the accommodation, scramble across the main deck and jump over the vessel's stern; the remaining crewman and the skipper remained trapped in the upturned hull. The vessel then foundered by the stern and sank to the seabed in approximately 143m of water.

The focus of the MAIB investigation and subsequent analysis has been centred on the reason for *Nancy Glen*'s sudden heel to starboard, why it failed to recover from the heel and why the skipper and one crewman were unable to escape from the vessel.

2.4 LOSS SCENARIO

Underwater surveys following the loss of *Nancy Glen* show that the port net was empty and on top of the seabed while the starboard net was full of mud and largely buried beneath the seabed surface.

It is concluded that *Nancy Glen*'s turn moved the single towing point to starboard due to the banana bar arrangement and this, coupled with the increased load from the fouling of the starboard net, resulted in the heel. The vessel's righting lever was insufficient to overcome the effect of the heeling moment. Consequently, *Nancy Glen*'s stability was insufficient to overcome the combined effect of these factors and so was unable to prevent the vessel from capsizing.

The accepted industry practice, and that exercised on *Nancy Glen*, was to attempt to recover from any excessive heel by reducing the towing load. This can be achieved by either reducing the vessel's forward momentum by putting the propulsion into neutral and thus allowing the vessel to 'come back' onto the gear or releasing the fishing gear in its entirety.

On this occasion, the heeling moment developed rapidly to a point at which the vessel's righting lever vanished before the skipper was able to take any effective restorative action.

The survivor recognised that the heel was significant and that the vessel did not appear to be recovering, so he immediately exited the accommodation to escape from the capsizing vessel. In the very short time that it took for him to climb the companionway from the accommodation to the wheelhouse and escape onto the main deck, *Nancy Glen* was already on its side and close to capsize. He had shouted to his crewmate to follow him out, and during his rapid transit of the wheelhouse, shouted at the skipper to leave the stricken vessel.

The crew of *Nancy Glen* was not concerned when the boat initially started heeling as this was not unusual and the vessel would normally level out as the turn completed. Despite one crewman dashing to escape, it is highly likely that the skipper remained in the wheelhouse to take actions intended to bring the situation under control. In darkness, it will also have been difficult to visually judge the boat's loss of forward momentum as the starboard net dug into the seabed. Moreover, the rapid subsequent capsize, inrush of water to the wheelhouse, displacement of loose gear and disorientation will have denied the skipper and second crewman the chance to escape.

2.5 LOSS CONDITION

Snags or fasteners, 'muddied doors' and debris in the nets, are an acknowledged heeling hazard experienced by bottom trawling fishing vessels. But vessels are normally able to recover from these situations, particularly those vessels that meet the stability criteria currently required for new or significantly modified fishing vessels of 12m L or more. During the summer of 2017, both of *Nancy Glen*'s nets had filled with mud and seaweed while trawling. The nets were recovered as far as possible onto the net drums and the cod ends were secured to the transom until divers could be arranged to release the cod ends and clear the debris.

Nancy Glen had operated successfully since the modifications carried out in 2002, and had continued to operate without incident following the various modifications to its structure and equipment. However, the cumulative effect of those modifications, culminating in the replacement of the crane during the 2017/18 Christmas layover, was to reduce the vessel's stability, significantly increasing its vulnerability to capsize.

Figure 11 shows *Nancy Glen*'s GZ curves derived from the 2018 inclining compared with a GZ curve meeting the minimum stability requirements for a vessel over 15m LOA (curve a). The curves b, c and d were calculated with the vessel full of fuel and with ice in the fish hold. Curve e was the estimated departure condition on 18 January 2018 (70% fuel and no ice but with the three prawn tanks full of water).

In addition to *Nancy Glen*'s increased inherent top weight, as the week's fishing progressed the amount of fuel, stored low in the vessel, would have decreased. Assuming that *Nancy Glen* had departed Tarbert Harbour with full tanks on 15 January, it is likely to have used approximately 1200l of fuel by the time of the accident, equating to approximately 1t of weight being removed from low down in the vessel and consequently raising its VCG.

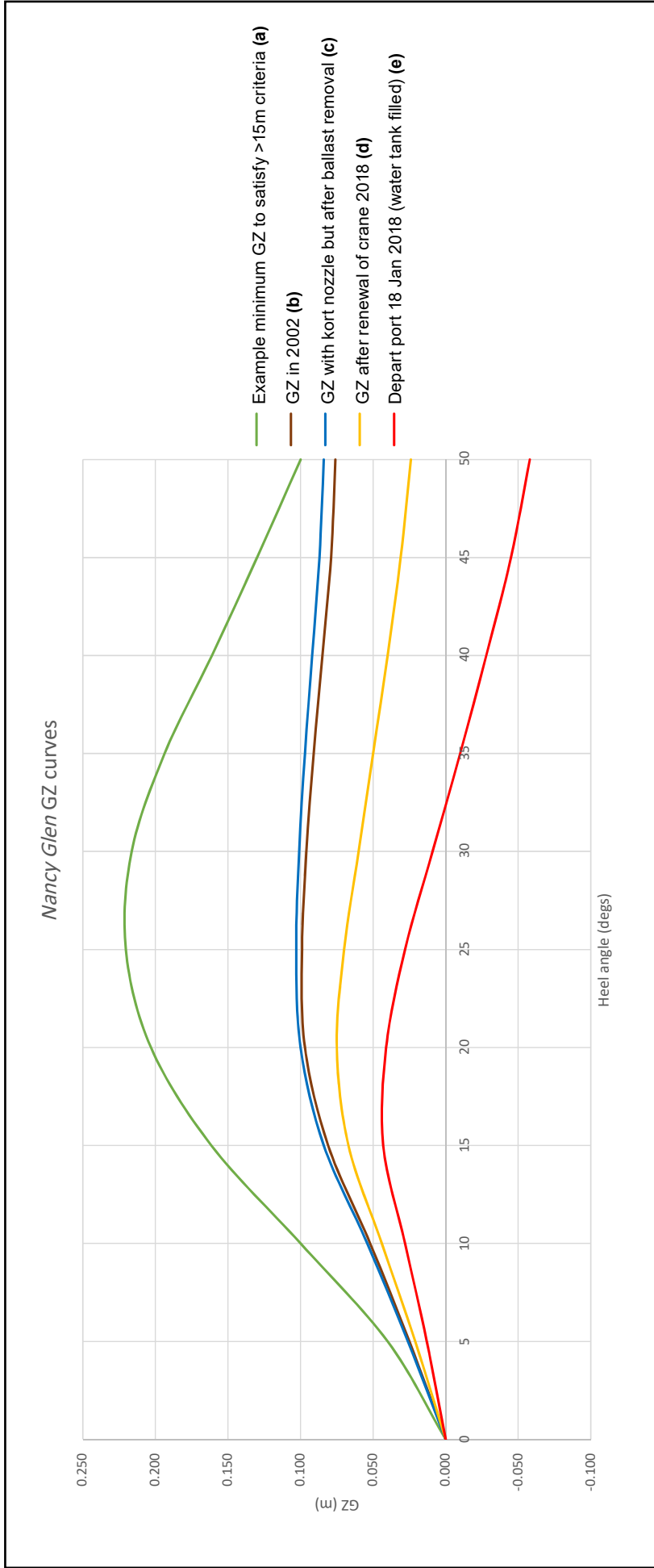


Figure 11: Graph showing a minimum required GZ curve for over 15m LOA fishing vessels compared with results from Nancy Glen calculations

2.6 CONSIDERATION GIVEN TO THE EFFECT OF MODIFICATIONS

2.6.1 2002 stability assessment and modifications

Nancy Glen's reduced stability can be directly attributed to the effect of the modifications carried out to the vessel since 2002.

The modifications completed in 2002, which included both replacement of machinery (net drums and crane) and alterations to the vessel's structure (shelter deck extension), fell outside any regulatory requirement, at the time, to assess the vessel's stability or to notify the MCA. Nonetheless, the action of the owners to engage a naval architect to plan the changes, and his subsequent stability calculations, demonstrated an awareness of the need to monitor the potential effects of the modifications on the vessel's stability. These alterations were carried out to increase the utility of the main deck and improve crew working conditions through extension of the shelter, to improve handling of the nets, and to allow transfer of nets and equipment to the quayside (the original Palfinger crane would not plumb the jetty at Tarbert Harbour).

The MAIB calculations using a model developed from the post salvage inclining of *Nancy Glen*, indicate that, despite the use of a factor of safety, the theoretical calculations completed in 2002 are likely to have resulted in an optimistic estimate of the vessel's initial stability (GM).

Although the inclining carried out in 2002 allowed an estimate of *Nancy Glen's* GM, the lack of empirical stability data from build prevented the naval architect from assessing the righting lever curve. Although not directly applicable to *Nancy Glen*, the MAIB's calculations indicate that the righting lever in 2002 would have fallen short of the intact stability criteria applied to fishing vessels of over 15m LOA.

2.6.2 The Kort nozzle

In 2012 *Nancy Glen* was fitted with a Kort nozzle to improve both fuel efficiency and towing characteristics. In order to accommodate the nozzle and improve the rudder post arrangements, additional stiffening of the support structure was required. The additional support work was completed on the advice of a naval architect, and a boatyard engineer was consulted on the Kort nozzle fitment. Although published stability guidance had been introduced in the form of MGN 427 (F) for fishing vessels of under 15m LOA, no empirical calculations were carried out prior to this modification. However, additional weight would have improved the vessel's overall GM, and also increased the vessel's stern trim by approximately 0.1m to the detriment of wheelhouse visibility, particularly while towing.

2.6.3 2016 proposed modifications

The 2016 proposal to raise the height of the wheelhouse to improve visibility, and to relocate the net drums, was not completed following advice from a naval architect. It would have been possible to raise the wheelhouse height by replacing the steel structure with aluminium, but it was decided that the benefit would be outweighed by the cost. The relocation of the net drums was vetoed as this would have had a detrimental effect on the vessel's top weight. The decision to replace the steel communication mast with an aluminium structure was taken as a measure to reduce

top weight. The employment of a naval architect to advise on these proposed changes again demonstrated an awareness of the need to consider the effect of modifications on vessel stability.

The subsequent removal of concrete ballast from the fish hold, carried out to adjust the vessel's trim in order to improve wheelhouse visibility, was not carried out with professional advice. The removal of concrete ballast could be considered a structural modification that MGN 502 (F) recommended should be notified to the MCA prior to the work taking place. It is estimated that around 1t of ballast was removed, but it is likely that it equated approximately to the additional weight of the Kort nozzle. The MAIB's calculations estimated that removal of the ballast reduced the stern trim by approximately 0.1m. Although the removal of ballast reduced the vessel's GM, the MAIB estimates indicate a marginal improvement in the righting lever due to the increase in the freeboard at the aft end of the vessel.

2.6.4 Adoption of the live catch storage tanks

During the winter of 2016, an aluminium storage tank was positioned in the fish hold. The tank was filled with seawater and used to store live prawns, which increased the value of the catch. During summer months the skipper reverted to storing the prawns on ice. For the winter 2017/18 season, the aluminium tank was divided into two tanks and the tanks were relocated to the upper deck. This modification made it easier to refresh the seawater in the tanks. The two aluminium tanks were supplemented with a 1t IBC located on the main deck. The new tanks could also be interpreted as structural modifications. The effect of using these tanks was to move weight from low down in the vessel to higher up, which ultimately had the effect of reducing the vessel's GM. The use of these tanks both in 2016 and again in 2017 preceded the mandatory requirement to notify the MCA of proposed modifications (Section 2.6.5).

2.6.5 Substantial modifications

In October 2017, SI 943 (Section 1.10.9) placed an obligation on fishing vessel owners to notify the MCA about any proposed modifications. The 2017 Code of Practice for the Safety of Small Fishing Vessels (MSN 1871 (F)) was issued as a consequence of SI 943 coming into force. MSN 1871 (F) mandated that *substantial modifications or alterations... shall only be undertaken after consultation and with the MCA's approval*. The wording of the MCA's MSN 1871 (F) was inconsistent with SI 943 as it allowed vessel owners to make a judgement about the interpretation of whether proposed vessel modifications were notifiable to the MCA as *substantial* or not.

2.6.6 2017/18 crane replacement

During the 2017/18 Christmas layover, *Nancy Glen's* owners decided to replace the deck crane. The Guerra crane had become unreliable and, following discussions with the supplier, it was deemed more economically viable to renew the crane rather than refurbish the existing one.

If the wording of MSN 1871 (F) had been consistent with that of SI 943, which gave an obligation to notify the MCA of any proposed changes to structure, engines, machinery or mode of fishing, it is possible that the owners would have recognised that this applied to the replacement crane. However, because the owners considered

the replacement crane to be similar to the existing one, no action was taken to notify the MCA of the proposed changes or to assess the likely effect on *Nancy Glen*'s stability. These decisions were underpinned by the fact that the owners had assessed the stability when the original Guerra crane had been fitted in 2002.

It is apparent that no empirical stability assessments were carried out in respect of the change of crane, although an attempt was made to compensate for the additional weight of the new crane by replacing the steel lifting post with an aluminium structure. The MAIB's calculations indicate that the installation of a heavier crane had a significant and detrimental effect on the vessel's stability. This can be seen in **Table 1** and **Figure 11**, which identify both a reduction in GM and GZ, coupled with an increase in stern trim. In practical terms, following the change of crane and with the vessel in a towing condition, the application of a sudden increased load offset from the centreline on the trawl wires would rapidly overcome the vessel's inherent stability, significantly increasing the vessel's vulnerability to capsize.

2.6.7 Summary

Despite the lack of empirical assessment, it is apparent that *Nancy Glen*'s owners had made their own stability judgment and, in some cases, had taken professional advice on the effect of through life vessel modifications before they were implemented. However, with no baseline and without conducting regular checks of the vessel's stability using heel or roll tests, the actual cumulative effect on stability of these modifications was unknown.

2.7 STABILITY AWARENESS

All vessels must have sufficient stability in order to operate safely. It is therefore vital that owners and skippers are aware of the factors that affect the stability of their vessels.

Relevant training is available through Seafish, and guidance is provided by the MCA, particularly through its Fishermen's Safety Guide, and by the RNLi, notably as a result of its 2016 campaign. However, there was no mandated requirement for any stability training or qualification for skippers or crew working on vessels under 16.5m L. This omission limits their ability to conduct effective stability assessments. Following the loss of *JMT* in 2016, the MAIB recommended that the MCA introduce a mandatory requirement for skippers of under 16.5m L fishing vessels to complete stability awareness training.

With no formal training and therefore limited knowledge of stability fundamentals, the owners and previous skippers of *Nancy Glen* relied on their experience of operating the vessel, and how it felt at sea, to support their decisions in respect of vessel modifications. The owners had always felt that *Nancy Glen* was a 'good sea boat'. However, as stated in MGN 427 (F):

'A vessel which appears very sea-kindly and comfortable with a slow roll period can actually be potentially unsafe in terms of stability.'

The experience of fishing in various conditions could easily have led the owners and previous skippers to overestimate *Nancy Glen*'s stability following the various modifications carried out since 2002.

Although training can provide an understanding and appreciation of the potential for diminishing stability through modifications, the net effect on residual stability following a modification will still be based purely on an estimation unless the original stability condition is known. This applies equally to owners, skippers, naval architects and the MCA. Therefore, regardless of any requirement or recommendation to seek professional advice and/or approval for any proposed vessel modification, unless a vessel's stability is known, there will be uncertainty as to the extent to which that modification may increase the potential for the vessel to capsize.

2.8 STABILITY INFORMATION

The only stability information available to the owners of *Nancy Glen* was developed by the naval architect prior to completing modifications to the vessel in 2002. The methodology used in these calculations was unusual in that it used data derived from a different sized vessel that was extrapolated to represent *Nancy Glen*. Not only was the basis for the calculations estimated, but also the derived information was limited and the report to the owners stated only that the GM was consistent with 1975 build requirements for larger (over 12m L) fishing vessels, albeit at the minimum limit of 0.35m. Notwithstanding this, the report to the owners stated that, based on the calculations, any additional top weight should be kept to a minimum.

It is commendable that in 2002, prior to completing modifications, a naval architect was consulted to assess *Nancy Glen*'s stability. However, the assessment was very simple, using GM as a measure and a Seafish Construction Standards factor of safety method that was discontinued 2 years later.

When *Nancy Glen* was constructed, no stability requirements were specified in The Fishing Vessels (Safety Provisions) Rules 1975 for fishing vessels under 12m L. *Nancy Glen*, at 11.98m L, in common with many other fishing vessels was built as a 'rule beater' to circumvent the application of the more stringent requirements stipulated for over 12m L vessels in the 1975 Rules, particularly in respect of stability.

The Fishing Vessels (Code of Practice for the Safety of Small Fishing Vessels) Regulations 2001 placed no specific requirement for stability on fishing vessels under 12m L. Since 2001, further amendments to the Code and MGNs have been issued that provide guidance on stability, but no minimum stability for under 12m L vessels has ever been introduced. Instead, the MCA has placed reliance on owners and skippers to exercise their legal responsibilities for health and safety by following its published guidance on stability assessment.

The MAIB has investigated the capsize of numerous small fishing vessels and has recommended repeatedly that better stability information be provided to fishermen. In 2014 the MAIB investigated the capsize and sinking of the trawler *Stella Maris* and consequently recommended that the MCA introduces intact stability criteria for all new and significantly modified decked fishing vessels of under 15m LOA. Following the capsize and loss of the fishing vessel *JMT* in 2015, the MAIB extended its recommendation for stability requirements to apply to all new and existing fishing vessels of less than 15m LOA. The MCA accepted these recommendations and stated that its target date for implementing appropriate action was 31 December 2020.

The MAIB's calculations demonstrate that *Nancy Glen*'s stability had deteriorated since the assessment in 2002. Given the lack of any requirement to assess its stability, *Nancy Glen*'s residual stability following its various modifications since 2002 remained unknown.

The loss of *Nancy Glen*, and other small fishing vessels highlighted in previous MAIB investigations, confirms that the lack of clear stability criteria for new fishing vessels under 12m L and existing fishing vessels under 15m LOA continues to put crews of small fishing vessels at considerable risk.

There are currently (as of 31 December 2018) 5603 UK registered fishing vessels, of which 4872 (87%) are less than 12m LOA. None of these have ever been subject to any stability criteria relating either to their original build condition or following through life modifications. Unless stability standards are introduced and retrospectively applied, these vessels will remain exposed to unassessed risk until they are retired from service. Vessels engaged in trawling and other forms of bulk fishing are particularly at risk.

The evidence from multiple investigations into the capsize and foundering of small fishing vessels, coupled with the negligible adoption of the Wolfson Mark, clearly indicates that most owners and skippers of small vessels are unaware of the risks of not conducting stability assessments of their vessels. There is no lack of published guidance, but it is being ignored with the consequence that vessels and lives continue to be lost. The case for introducing stability criteria for small fishing vessels has been made by the MAIB and has been accepted by the MCA. However, until stability criteria for small fishing vessels is introduced, their potential vulnerability to capsize, as highlighted in this report, will remain.

2.9 REGULATION

The current Code of Practice for the Safety of Small Fishing Vessels of less than 15m LOA, which reintroduced stability criteria for new and significantly modified fishing vessels of 12m L to less than 15m LOA, is welcomed. However, the application of stability requirements to encompass all new and existing fishing vessels of less than 15m LOA remains uncertain, both in terms of scope and timing.

The Fishing Vessels (Safety of 15-24 Metre Vessels) Regulations 2002, which were introduced on 23 November 2002, inadvertently removed the requirement for fishing vessels of 12m L to 15m LOA to be built with or to maintain stability information. This was eventually corrected in The Fishing Vessels (Codes of Practice) Regulations 2017, which came into force on 23 October 2017, almost 15 years after the original error. During these intervening years numerous fishing vessels between 12m and 15m have been built without any regulatory requirement for stability information.

SECTION 3 - CONCLUSIONS

3.1 SAFETY ISSUES DIRECTLY CONTRIBUTING TO THE ACCIDENT THAT HAVE BEEN ADDRESSED OR RESULTED IN RECOMMENDATIONS

1. *Nancy Glen's* stability was insufficient to overcome the combined effect of increased loading of the starboard trawl warp and the vessel's simultaneous turn to starboard. [2.4]
2. The cumulative effect of the various modifications to *Nancy Glen* carried out since 2002, culminating in the replacement of the crane during the 2017/18 Christmas layover, was to reduce the vessel's stability, and significantly increase its vulnerability to capsize. [2.5, 2.6]
3. *Nancy Glen's* owners had made their own stability assessment and, in some cases, had taken professional advice on the effect of through life vessel modifications before they were implemented. However, there was no requirement for the skipper or crew of under 16.5m registered length fishing vessels to undertake stability awareness training, which limited their ability to conduct effective stability assessments. [2.6.7, 2.7]
4. Regardless of any requirement or recommendation to seek professional advice and/or approval for any proposed vessel modification, unless a vessel's stability is known, there will be uncertainty as to the extent to which that modification may increase the potential for the vessel to capsize. [2.6]
5. The evidence from multiple investigations into the capsize and foundering of small fishing vessels, coupled with the negligible adoption of the Wolfson Mark, clearly indicates that, despite available guidance most owners and skippers of small vessels are unaware of the risks of not conducting stability assessments. The case for introducing stability criteria for small fishing vessels has been made by the MAIB and has been accepted by the MCA. However, until such criteria have been derived and implemented it is likely that more vessels will be lost. [2.8]
6. The 2017 Code of Practice only required owners of UK fishing vessels to notify the MCA of *substantial modifications*; however, this was inconsistent with SI 943 that obligated owners to notify the MCA of any proposals to alter or modify a vessel. This inconsistency introduced an environment where owners could exercise judgement on what constituted a *substantial* modification, rather than meeting the requirement of SI 943. [2.6.5]

3.2 OTHER SAFETY ISSUES DIRECTLY CONTRIBUTING TO THE ACCIDENT

1. The heeling moment developed rapidly to a point at which the vessel's righting lever vanished before the skipper's restorative action could take effect. [2.4]
2. The rapid capsize and inversion of *Nancy Glen* would have resulted in significant displacement of any loose gear which, coupled with the men's inevitable disorientation exacerbated by darkness, is likely to have impeded their attempts to exit the vessel. [2.4]

3. In addition to the vessel's increased inherent top weight, as the week's fishing progressed the amount of fuel, stored low in the vessel, would have decreased, thereby raising the vessel's VCG and negatively impacting on its inherent stability. [2.5]

3.3 SAFETY ISSUES NOT DIRECTLY CONTRIBUTING TO THE ACCIDENT THAT HAVE BEEN ADDRESSED OR RESULTED IN RECOMMENDATIONS

1. The cumulative effect of long working days could have impacted on the skipper and crew's ability to react to an emergency. [2.2]
2. The Fishing Vessels (Safety of 15-24 Metre Vessels) Regulations 2002, which were introduced on 23 November 2002, inadvertently removed the requirement for fishing vessels of 12m L to 15m LOA to be built with or to maintain stability information. This was eventually corrected in The Fishing Vessels (Codes of Practice) Regulations 2017, which came into force on 23 October 2017, almost 15 years after the original error. During these intervening years numerous fishing vessels between 12m and 15m have been built without any regulatory requirement for stability information. [2.9]

SECTION 4 – ACTIONS TAKEN

4.1 MAIB ACTIONS

The **MAIB** has:

1. Issued a safety flyer to the fishing industry (**Annex F**).
2. Previously recommended the MCA to:

‘Include in its intended new legislation introducing stability criteria for all new and significantly modified decked fishing vessels if under 15m in length a requirement for the stability of new open decked vessels, and all existing vessels of under 15m to be marked using the Wolfson Method or assessed by use of another acceptable method.’¹⁹

‘Require skippers of under 16.5m fishing vessels to complete stability awareness training.’²⁰

4.2 ACTIONS TAKEN BY OTHER ORGANISATIONS

Although not directly as a result of this accident, the **MCA** has published the following guidance and direction:

1. MGN 526(F) *Stability Guidance for Fishing Vessels – Using the Wolfson Method*. MGN 526(F) replaced MGN 427(F) (Section 1.10.5) and provided guidance for fishing owners on the safe operation of vessels using the Wolfson Method of assessing stability.
2. The *Fishing Vessel Stability Guidance* booklet. The aim of this booklet was to help fishermen to understand the principles of stability, the associated risks and hazards, and actions that can be taken to manage stability effectively.
3. MSN 1884 (F)²¹ *Application of the Fishing Vessels (Working Time: sea fishermen) Regulations 2004 as amended*. MSN 1884 (F) explained the requirements for the provision of adequate rest for all fishermen, whether employed or self-employed.

¹⁹ MAIB recommendation 2016/130

²⁰ MAIB recommendation 2016/131

²¹ MSN 1884 (F) was published in October 2018 so did not apply to *Nancy Glen* at the time of the accident.

SECTION 5 - RECOMMENDATIONS

The **Maritime and Coastguard Agency** is recommended to:

2019/109 Include in its new legislation addressing the stability of existing fishing vessels of under 15m, a requirement to undertake both a freeboard check and stability check, which should be recorded and repeated at intervals not exceeding 5 years.

Provide guidance on the conduct of 5-yearly stability checks to ensure the results can be effectively compared to determine whether the vessel's stability has altered.

Align the text of MSN 1871 (F), The Code of Practice for the Safety of Small Fishing Vessels of less than 15m Length Overall, to mirror Statutory Instruments 2017 No. 943 Merchant Shipping, The Fishing Vessel (Codes of Practice) Regulations 2017. This amendment should be in respect of vessel owners' obligation to notify the MCA of any proposal to alter or modify a vessel's structure, remove or reposition engines or machinery or change the mode of fishing.

Include in its new legislation introducing stability criteria for all new and substantially modified vessels, a requirement for this to be validated by a 5-yearly lightship check.

Safety recommendations shall in no case create a presumption of blame or liability

