Report on the investigation of the

capsize and foundering of the fishing vessel

Angela

in the North Sea

on 6 February 2000

Marine Accident Investigation Branch
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Report No 14/2001

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GLOSSARY OF ABBREVIATIONS

EPIRB	-	Electronic position indicating radio beacon
kHz	-	kilohertz
m	-	metre
MAIB	-	Marine Accident Investigation Branch
MCA	-	Maritime and Coastguard Agency
MF	-	Medium Frequency
mm	-	millimetre
MRCC	-	Maritime Rescue Co-ordination Centre
rpm	-	revolutions per minute
SFIA	-	Sea Fish Industry Authority
UKFVC	-	United Kingdom Fishing Vessel Certificate
UTC	-	Universal Co-ordinated Time
VHF	-	Very High Frequency

GLOSSARY OF TERMS

capsize	-	A roll to starboard or port caused by a loss of stability which leads to a vessel turning on to its side or inverting. A capsize is normally followed by foundering.
cod end	-	The narrow end part of the net, which can be opened to release the catch into the hopper.
free surface	-	The tendency of a fluid to shift as a vessel rolls in a seaway. This usually causes a de-stabilising effect.
founder	-	To fill up with water and sink.
painter	-	A length of line attached to a liferaft. It also activates the inflation.

SYNOPSIS

Angela was lost at about 1320 UTC on 6 February 2000. The MAIB was informed at 1657 that day. An investigation began on 8 February 2000, undertaken by MAIB Inspector Richard Barwick.

Angela left Peterhead on 31 January 2000, with a crew of five to fish in the North Sea. The fishing operation prior to the accident was to be her last before returning to Peterhead. When the trawl was hauled there was a good catch in the nets; enough to fill the single hopper. The full hopper caused an angle of list of about 9° to starboard. While the crew were gutting the catch, floodwater started to build up inside the shelter. This led to *Angela* slowly capsizing to starboard. All the crew were saved by the fast rescue craft from the stand-by vessel *Scott Guardian*. *Angela* sank in water about 140m (460ft) deep; she has not been recovered. After *Angela* sank, the EPIRB failed to release, so it transmitted no distress message.

A tonnage valve was fitted on either side of the shelter for discharge of deck water. These valves are freeing ports fitted with a flap, which should allow water to flow overboard, but not back in. It is possible that the tonnage valve on the starboard side became jammed open, perhaps by a piece of fish offal. This would have allowed the shelter to flood, if *Angela*'s stability had been sufficiently degraded by the weight of the fish in the hopper, which was high up on the starboard side. The deckwash supplied seawater to the shelter for washing the fish before being stowed in the hold. If the tonnage valve was blocked or seized closed, and the deckwash on, it would have taken about 30 minutes for enough seawater to build up to capsize the vessel. In both these scenarios the tonnage valve on the starboard side malfunctioned. Surveyors often find these units are not working properly.

This report recommends that when the Maritime and Coastguard Agency (MCA) approves stability books for fishing vessels similar to *Angela*, at least one of the operating conditions in the book should show a full hopper.

Recommendations regarding safety courses and crew training have also been made to the owner and skipper.

VESSEL AND ACCIDENT PARTICULARS

Name	:	*Angela*
Type	:	Fishing vessel (twin trawler)
Port of registry	:	Peterhead
Fishing number	:	PD 400
Official number	:	A 13339
Owners	:	Mark Addison 10 Cowie Crescent, St. Fergus, Peterhead Peter Strachan 15 Eden Drive, Peterhead
Built	:	1981, by Arma Marine, Brightlingsea
Materials of construction	:	Steel, with aluminium shelter
Length	:	15.24m – registered, 16.99m - overall
Breadth	:	6.10m
Depth moulded	:	2.97m
Gross tonnage	:	27.66
UKFVC	:	Issued 22 March 1999 by the MCA in Aberdeen Valid until 28 February 2003
Position of accident	:	58° 18′N 000° 09′E (About 78 miles east-north-east of Peterhead)
Time and date	:	About 1310 UTC on 6 February 2000
Injuries	:	One crewman suffered from mild hypothermia

General views of *Angela* are shown in **(Figure 1)**.

General views of *Angela*

SECTION 1 - FACTUAL INFORMATION
(All times are UTC)

1.1 NARRATIVE

Angela left Peterhead on 31 January 2000, to fish in the North Sea. Fishing began the next day in one of the Bressay fishing grounds, about 150 miles north-north-east of Peterhead. *Angela* fished in this area for five days, with no unexpected problems. Bad weather was forecast, so the skipper headed back towards Peterhead. After steaming for 70 miles, the skipper decided to fish one last time near the Scott oil platforms, in a position 78 miles east-north-east of Peterhead. By then it was 6 February 2000, about 6.5 tonnes of fish and prawns had been caught, and about 2 tonnes of fuel was left in the tanks.

The shooting and trawling part of the last fishing operation proceeded normally. The final haul began at about 1130. There was a good catch in the nets, which consisted mainly of middle to large size saithe and cod. The nets were manoeuvred alongside and about four to five lifts were performed, which filled the single hopper in the shelter with about 3 tonnes of fish. The starboard net was emptied, and about 1 tonne was left in the port net. The full hopper caused an angle of list of about 9°, and the tonnage valve and offal chute were about 600mm above the static waterline. The time was about 1240 when the hopper was filled. The starboard side was beam on to the wind and waves, and the vessel was rolling about 5° or 10° either side of the equilibrium position.

The crew set about processing some of the catch to make space in the hopper, and allow the port net to be emptied, completing the loading. The crew took up their positions for gutting the fish. All the deckhands stood outboard of the gutting trough: deckhand 1 stood furthest forward, followed by deckhand 2, deckhand 3, and deckhand 4 who stood furthest aft. The crew tried to process the catch quickly, as the weather forecast was not good. The skipper stood inboard of the gutting trough, and helped the crew with the gutting, but after a few minutes he went up to the wheelhouse to see if there were any other vessels around. While in the wheelhouse he talked to the fishing vessel *Heather Spring* on the radio. The skipper had been talking for about five minutes when he heard shouts from the crew in the shelter; the time was about 1255. They were shouting because they had become alarmed by the amount of water on the starboard side of the shelter, which started to lap over the top of their sea boots. As they were standing on a platform about 0.25m high, and their boots were about 0.4m high, the top of their boots was about 0.65m above the main deck.

When the crew became alarmed, they scrambled over the gutting trough to escape from the water on the starboard side. About six to eight baskets of fish had been gutted by this time. After hearing the shouts, the skipper went down to the shelter and saw the water, which he thought was about a metre deep. He was not sure what to do at first but, after briefly considering the situation, he decided to return to the wheelhouse, where he put *Angela* full ahead, while steering hard to starboard for one or two minutes, to try to throw the floodwater to port. However, this failed to correct the list. During this turn, the main engine was running at 1800 rpm on full power.

Bilge alarms were fitted in the engine room and the fish hold. The crew did not hear either of these devices activate when the angle of list increased. Melting ice tends to cause water to build up in the bilges of the fish hold, but this space was pumped just before the accident.

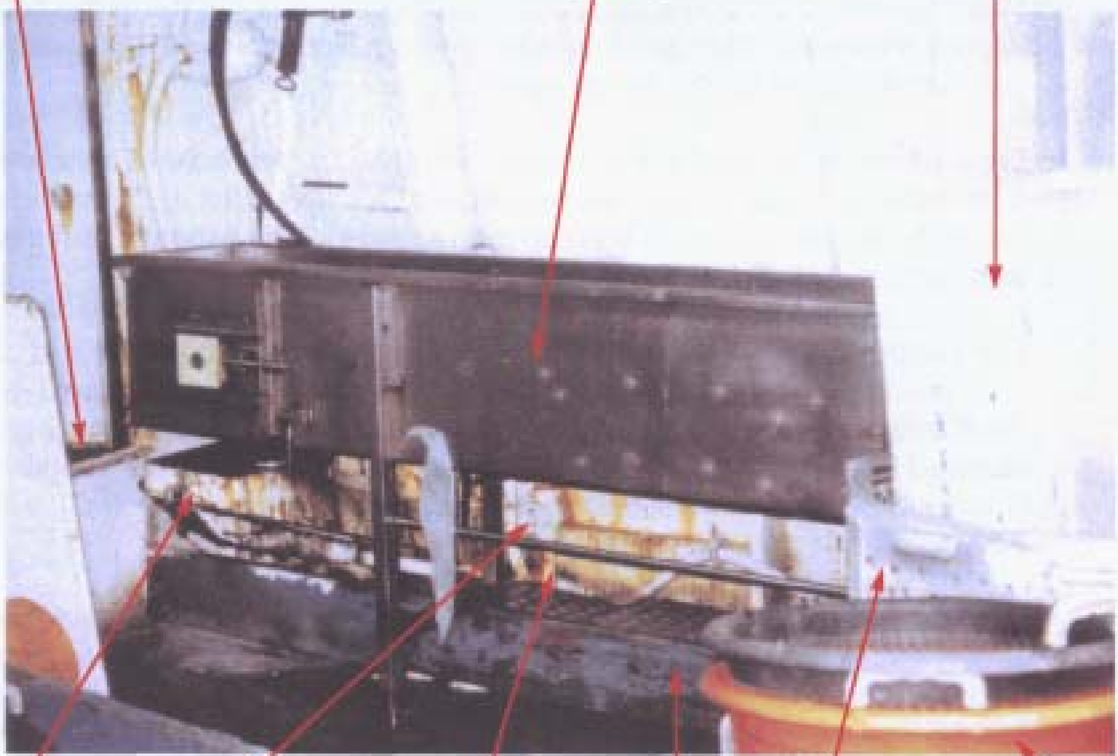
The skipper called the vessel *Scott Guardian* at about 1300 on VHF channel 16. This vessel was engaged in stand-by duties for the offshore platforms in the Scott oilfield. The second mate on *Scott Guardian*, as officer of the watch, received the call; he assumed it was routine, so asked *Angela*'s skipper to go to channel 15. When contact had been made on this channel *Scott Guardian* was advised that *Angela* was taking on water.

After the call, the skipper returned to the shelter where he instructed three of the deckhands to go up and shovel fish overboard through the fish hatch, and throw empty fish boxes overboard. He and the other crewman tried to discharge whole fish through the offal chute using the conveyor to feed fish into the trough. This was not possible, because the outlet was now below the outside water level. The water in the shelter started to lap over the sill of the door into the accommodation **(Figure 2)**, so the skipper shut this door. He, and the other crewman, went up to the open deck. Two of the deckhands on the shelter top had only been able to shovel about four or five boxes of fish overboard. When the skipper arrived, the fish-loading hatch was starting to dip below the waterline, allowing water ingress, as the vessel was rolling in the waves. The skipper told the crew to close the fish-loading hatch, he then entered the wheelhouse through a window. One of the crew was at the aft end throwing empty fish boxes into the sea.

The crew were not wearing their lifejackets while they were trying to dump fish and boxes overboard. The lifejackets were stowed below in the cabin.

The lights inside the vessel stayed on until the evacuation.

Figure 2



Gutting trough

1.2 EVACUATION AND RESCUE

On returning to the wheelhouse the skipper called Scott ***Guardian*** at 1305 on VHF channel 16, and said that ***Angela*** was sinking. The second mate on ***Scott Guardian*** called the master to the bridge. At 1307 the skipper called the coastguard on MF 2182kHz and advised them briefly of the situation.

When Scott ***Guardian's*** master arrived on the bridge at 1307 he called ***Angela,*** and confirmed her position. He was also informed that the crew were taking to the liferaft. ***Scott Guardian*** was about 4.5 miles away. ***Scott Guardian's*** master asked the offshore installation manager of the Scott Platform to be released from stand-by duty. This was granted, and ***Scott Guardian*** then proceeded towards ***Angela.***

The fishing vessel ***Tranquillity*** was only about a mile from ***Angela*** at the time of the accident, but she had her nets out. Although the radio transmissions were heard on board ***Tranquillity,*** her nets prevented her from responding immediately. The rescue, therefore, was left to ***Scott Guardian.***

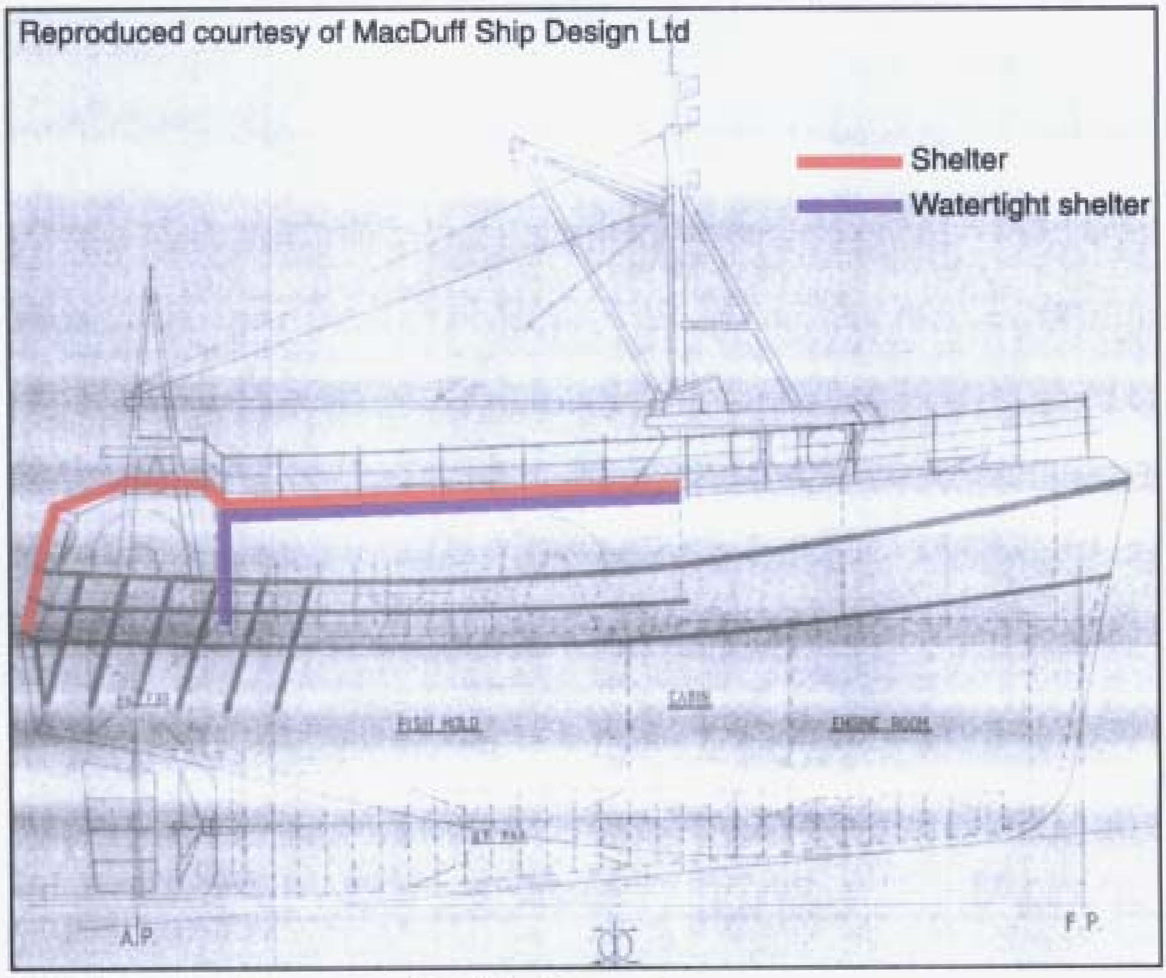
1.6 SHELTER

Angela was built in **1981** without a shelter. Two years later an aluminium shelter was fitted **(Figure** 5) to provide protection for the crew, particularly when processing the catch. Although it sheltered them from the weather, the structure was non-watertight and did not contribute to the vessel's buoyancy for stability purposes, because freeing ports were fitted at the level of the main deck.

By **1995,** various modifications had been made, particularly the change to twin trawling, which meant that ***Angela*** no longer met the required stability criteria. The solution was to make the forward portion of the shelter watertight **(Figure** 5) by removing the freeing ports. Some method of draining the shelter deck was still necessary, so tonnage valves and pumps were fitted.

A plan of the main deck, showing the internal arrangement of the shelter, is shown in **(Figure** 6). A photograph of the gutting trough can be seen in **(Figure** 2). While gutting the fish, the deckhands stood on a platform, outboard of the trough, which was about 250mm above the deck.

Figure 5



Profile of *Angela*

After making the radio calls, the skipper told the deckhands to get the liferaft ready **(Figure 1)**. He then went to collect the lifejackets but, on his way down below to the cabin, the vessel lurched as if it was about to suddenly capsize suddenly. He therefore went back up again without the lifejackets. The skipper did not see any floodwater at the bottom of the stairs leading to the cabin. The skipper left via a wheelhouse window, helped by two of the deckhands.

While the skipper was being pulled from the wheelhouse, one of the deckhands prepared the liferaft. The liferaft was dipping below the surface at this stage. In his haste to release the canister the deckhand cut the painter as well as the main strap. He intended to catch hold of the painter, but he lost it.

The deckhands removed their boots and oilskins because they felt these items would tend to drag them down when they were in the water. The crew were gathered on the open deck close to where the liferaft was floating, that is, except deckhand 2 who was towards the aft end disposing of fish boxes; he made for one of the lifebuoys **(Figure 1)**. Deckhand 2 only managed to get his head and one arm into the lifebuoy before a wave broke over the aft end and carried him away. He was not a good swimmer, but managed to tread water to keep himself afloat.

The liferaft painter had been cut, so the skipper went into the sea to retrieve it. Once in the water he removed his oilskins and boots. When he reached the painter he pulled it out of the canister, which took a while as it was 24m long. He then used his feet to push on the end of the canister, while pulling on the painter with his hands. This initiated inflation. The liferaft was next to *Angela*, so the skipper was able to hold on to the vessel with one hand, while holding the liferaft painter in the other. Deckhand 1 managed to jump into the inflated liferaft. The skipper managed to get on board after pulling himself around to the entrance. Deckhand 4 jumped into the water, and after a short swim was hauled into the liferaft by the skipper and deckhand 1. Deckhand 3 swam about 8m, and he too was then hauled aboard.

The main engine stopped when the crew were standing on the port side. The liferaft was boarded shortly after, at about 1310. By about 1320 the vessel had rolled upside down; she then sank bow first. Many fish boxes remained floating on the surface of the sea.

Once in the liferaft, those on board tried to paddle towards deckhand 2, but the windage of the liferaft meant they were blown downwind from him. The use of the paddles in the liferaft was not effective and deckhand 2 was moving further and further away. They took turns at paddling, two at a time. The sea anchor was deployed to reduce further drift, and a parachute flare was set off.

Scott Guardian sighted the flare at 1320, and reported to the coastguard at 1322 that the liferaft could be seen. The fast rescue craft on board *Scott Guardian* was launched at 1327 and arrived at the liferaft a couple of minutes later. The crew in the liferaft immediately advised the rescuers about deckhand 2, so the fast rescue craft diverted, to search for him.

Deckhand 2 was located in the sea at 1333, and once he had been lifted aboard the fast rescue craft he was taken directly to *Scott Guardian*. The craft then returned to the liferaft to pick up the rest of the crew. The fast rescue craft was recovered at 1352.

Deckhand 2 had been in the water for 20 to 25 minutes, and when he was taken on board *Scott Guardian* he was shaking with cold. He had also swallowed a lot of water. He was taken to the ship's hospital, where he was given oxygen. He was then put under a hot shower.

At 1355 *Scott Guardian* informed the coastguard of the situation. The ship was requested to proceed west to meet a rescue helicopter which had been scrambled. *Angela*'s five crew were winched aboard between 1408 and 1422. On arrival at Aberdeen airport, deckhand 2 was taken to hospital for a check-up. He was kept in overnight, but subsequently made a full recovery.

The stand-by vessel *Bue Islay* recovered the liferaft, but it had not been put ashore when the MAIB undertook the field investigation. Once the crew had boarded the liferaft, it functioned satisfactorily, although they found it difficult to paddle. As well as making little progress, the very act of paddling caused water to enter the liferaft.

The manufacturer had fitted an EPIRB to the aft side of the mast about six months before the accident, but this failed to activate when *Angela* was lost.

Angela sank in water about 140m deep. She has not been recovered.

1.3 WEATHER

The weather at the time of the accident was: wind from the south south west, force 5 (fresh breeze, 17-21 knots). Sea state 4 (moderate), with a 2m swell. Visibility 8 miles.

1.4 CREW

Angela had a crew of five, all of whom were experienced fishermen.

Mark Addison, the 31 year old skipper and engineer, was also the co-owner. On 23 February 1999 he obtained a Deck Officer Certificate of Competency (Fishing Vessels) Class 2, although this was not required to skipper *Angela*, as the vessel was less than 16.5m registered length. After school he worked as a joiner for about three years, since then he had been a fisherman. He had worked on board *Angela* for about 9 years; for the last 6 years as her skipper. He had undertaken the basic survival at sea course, and the content of the basic fire-fighting and prevention, and basic first-aid courses were covered in the syllabus for Class 2.

Duncan Taylor, age 39, was a deckhand. He worked as a builder for about 5 years after he left school, since then had been a fisherman. He is referred to as deckhand 1 in the report.

Michael Simpson, age 45, was a deckhand. He too had been a fisherman all his working life. He usually did the cooking on *Angela*. He is referred to as deckhand 2 in the report.

Stephen Cowie, age 39, was a deckhand. He too had been a fisherman all his working life. He had attended the course on basic survival at sea and is referred to as deckhand 3 in the report.

Gary McLeod, age 31, was a deckhand. He had been a fisherman all his working life and is referred to as deckhand 4 in the report.

1.5 FISHING OPERATION

Angela used a twin trawl arrangement **(Figure 3)**. A twin trawl tends to catch more fish than a single trawl. The arrangement was used for bottom trawling which was good for catching prawns, and fish such as saithe and cod.

Figure 3

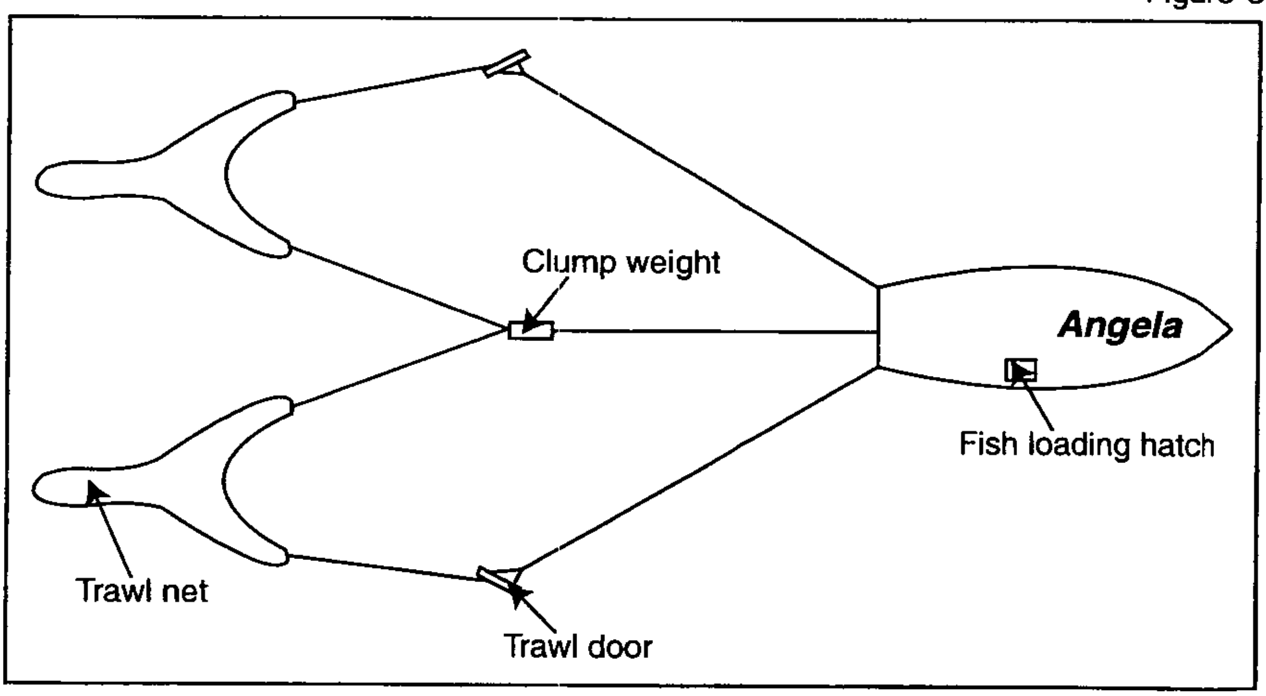


Diagram of twin trawl arrangement

When the catch was loaded, the starboard net was emptied first. This net was hauled to the starboard side, and the cod end was lifted with about half a tonne of fish in it. This lift was performed using a rope called a gilson, which was attached to a derrick. The cod end was positioned over the fish hatch in the top of the shelter **(Figure 1)**, which was also on the starboard side. The fish hatch was at the top of a hopper, which could contain about 3 tonnes of fish. The cod end was opened, and the catch was allowed to spill into the hopper. When loading from the starboard net was complete, the port net was hauled to the starboard side, and emptied in a similar way.

When the hopper was full, the processing began. A conveyor was fitted in the bottom of the hopper, and when this was moving it carried fish on to the gutting trough **(Figure 2)**. The conveyor was a mesh, which allowed seawater and debris such as small stones etc. to drop through on to the deck. When enough fish were in the trough, the conveyor was stopped and the gutting began. The gutted fish were then placed in baskets according to species and size.

When between 5 and 20 baskets were filled with gutted fish, the deckwash was started, so that the fish could be washed with seawater. The pump supplying the deckwash could be directed either to a hose pipe, or to the fish washing machine. The hose pipe was kept coiled on the deck when not in use.

The gutted fish were kept in plastic baskets before being tipped into the washing machine. A fish washing machine on another vessel is shown in **(Figure 4)**. The unit comprises an open topped container, into which gutted fish are placed for washing. The seawater supply is fed into the bottom, which swirls the fish around, and washes away any dirt and offal. When they are sufficiently clean, the front of the machine is opened and the fish are allowed to spill into an empty basket placed on the deck. The fish washing machine was always used for prawns, but baskets of gutted fish were sometimes washed, simply by playing the hose on the baskets.

The baskets of washed fish were kept on the port side of the shelter, away from the baskets of unwashed fish on the starboard side. One of the crew remembered that the baskets of washed fish on the port side started to slide to the starboard side just before the crew became alarmed about the amount of water on the deck.

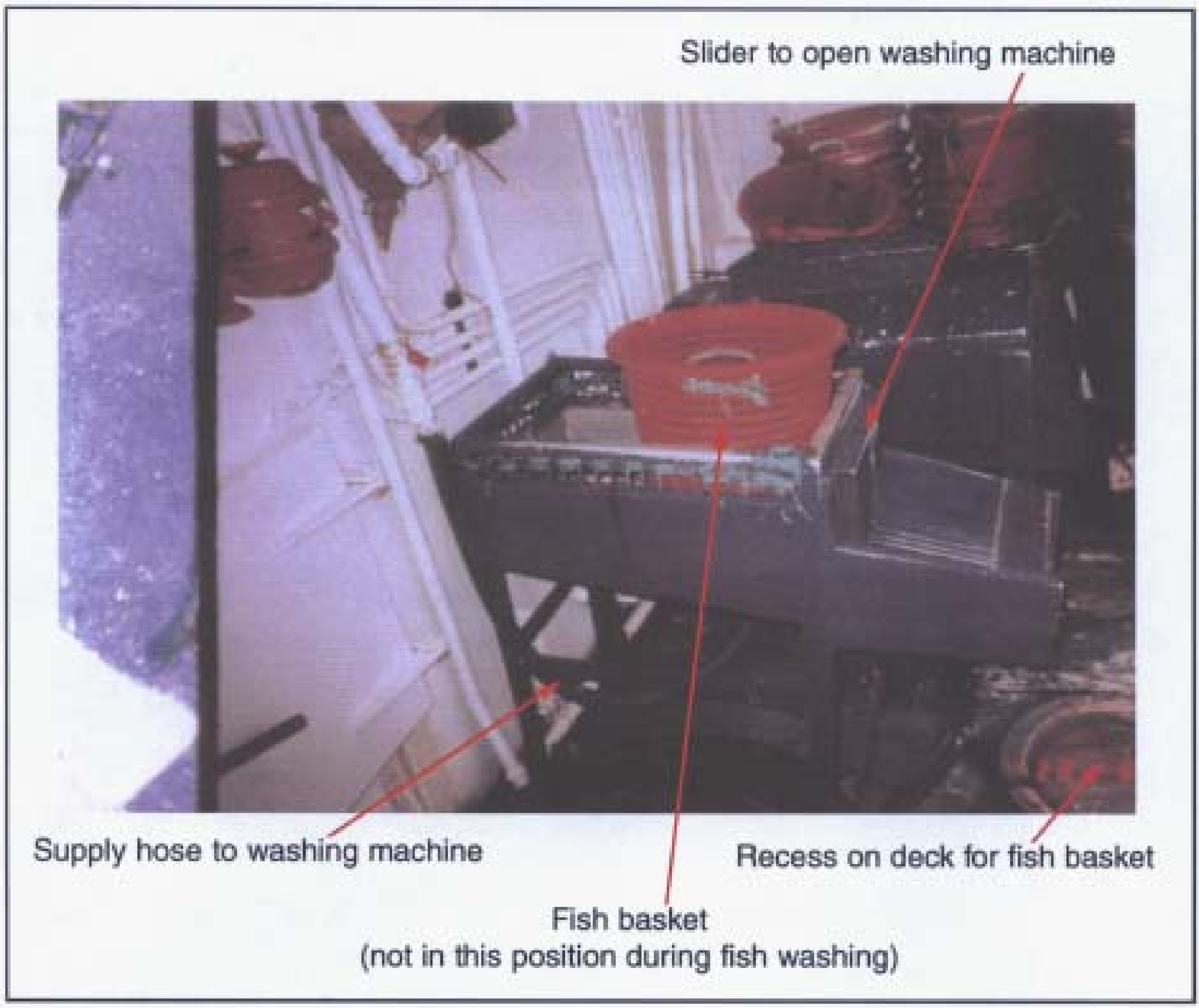
During a normal fish processing operation, when several baskets of washed fish had built up, they were passed down into the fish hold. A rope was attached to each basket; the rope was run over a pulley attached to the deckhead. By holding the end of the rope and gently releasing it, each basket was lowered into the fish hold. The crewman in the fish hold emptied the fish into boxes, and then shovelled some ice on top. The filled boxes were then stacked in the hold. Finally the empty fish baskets were passed by hand back up to the shelter. The crew had not begun to stow the previous catch in the fish hold.

To complete the fish processing operation, the deck and the gutting trough were washed down using the deck wash hose. During this cleaning operation the tonnage valves were usually wedged open to help clear the water and fish offal from the deck.

It was very unusual to catch enough fish to fill the hopper. Recently this had occurred only about once a year. A typical catch was about a half a tonne in each net, which would result in 1 tonne of fish being loaded in the hopper. With a typical catch, there was no need to gut some of the fish to make space in the hopper, to complete the loading. Also with only about 1 tonne in the hopper the angle of list was much less than with the hopper full.

When the catch was being loaded, and during the gutting and washing of the catch, the main engine was in neutral and running at about 1000 rpm. Angela came beam on the sea when not making way.

Figure 4



Fish washing machine on another fishing vessel

1.6 SHELTER

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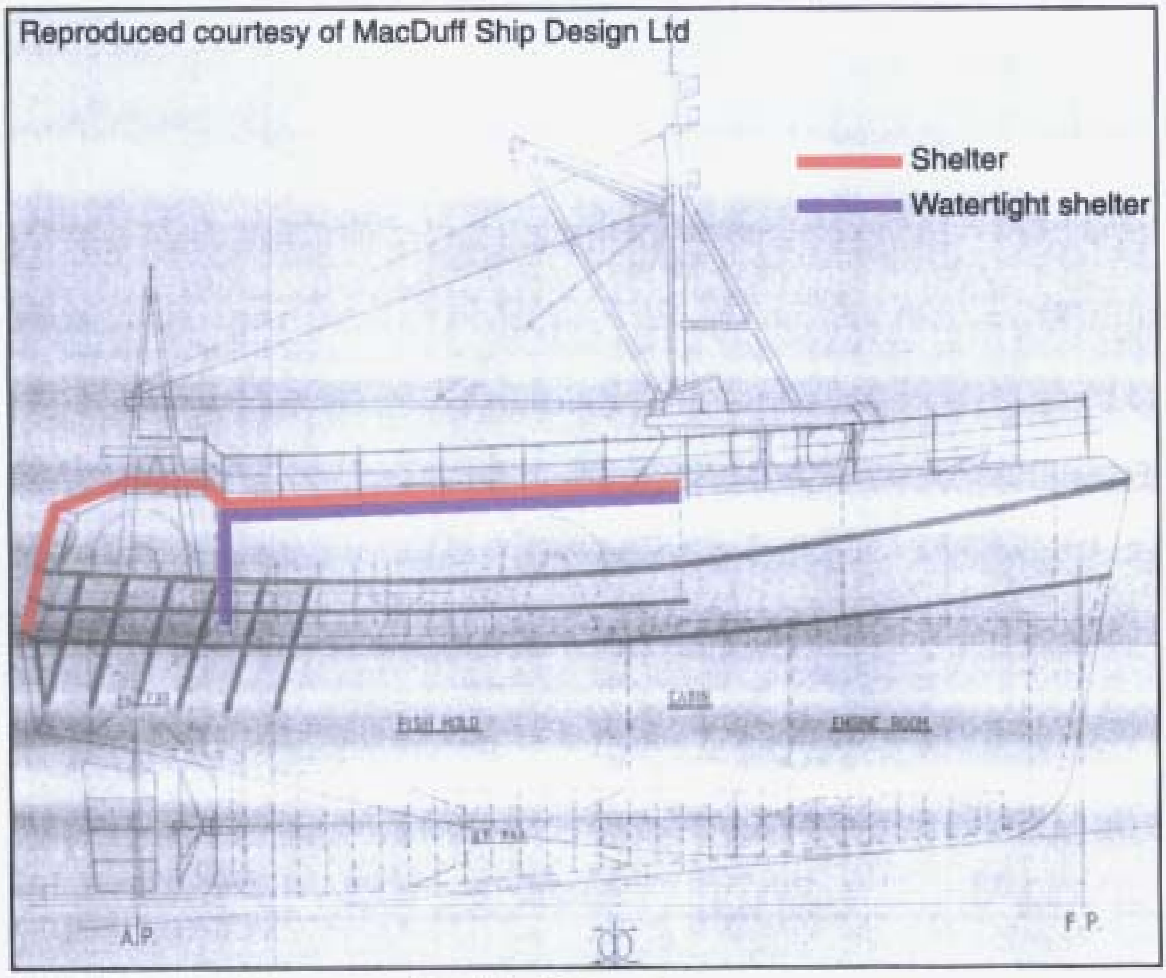
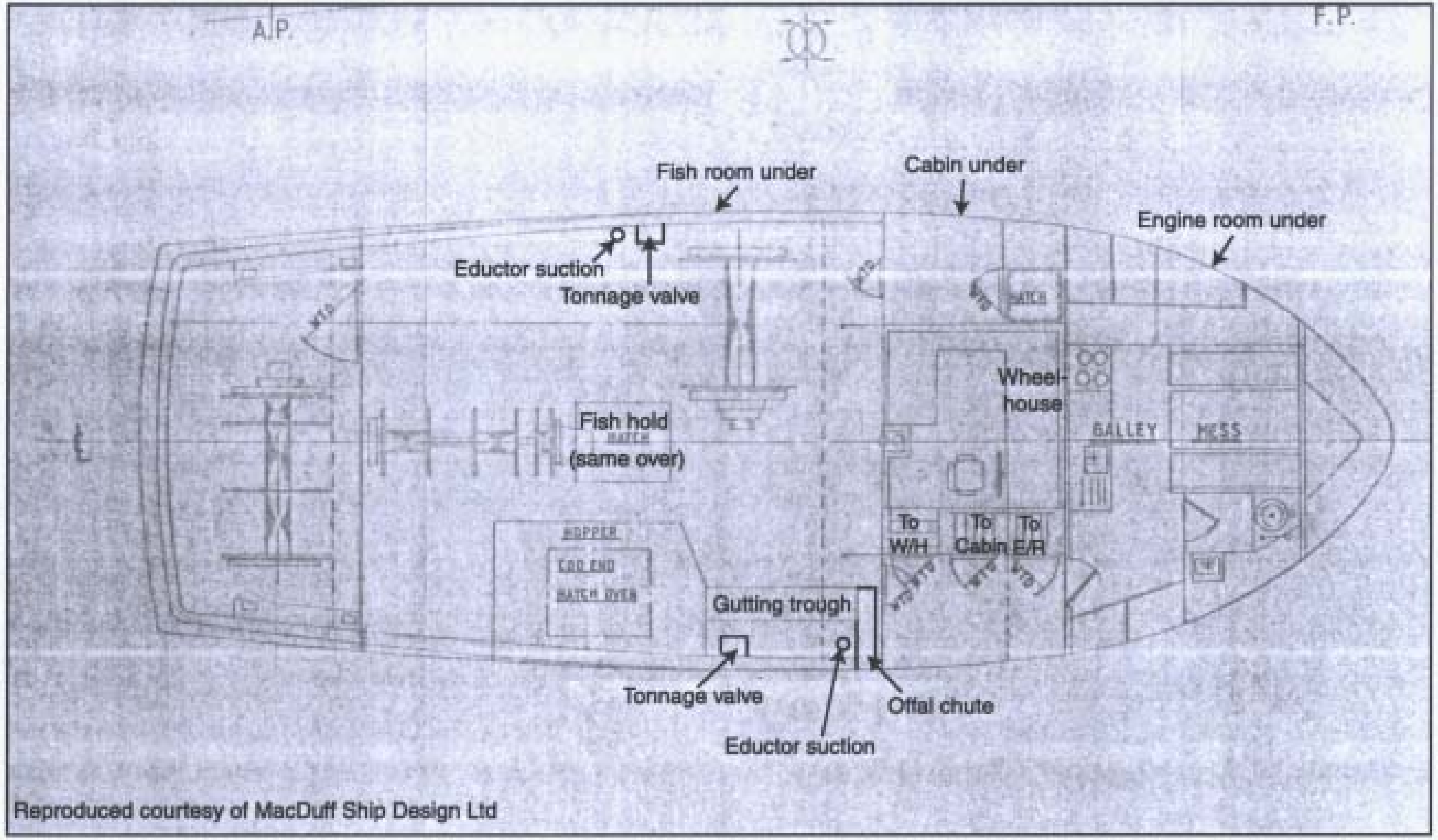
Figure 5



Profile of *Angela*

Figure 6

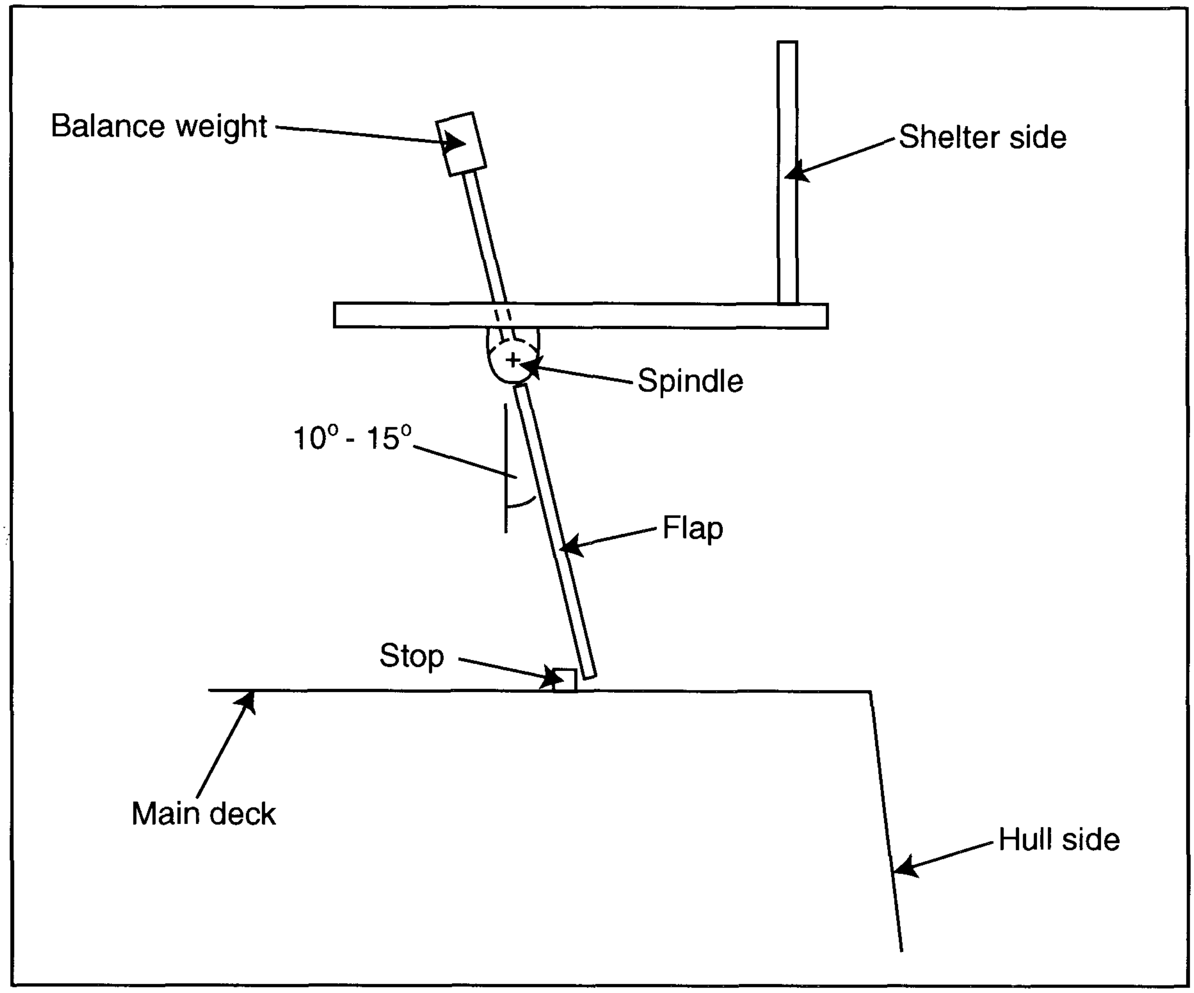


Plan at main deck

Tonnage valves

Tonnage valves perform a similar function to freeing ports, but they contain a weighted flap. This allows water to flow outboard, but not back in **(Figure 7).** During the latter part of processing of the catch the deckwash was kept running; the water and debris was evacuated mainly via the two tonnage valves. If the tonnage valves were working correctly, they ensured that the shelter provided buoyancy when the vessel rolled and the valves dipped under the water level, because the flaps in the valves prevented seawater entering the space. This meant that the shelter could be included in the stability calculations.

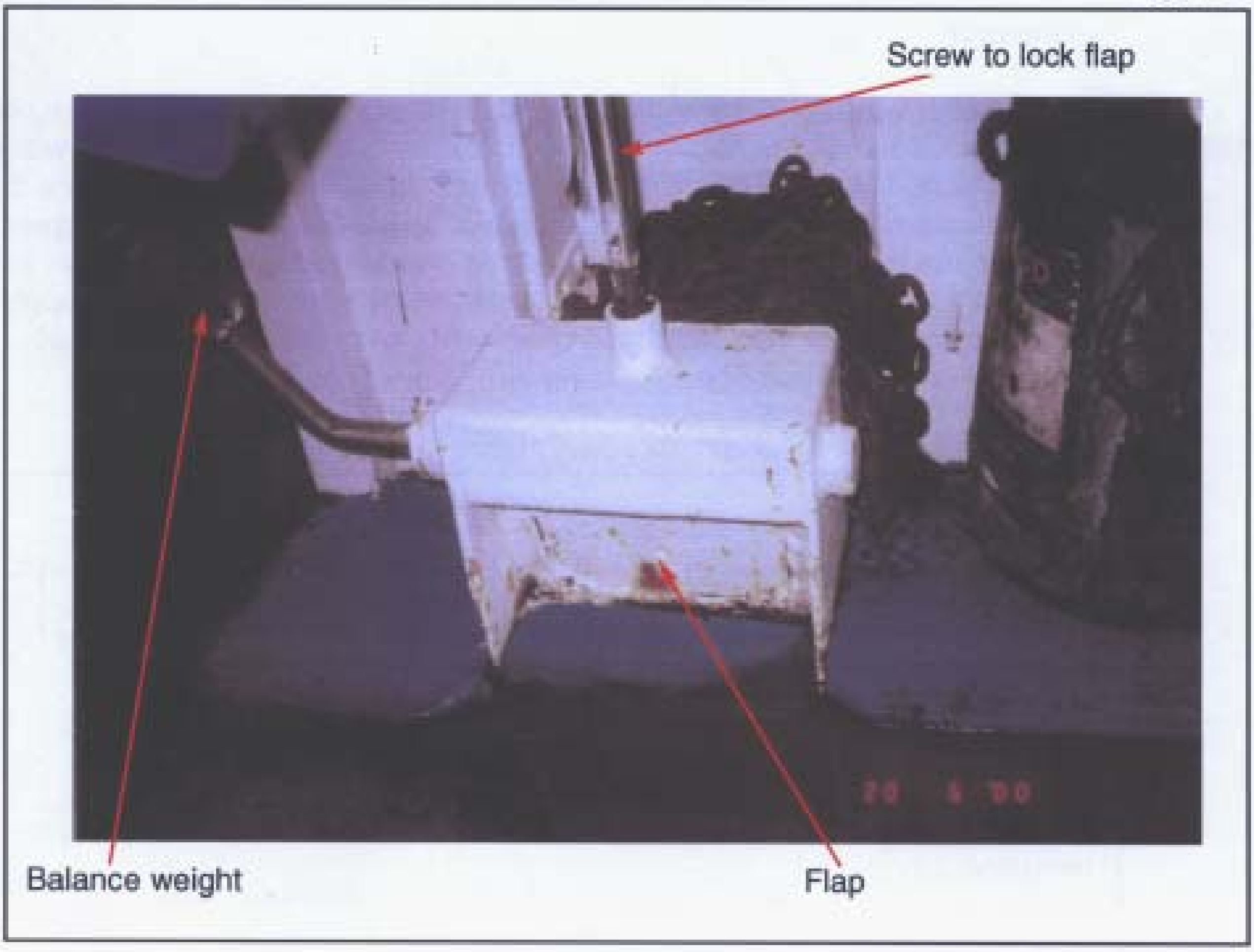
Figure 7



Section through tonnage valve

Tonnage valves are sometimes referred to as balance valves or weighted valves. Guidance on tonnage valves is contained in Survey Memorandum No 54 produced by the **MCA.** The tonnage valve on another fishing vessel is shown in **(Figure 8);** those on board *Angela* were similar, except that a balance weight was fitted on either side. The valve should be screwed shut when there is no fish washing taking place.

Figure 8



Tonnage valve on another vessel

For two or three minutes before the crew became alarmed by the amount of water on the starboard side, one of the deckhands put his foot on one of the balance weights on the starboard tonnage valve, and applied pressure in the outboard direction to force it shut, to try to stop water coming in. The flap in the tonnage valve is at an angle of 10" to 15°. If the vessel is rolling beyond this angle, the valve will open. Even after the deckhand put his foot on the valve, water was still coming in.

The flap valve under the forward end of the gutting trough was used to eject fish offal. It was not a weighted valve. There was a chute on the inboard side of the valve (Figure 2), which was directly under an opening in the bottom of the gutting trough. This chute helped to prevent seawater getting on to the shelter deck via the flap valve, because the top of it was well above the deck. The chute meant that a tonnage valve was considered unnecessary ie a simple flap was adequate.

Giljector

The shelter was also fitted with two suctions which could remove relatively clean water, but were not suitable for ejecting deck wash water contaminated with large pieces of fish offal and debris. The suctions were activated by eductors with the trade name Giljector. **A** sectional diagram of an eductor is shown in **(Figure 9);** the force of the water supplied by the pump creates a drop in pressure in the eductor which draws drain water up the suction pipe, so that both the supply water and the drain water are discharged overboard. The suctions were normally cleaned out at the end of each fishing trip.

Figure 9

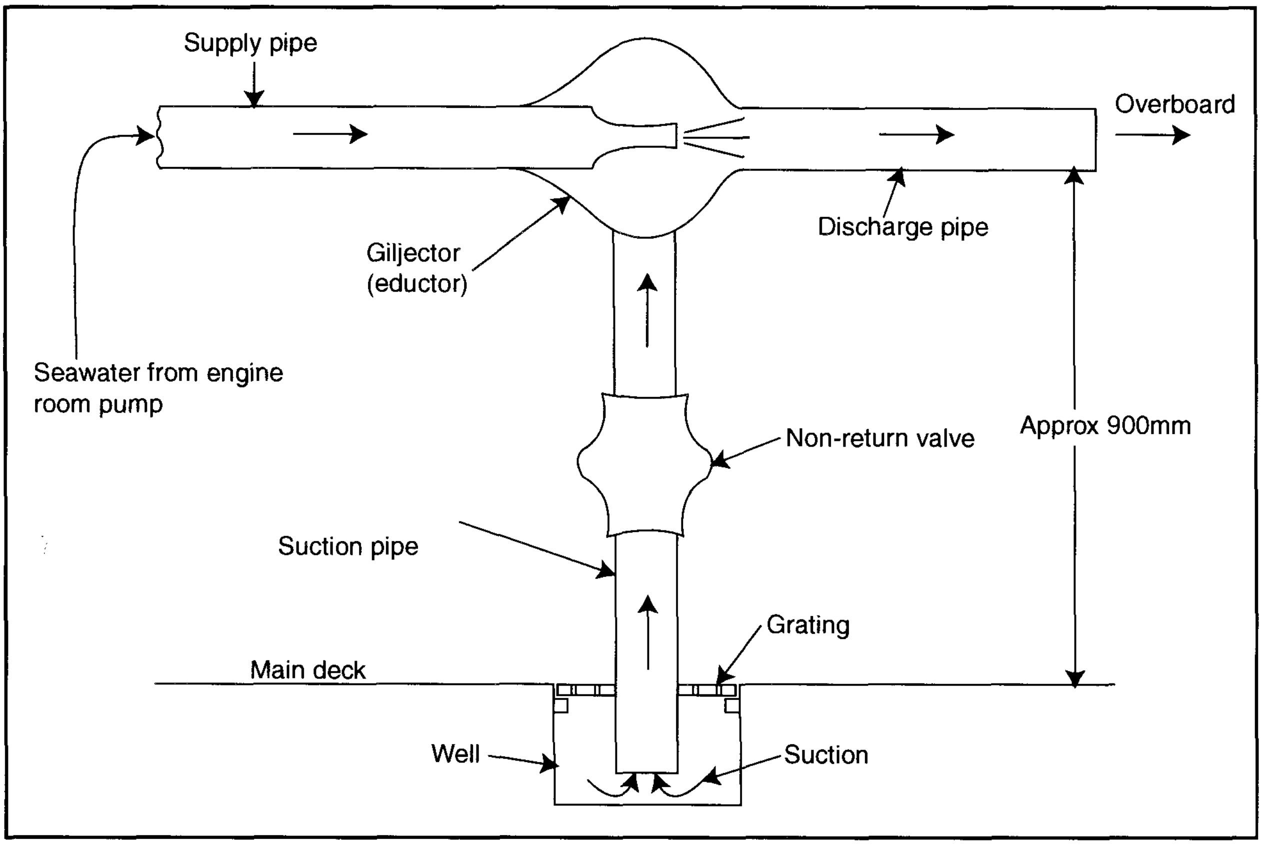
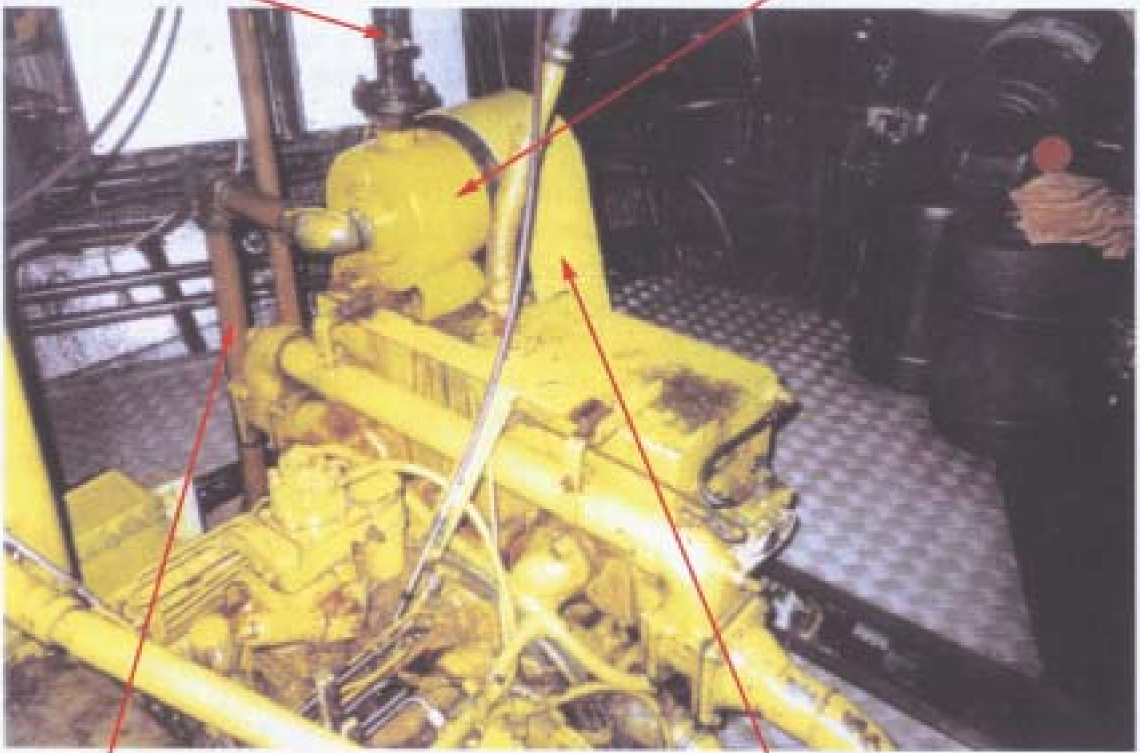


Diagram of giljector

Seawater was supplied to the eductors from pumps in the engine room. An engine-driven Desmi pump **(Figure 10)** fed the starboard eductor. The amount of water which was supplied depended on the speed of the main engine. When *Angela* was stopped, and the main engine was on idle at about 1000 rpm, the amount of seawater supplied to the starboard eductor was about 14 tonnes per hour. When the main engine was on full power at about 1800 rpm, this eductor was supplied at about 25 tonnes per hour. The suction was fitted in a well with a grating over to stop large pieces of offal and other debris from entering. As both the pumps driving the eductors were belt-driven from the main engine, the eductors were being powered all the time the main engine was running, which was **24** hours a day when the vessel was at sea. The sea inlets to the pumps supplying the eductors were in the engine room.

Figure 10



Pump supplying giljector

The Giljector on the starboard side had a nominal suction capacity of 10 tonnes per hour. The Giljector was probably optimised to work with a supply of 25 tonnes per hour. This quantity was fed from the engine-driven Desmi pump with the main engine running at 1800 rpm. With the main engine on 1000 rpm the Giljector would have not been able to evacuate as much water from the shelter.

The crew did not notice any spurting from Giljector suction during the time the water was building up on the starboard side. Neither did they notice any floodwater running across the deck from the port Giljector.

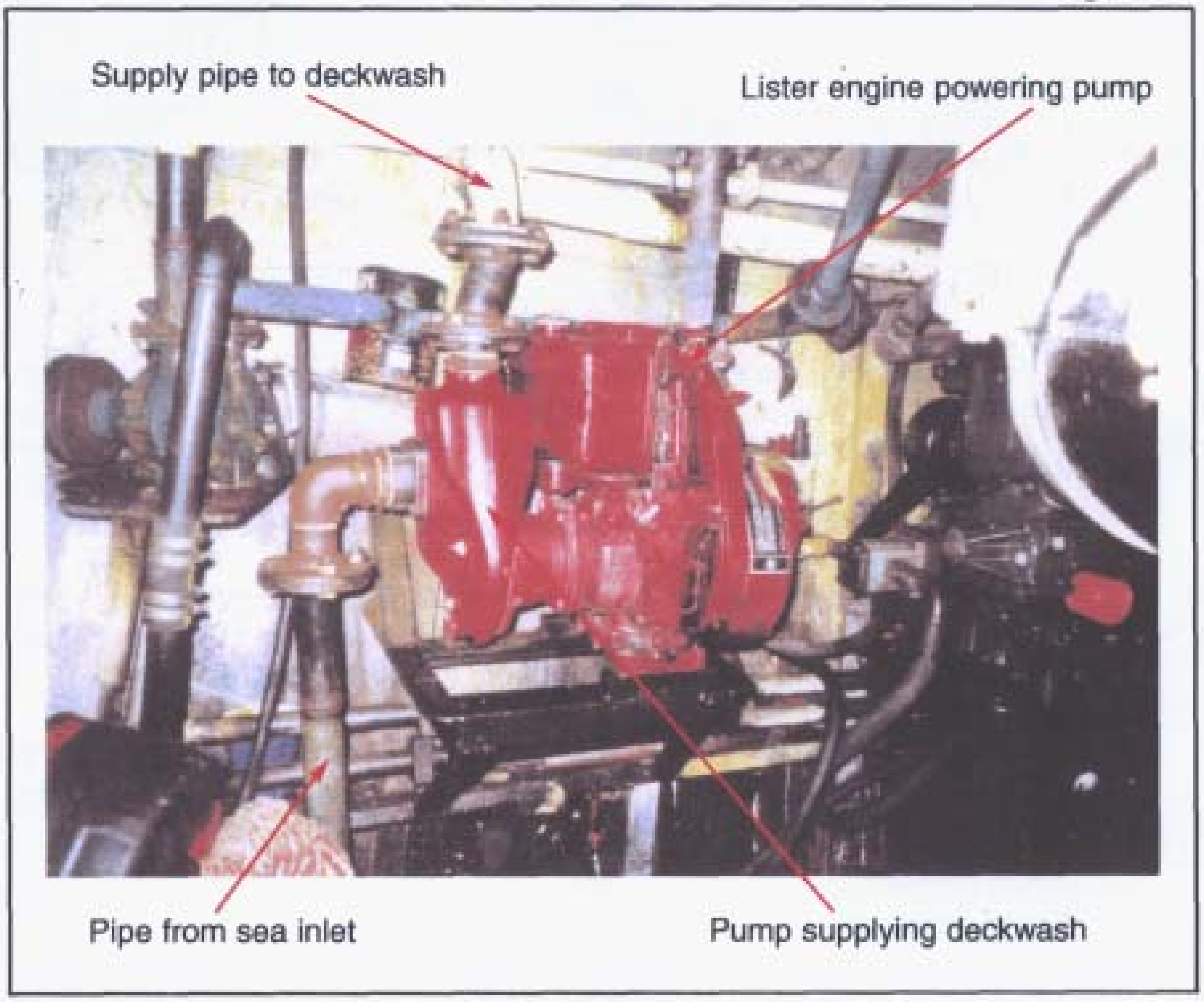
In the past, a discharge had become blocked, leading to flooding from the Giljector on the port side. After this incident non-return valves were fitted in the suction pipes on each side.

Deckwash

A deckwash was fitted in the shelter. This was used for hosing down the deck; fish offal and other debris was swept towards the tonnage valves, and then disposed of through one of these openings. There was a valve in the pipe from the pump, so that the supply could either be fed to the hose, or to the fish washing machine. The supply could not be turned off in the shelter.

The pump in the engine room shown in (Figure 11) normally fed the deck wash. This pump had own power source, and supplied seawater at about 50 tonnes per hour. A deckwash with this capacity is typical for a fishing vessel of this size. The pipe to the deckwash was about 50mm in diameter. One of the crew needed to go down to the engine room to start and stop the deckwash pump, which was normally only kept running during the latter part of the fish processing operation. The diesel engine which drove the deckwash pump had its own tank, which contained about 9 litres of fuel; sufficient for about five to six hours running.

Figure 11



Deckwash pump

1.7 STABILITY

Stability calculations

To help establish the cause of the flooding, the MAIB employed a naval architect to undertake stability calculations. The contractor used was the author of *Angela*'s stability book which was current at the time of the accident. The computer model of *Angela* was the one used for the stability book.

The basis for the work was the estimated condition of *Angela* just before the accident ie with the hopper full, 160 boxes of fish in the hold, about 2 tonnes of fuel in the tanks, etc.

The first stability case the contractor compiled was with the shelter free-flooding. This assumed that the tonnage valve on the starboard was seized open. In this situation the buoyancy of the shelter did not help to counteract the list.

The second case assumed the shelter was watertight, but 1 tonne of floodwater was added to the shelter, which was thought to have come from either the deckwash or the Giljector. The tonnage valve was assumed to be seized, closed. Subsequent cases were run adding floodwater in 1 tonne increments **(see section 2.3)**.

Stability book

The MCA approved the stability book on 25 May 1995.

There is no condition shown in the stability book with the hopper full. There is, however, a guide to show the skipper how to calculate extra conditions. The stability book contains the note:

"It is also of the utmost importance for the skipper to follow the loading arrangements and to keep the quantity of fish stored on deck, especially at the side of the vessel, to a minimum at all times."

The fish load carried at the time of the accident comprised about 6.5 tonnes in the hold and about 3 tonnes in the hopper. One tonne of fish was still in the port net, but this part of the catch was still floating in the sea and therefore did not affect *Angela*'s stability. The maximum load shown in the stability book was 12.65 tonnes in the fish hold; this weight included an allowance for ice.

The skipper had not signed the form FV10, which acknowledges that the stability book has been read and understood.

Fish boxes were normally stowed on top of the shelter when empty, but the stability book shows that they should have been stowed in the fish hold. At the time of the accident about 160 boxes were full of fish in the hold. A total of 275 boxes were normally carried. About 15 boxes were in the shelter ready to be filled, which left about 100 boxes on top of the shelter, each weighing about 4.5kg.

1.8 SAFETY TRAINING

The Fishing Vessels (Safety Training) Regulations 1989 require fishermen born after 1 March 1954 to have undertaken training courses in basic survival at sea, basic fire-fighting and prevention, and basic first-aid. The SFIA keeps records of the fishermen who have undertaken these courses. Apart from deckhand 3, who had undertaken the basic survival at sea course, the SFIA has no record of any of the deckhands attending these basic safety training courses. The requirement does not apply to deckhand 2, since he was born before the date shown above.

The Fishing Vessels (Safety Provisions) Rules 1975, Regulation 120(2) requires, for vessels of this size that:

"The skipper shall ensure that the crew are trained in the use of all life-saving and fire appliance equipment with which the vessel is provided and shall ensure that all members of the crew know where the equipment is stowed. Such training shall be carried out at intervals of not more than one month."

SECTION 2 - ANALYSIS

2.1 FLOODING

The capsize to starboard, and foundering of *Angela* was caused by flooding of the shelter. Flooding of the lower spaces is not considered to be the cause. Neither the bilge alarm in the engine room, nor the one in the fish hold, activated before the loss. Also, the skipper noticed no floodwater at the bottom of the stairs leading to the cabin when he went to collect the lifejackets. The arrangement of the lower spaces is shown in **(Figure 5)**.

The washing down of the fish hold in harbour normally activated the bilge alarm, which served as a test. The bilge alarm in the engine room was also normally tested after each fishing trip.

Three possible causes of the flooding of the shelter have been identified:

Tonnage valve

When the stability book was compiled it was assumed that the tonnage valves would operate properly, and therefore no conditions were shown without the buoyancy of the shelter.

Had the starboard tonnage valve been jammed open, for instance, by a piece of fish offal, this would have allowed an ingress of water, which could have led to the capsize.

Surveyors of fishing vessels often find that tonnage valves do not work properly when they are inspected. The problem usually is that the hinge on the flap has become stiff or seized, allowing the valve to remain in the open or closed position. Either is potentially dangerous. If stuck open it would allow free flooding of the shelter i.e. the buoyancy of the shelter would not counteract large angles of list. If stuck closed it would not allow deckwash water to drain over the side, allowing this destabilising weight, which has a free surface, to build up inside the shelter.

Some fishing vessel surveyors prefer pumps to be used for drainage. However, it is the experience of the MAIB that pumps can be unreliable; for instance, they can break down or become blocked.

Giljectors

The floodwater built up on the starboard side of the shelter. The Giljector on this side could have been the cause, if the non-return valve was not working and the overboard discharge had become blocked. The non-return valve had not been checked for some time, and it could have become stuck open. This defect would not have been readily apparent as the Giljector would still have pumped satisfactorily. However, if the overboard discharge became blocked, for instance, by a piece of fish offal, the supply to the Giljector would have been directed into the shelter. If so, the starboard Giljector would have been pumping water into the shelter, rather than extracting it, as it was supposed to.

The supply to the starboard Giljector was about 14 tonnes per hour before the accident, except for the short time the vessel was full ahead, and being steered to starboard. If this water was diverted inside, and if no water had flowed out of the starboard tonnage valve, the shelter would fill at the same rate.

The crew first became alarmed at about 1255, when there were about 4 tonnes of water in the shelter. Stability calculations have shown that it would have taken about another 16 tonnes of water to cause a capsize. *Angela* sank at about 1320, so 16 tonnes would have had to have been pumped into the shelter in 25 minutes. This is equivalent to about 37 tonnes per hour. The misdirected supply to the Giljector could not have been responsible for this quantity of water.

None of the crew remembers any spurting from the Giljector suction in the early stages of the flooding. If the supply to the Giljector had been misdirected, this would probably have been noticed, as the deckhands were standing immediately adjacent to this position.

It is therefore concluded that the Giljector on the starboard side was probably not the cause of the capsize.

It is possible that a cracked supply pipe to the starboard Giljector was the cause of the flooding, but none of the crew remembers any spurting from the pipe before the accident. If so, the flooding rate would have been similar to a blocked discharge.

It is very unlikely that the Giljector on the port side caused the flooding, because the crew would have noticed the water running across the deck to the starboard side ie from the high side to the low side. However, flooding from the port Giljector had occurred in the past, but this was before the non-return valves were fitted.

The main advantage of eductors is that they contain no moving parts. A disadvantage is that they are usually supplied with water continuously; this water can be diverted inside the vessel via the suction pipe, which could lead to undetected flooding. Giljectors used to be quite popular, but few fishing vessels have them now.

Some fishing vessel surveyors prefer trash pumps, which are designed to handle fish offal and debris. These pumps have a large clearance around the impeller, so do not usually become blocked. However, the large internal clearances tend to make them inefficient, in terms of the power supplied, versus the amount of water pumped.

Mascerator pumps can also handle debris. These are fitted with an impeller which has a cutting edge, which chops up the debris as it is pumped. Mascerator pumps do not have large clearances, but can become blocked by hard pieces of debris.

Another method of pumping out the shelter is to feed the drains into the bilge system used to pump out the lower spaces. The danger with this method is that fish offal may block the main bilge system.

Deckwash

The shelter had filled with about 20 tonnes of water when the capsize was complete. If the deckwash was on, it would have supplied about 50 tonnes per hour. The suction of the Giljector needs to be deducted from this; an estimate has indicated that this would be close to the nominal value i.e. 10 tonnes per hour. Therefore about 40 tonnes an hour would be fed into the shelter, if the tonnage valve was either blocked, or jammed closed. If the deckwash was on, it would take about 6 minutes for 4 tonnes of water to build up. The crew first became alarmed by the water at about 1255, so if the deckwash had been the cause of the flooding it would have had to have been turned on at about 1249; which is around the time the skipper went up to the wheelhouse.

It would have taken about another 16 tonnes of water to capsize *Angela*; this would take about 24 minutes if the deckwash caused the flooding. Adding 24 minutes to 1255 takes the time to about 1320, which corresponds with the time the vessel sank.

The deckwash potentially supplied enough water to the shelter to cause a capsize. This quantity of water corresponds with the timing of the accident, but most of the crew recall that the deckwash was not turned on before the accident. The skipper is sure the deckwash was off at this time.

Summary of factors

Had the starboard tonnage valve been jammed open, it could have allowed an ingress of seawater into the shelter, which could have capsized the vessel. It is considered that this is the most likely cause of the flooding. Alternatively, had this tonnage valve been jammed closed, flooding of the shelter could have come from the one of the Giljectors or the deckwash. Calculations have shown that *Angela* was fully capsized once 20 tonnes of floodwater had entered the shelter.

If tonnage valves are fitted, the crew should inspect them regularly, preferably between each trip. It is most important that spindles are kept lubricated so that flaps move freely.

When fish are being gutted, the tonnage valves should be checked regularly to ensure they have not become blocked by fish offal; this is especially important when the deckwash is running. If water starts to build up in the shelter, the deckwash should be checked immediately to ensure that it is turned off.

Tonnage valves should be screwed shut unless the deckwash is on. These valves should never be wedged open.

2.2 SHELTER

Although not ideal, the reasons for including the buoyancy of the shelter in order to pass the stability criteria are clear, since otherwise the vessel would probably have to be withdrawn from service. Usually, in these circumstances, the portion of the shelter made watertight is used for gutting the catch, so large quantities of seawater need to be pumped into the space for washing. On board *Angela* the only means of discharging the water used for washing were the Giljector suctions, and the tonnage valves. When the hopper was full, the vessel was listed to starboard, consequently only the Giljector and the tonnage valve on the starboard side were effective. With the vessel listed and rolling in the seaway, the starboard tonnage valve might have occasionally dipped below the surface of the waves; at these times no discharge could have taken place if the unit was operating properly.

The suction of the starboard Giljector was much less than the supply to the deckwash/washing machine, especially during the gutting/washing operation when the vessel was stopped and the main engine was idling.

The deckwash on *Angela* had a high capacity which could not be discharged by the Giljector alone. To stop the deckwash water building up in the shelter, the tonnage valve on the low side had to be working.

This accident has highlighted the dangers of watertight shelters used for fish washing. There are many vessels with such spaces.

When shelters are made watertight to pass stability criteria, the portion of buoyancy used preferably should not contain the area where the fish are washed, as this is prone to flooding. A part of the shelter which is not used for fish washing, would not need to be fitted with tonnage valves, or suctions, as there would be no need to clear water used for fish washing. However, it is recognised that only rarely can this be arranged, because the area used for fish washing normally includes most of the shelter, and it is not always practical to sub-divide this area from the rest of the shelter. Also, the buoyancy of all the shelter is often necessary to meet the stability criteria.

2.3 STABILITY

In the first stability case that the naval architect contracted by the MAIB compiled, the vessel was without the buoyancy of the shelter. This condition assumed that the starboard tonnage valve was jammed open, allowing the free flooding of the shelter. In this condition, *Angela*'s stability was substantially less than the normal stability criteria **(Annex A)**, with the area under the righting lever curve up to 30°, being only about one tenth of the criteria.

The basis for this stability information was an inclining test undertaken in 1995. An inclining test will establish the position of the centre of gravity at a known displacement. It is possible that the centre of gravity had moved to a higher position since 1995; this is quite common. The top weight of vessels tends to increase the longer they are in service. For example, on board *Angela* at the time of the accident, empty fish boxes were stowed on top of the shelter, whereas the stability book indicated they were stowed in the fish hold; this would have raised the centre of gravity.

The last tenth of the required area under the righting lever curve may have been lost if the centre of gravity was higher than assumed. If so the vessel was unstable without the buoyancy of the shelter. Therefore, if the tonnage valve on the starboard side was open. *Angela* would have capsized slowly as the shelter filled. This scenario agrees with the description of one of the deckhands; he put his foot on the valve to try to stop water coming in.

When the hopper was full, *Angela* had a list to starboard of about 9°. She did not meet the stability criteria with a full hopper even assuming the shelter was watertight. The relevant case the naval architect compiled is shown in **(Annex B)**. The area under the righting lever curve up to 30°, was less than half that which was required.

The crew became alarmed when the floodwater on the starboard side was about 0.65m deep. At this time the angle of list was about 21°, with about 4 tonnes of floodwater in the shelter **(Annex C)**. The tonnage valve and offal chute were about level with the waterline. With the vessel rolling, together with the waves, the seawater would be above this level for about half of the time.

The decision to abandon was taken when the fish loading hatch started to dip below the waterline. At this time the steady angle of list was about 37° and there were about 10 tonnes of floodwater in the shelter **(Annex D)**.

The capsize was complete when about 20 tonnes of water had entered the shelter. *Angela* rolled upside down and then foundered.

The Fishing Vessels (Safety Provisions) Rules 1975, Regulation 16, requires that, for vessels of this size, the required stability criteria should be met in "all foreseeable operating conditions". Also in Schedule 3(4) of the Rules it is stated that: "*Where deck cargo is carried by a vessel, the estimated weight and disposition of the deck cargo the vessel may be expected to carry while satisfying the stability criteria set out in Rule 16 of these Rules shall be included in such information.*" Therefore, at least one of the operating conditions shown in the stability book should be with the hopper full. For vessels fitted with a watertight shelter, when there is a great danger of flooding this space, it is especially important that the full criteria are met. It is not considered to be satisfactory to rely on the skipper to compile stability condition(s) with the hopper full. It would be better if the condition(s) were compiled by a naval architect before the MCA approved the stability book. The note regarding the loading, which was shown in the stability book, is felt to be of little relevance in this case, as it did not give specific guidance on loading the hopper. A recommendation to the MCA has been made on this.

2.4 LIFERAFT

The liferaft performed satisfactorily, but an error was made during its deployment. The painter should not have been cut before the liferaft canister was released into the sea. Fortunately the canister did not drift far. Only one of the crew was able to board the liferaft directly, three of them boarded after a short swim.

The mistake in cutting the painter is to some extent understandable, bearing in mind the precarious situation. The vessel was nearly on her beam ends. The crewman who cut the painter wanted to be sure the liferaft did not go down with the vessel. The crew believe that they did quite well in the circumstances.

For a manual deployment, the liferaft should have been released from its cradle using the senhouse slip, and then the canister should have been thrown into the water or been allowed to float off as the water level rose. The painter should have been left attached to the vessel; a crewmember still on board *Angela* could then have inflated it by jerking the painter. The liferaft could then have been boarded while holding it next to the vessel using the painter. The crew could then have boarded it without jumping into the sea first. Finally, once in the liferaft, the crew should have cut the painter using the knife provided on board for this purpose. The crewman cut the strap because he could not reach the senhouse slip as the liferaft was partially submerged.

The wind caused the liferaft to drift away from the survivor in the water. Liferafts are provided with water pockets on the bottom to minimise drift due to windage, but the drift cannot be prevented completely. These pockets make liferafts very difficult to paddle, as seen by the crew's inability to reach the man in the water.

2.5 EPIRB

The EPIRB did not activate after the accident. This is probably because it became tangled in the rigging around the mast. It is known that the EPIRB can become trapped in this way when a capsize occurs before sinking. EPIRB's should always be installed in a position where the chances of becoming tangled are minimal. The owner believes that the EPIRB was fitted in such a position on *Angela*.

Since the skipper transmitted distress messages on VHF channel 16, and MF 2182kHz, the EPIRB was not needed this time. However, had *Angela* capsized suddenly, the EPIRB might have been crucial to the crew's survival.

2.6 LIFEJACKETS

It would have been better if some lifejackets had been stowed in a readily accessible position, such as, in the wheelhouse, as there was no time to fetch those stowed below in the cabin.

2.7 LIFEBUOY

The crewman who used the lifebuoy could only get his head and one arm through it. He was not heavily built. This awkward position did not help him when he was in the water.

2.8 EVACUATION AND RESCUE

The skipper used 2182kHz, which is an MF frequency, to call the coastguard MRCC in Aberdeen, because this was suitable for over the horizon communication. VHF is only suitable for line of sight transmissions.

The skipper is commended for his prompt action in using the radios to summon assistance, and for jumping into the sea to retrieve the liferaft. The master and crew of *Scott Guardian* are also commended for quickly attending the scene and rescuing *Angela*'s crew. The fast rescue craft was handled skilfully.

2.9 SAFETY TRAINING

The mistake in deploying the liferaft shows a lack of knowledge in the use of lifesaving equipment. None of the deckhands had completed all the basic safety training courses, which were required by law for the youngest three. If all the deckhands had undertaken the course in basic survival at sea, the error would probably not have been made. This mistake might have had severe consequences if the liferaft canister had drifted too far for the crew to swim to it. The report contains a recommendation to the owners that, in the future, they should ensure that all the crew have attended these courses before being allowed to serve on board their fishing vessel(s).

Had crew training in lifesaving appliances been thorough on board *Angela*, this should have avoided the error in the deployment of the liferaft. The skipper did have informal discussions with the crew about the safety equipment, particularly what they would do in various potential emergencies. It is considered that this training should be formalised. The report therefore contains a recommendation to the skipper, that on any fishing vessel that he operates in the future, the crew should be properly trained in the use of all lifesaving and fire appliance equipment provided on board. The crew should also be made aware of where the equipment is stowed. Such training should be carried out at intervals of not more than one month.

SECTION 3 - CONCLUSIONS

3.1 FINDINGS

1. *Angela* capsized and foundered at about 1310 UTC on 6 February 2000. The vessel was abandoned and the five crew members were rescued. (1.2)

2. The vessel had a current UKFVC, which was issued on 22 March 1999.

3. *Angela* left Peterhead on 31 January 2000, to fish in the North Sea. The fishing operation just before the accident was due to be the last one before returning to port. (1.1)

4. The previous catch was a good one, and the fish hopper was filled. This caused an angle of list of about 9°. (1.1)

5. After loading the catch, the crew started to gut the fish. After 15 minutes they became alarmed by the amount of water on the starboard side of the shelter. (1.1)

6. A tight turn to starboard failed to correct the list. (1.1)

7. Bilge alarms were fitted in the engine room and the fish hold, but they did not sound as the list increased. (1.1)

8. The crew attempted to reduce the list by discharging whole fish through the offal chute, and shovelling fish out of the fish hatch. When the fish hatch started to dip below the waterline, the skipper decided to abandon the vessel. (1.1)

9. The skipper made a radio call to the standby vessel *Scott Guardian*, and asked to be rescued. The coastguard was also informed. (1.2)

10. The liferaft was deployed manually, but the painter was cut prematurely, so most of the crew had a short swim before being able to board. One of the crew did not board the liferaft; he used a lifebuoy to keep himself afloat. (1.2)

11. The liferaft drifted away from the man in the water with the lifebuoy. (1.2)

12. The fast rescue craft of *Scott Guardian* first rescued the deckhand with the lifebuoy, and then the rest of the crew in the liferaft. (1.2)

13. The deckhand who used the lifebuoy was suffering from mild hypothermia after the rescue, but he subsequently made a full recovery. (1.2)

14. The EPIRB did not activate when *Angela* sank. (1.2)

15. The crew were all experienced fishermen. The skipper held a Certificate of Competency. (1.4)

16. The structure forming the shelter was added a couple of years after *Angela* was built. The shelter was subsequently made watertight to meet stability requirements. (1.6)

17. The watertight shelter contained a deckwash, which was supplied with water at a rate of 50 tonnes per hour. Tonnage valves that acted like scuppers, and pumps, were fitted in the space to clear the water from the deckwash. (1.6)

18. With the exception of one deckhand, who had undertaken the basic survival at sea course, none of the deckhands had attended the basic safety training courses. (1.8)

19. Had the starboard tonnage valve been jammed open by, for instance, a piece of fish offal, this could have led to the capsize. (2.1)

20. The Giljector on the starboard side was probably not the cause of the capsize. (2.1)

21. The Giljector on the port side was probably not the cause of the capsize, because the crew would have noticed the water running across the deck. (2.1)

22. If the starboard tonnage valve had become blocked or jammed closed, it would have taken about half an hour for the deckwash to have pumped enough water into the shelter to cause a capsize. (2.1)

23. Where watertight shelters are used for fish washing, the water used poses a danger to the vessel's stability. (2.2)

24. *Angela* did not meet the stability criteria with a full hopper. (2.3)

25. It would have been better if some lifejackets had been stowed in a readily accessible position, such as in the wheelhouse. (2.6)

3.2 CAUSE

Immediate cause:

The capsize to starboard, and foundering of *Angela*, was caused by flooding of the shelter.

Contributory factors:

The most likely cause of the flooding is considered to be the starboard tonnage valve being jammed open, which could have allowed seawater to enter the shelter from the outside.

The starboard Giljector malfunctioning could have caused the flooding. If so, the Giljector would have pumped water in, instead of sucking it out. This would have caused flooding of the shelter if the tonnage valve had been jammed shut; or

The deckwash being turned on could have caused the shelter to be flooded if the tonnage valve had been jammed shut.

The vessel's resistance to capsize was reduced when the hopper was full of fish. The stability criteria were not met with a full hopper.

SECTION 4 - RECOMMENDATIONS

The Maritime and Coastguard Agency is recommended to:

1. Ensure, when approving stability books for fishing vessels similar to *Angela*, at least one of the operating conditions is with the hopper full. (2.3)

Mr Peter Strachan and Mr Mark Addison, as fishing vessel owners, are recommended to:

2. Ensure that all members of their crews have undertaken the basic safety training courses required by law. (1.8, 2.9)

Mr Mark Addison, as a fishing vessel skipper, is recommended to:

3. Ensure that his crew are trained in the use of all lifesaving and fire appliance equipment with which the vessel is provided. The crew should also be informed where the equipment is stowed. Such training should be carried out at intervals of not more than one month. (1.8, 2.9)

Marine Accident Investigation Branch
April 2001

ANNEX A - Vessel's stability condition - no watertight shelter

DEADWEIGHT TABLE

Vessel....: ANGELA - NO WT SHELTER
Condition.: 8:ANGELA PD 400 - CAPSIZE CONDITION - 6/2/00
State.....: Hull without added appendages
Water SG.: 1.025
compliance: Vessel fails requirements in this condition

Longitudinal dimensions about AFT PERP (STN 0) (-ve aft, +ve forward)
vertical dimensions about LINESPLAN BASE (+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	O.F WING TANK PORT	0.955	7.915	7.559	0.812	0.775	1.301	1.242	0.407
2	O.F WING TANK STBD	0.955	7.915	7.559	-0.812	-0.775	1.301	1.242	0.408
3	FRESHWATER TANK AFT STBD	0.301	0.197	0.059	1.507	0.454	2.648	0.797	0.087
4	STORES	0.380	11.500	4.370	0.000	0.000	4.500	1.710	-
5	FISHING GEAR	7.175	3.793	27.215	0.000	0.000	4.978	35.717	-
6	160 BOXES OF FISH & PRAWNS	6.500	6.400	41.600	0.000	0.000	2.320	15.080	-
7	CREW	0.370	6.860	2.538	2.590	0.958	4.700	1.739	-
8	FISH & PRAWNS IN HOPPER	3.000	4.270	12.810	2.000	6.000	5.180	15.540	-
	DEADWEIGHT TOTAL	19.636	5.282	103.710	0.377	7.412	3.721	73.068	0.902
	LIGHTSHIP	96.599	6.604	637.940	0.000	0.000	3.688	356.257	-
	DISPLACEMENT	116.235	6.381	741.650	0.064	7.412	3.694	429.325	0.902
	Free Surface Correction (Total Free Surface Moment/Displacement)						0.008		
						VCG fluid	3.701		

SAILING STATE

Vessel....: ANGELA - NO WT SHELTER
Condition.: 8:ANGELA PD 400 - CAPSIZE CONDITION - 6/2/00
State.....: Hull without added appendages
Water SG..: 1.025
Compliance: Vessel fails requirements in this condition

DRAFT SUMMARY (DIMENSIONS IN METRES)	Maximum	Actual
Draft forward (about USK at FP)	3.572	2.314
Draft midships (about USK)	-	2.875
Draft aft (about USK at AP)	3.600	3.438

FREEBOARD SUMMARY (DIMENSIONS IN METRES)	Minimum	Actual
Freeboard forward at FP to shelter deck (HB)	1.958	2.989
Freeboard aft at AP to main deck (HDA)	0.648	0.368

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	0.207 by bow	3.356	-0.064	0.000	-7.412	-0.064
5	0.245 ''	3.358	0.295	0.323	-3.183	-0.027
10	0.252 ''	3.313	0.652	0.643	1.062	0.009
15	0.257 ''	3.241	0.995	0.958	4.315	0.037
20	0.236 ''	3.153	1.303	1.266	4.349	0.037
25	0.184 ''	3.046	1.586	1.564	2.488	0.021
30	0.107 ''	2.916	1.849	1.851	-0.158	-0.001
35	0.005 ''	2.762	2.097	2.123	-3.048	-0.026
40	0.118 by stern	2.584	2.328	2.379	-5.953	-0.051
45	0.261 ''	2.382	2.543	2.617	-8.638	-0.074
50	0.417 ''	2.161	2.738	2.835	-11.356	-0.098
55	0.578 ''	1.924	2.907	3.032	-14.499	-0.125
60	0.735 ''	1.675	3.050	3.205	-18.034	-0.155
65	0.887 ''	1.414	3.167	3.355	-21.823	-0.188
70	0.992 ''	1.150	3.262	3.478	-25.159	-0.216
75	1.130 ''	0.876	3.328	3.575	-28.759	-0.247
80	1.267 ''	0.597	3.367	3.645	-32.290	-0.278
85	1.409 ''	0.316	3.383	3.687	-35.334	-0.304
90	1.561 ''	0.037	3.377	3.701	-37.721	-0.325

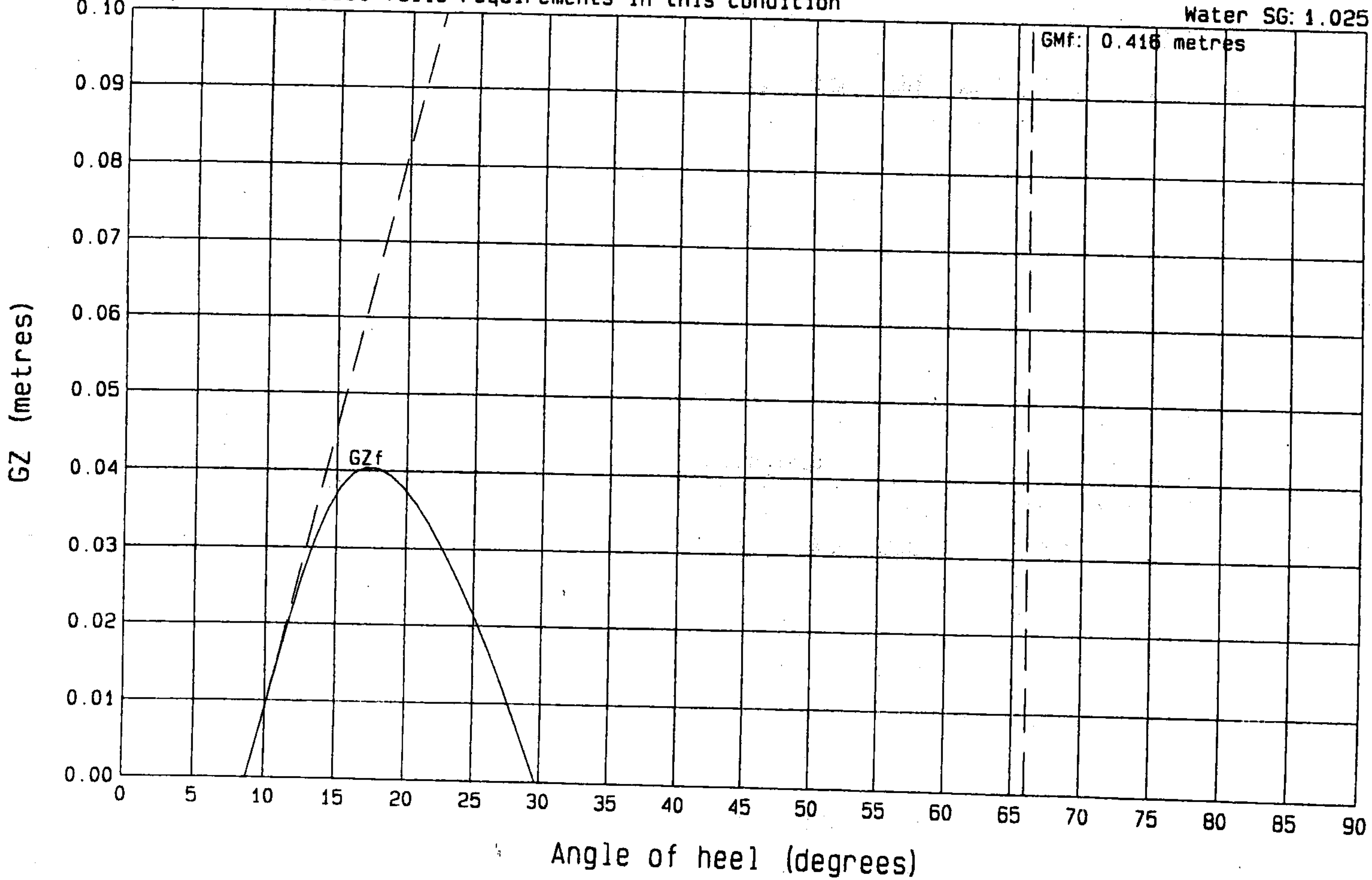
STABILITY SUMMARY	Minimum	Actual
Area under GZ curve between 8.73 and 30.00 degrees (metre.radians)	0.055	0.006
Area under GZ curve between 8.73 and 40.00 degrees (metre.radians)	0.090	0.006
Area under GZ curve between 30.00 and 40.00 degrees (metre.radians)	0.030	0.000
Maximum GZ (metres)	0.200	0.039
Angle of heel at which maximum GZ occurs (degrees)	25.000	17.591
Maximum GZ between 29 and 90 degrees (metres)	0.200	0.003
Positive GZ heel range (degrees)	-	20.991
GM solid (metres) (at angle of equilibrium)	-	0.424
Free Surface correction (metres)	-	0.008
GM fluid (metres) (at angle of equilibrium)	0.350	0.416

STABILITY SUMMARY (CONTINUED)	Maximum	Actual
Angle of equilibrium (degrees)	-	8.728

GZ PLOT

ANGELA - NO WT SHELTER

Condition.: 8: ANGELA PD 400 - CAPSIZE CONDITION - 6/2/00
State.....: Hull without added appendages
Compliance: Vessel fails requirements in this condition



ANNEX B - Vessel's stability condition - with watertight shelter

DEADWEIGHT TABLE

vessel.....: **ANGELA - WITH WT SHELTER**
Condition.: 8:ANGELA PD 400 - CAPSIZE CONDITION - *6/2/00*
State.....: Hull without added appendages
Water SG..: 1.025
Compliance: Vessel fails requirements in this condition

Longitudinal dimensions about AFT PERP (STN 0) (-ve aft, +ve forward)
vertical dimensions about LINESPLAN BASE (+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	O.F WING TANK PORT	0.955	7.915	7.559	0.812	0.775	1.301	1.242	1.515
2	O.F WING TANK STBD	0.955	7.915	7.559	-0.812	-0.775	1.301	1.242	0.502
3	FRESHWATER TANK AFT STBD	0.301	0.197	0.059	1.507	0.456	2.648	0.797	0.284
4	STORES	0.380	11.500	4.370	0.000	0.000	4.500	1.710	-
5	FISHING GEAR	7.175	3.793	27.215	0.000	0.000	4.978	35.717	-
6	160 BOXES OF FISH & PRAWNS	6.500	6.400	41.600	0.000	0.000	2.320	15.080	-
7	CREW	0.370	6.860	2.538	2.590	0.958	4.700	1.739	-
8	FISH & PRAWNS IN HOPPER	3.000	4.270	12.810	2.000	6.000	5.180	15.540	-
	DEADWEIGHT TOTAL	19.636	5.282	103.718	0.377	7.412	3.721	73.068	2.301
	LIGHTSHIP	96.599	6.604	637.940	0.000	0.000	3.688	356.257	-
	DISPLACEMENT	116.235	6.381	741.650	0.064	7.412	3.694	429.325	2.301
	Free Surface Correction (Total Free Surface Moment/Displacement)						0.020		
	VCG fluid						3.713		

SAILING STATE

Vessel....: ANGELA - WITH WT SHELTER
Condition.: 8:ANGELA PD 400 - CAPSIZE CONDITION - 6/2/00
State.....: Hull without added appendages
Water SG..: 1.025
Compliance: Vessel fails requirements in this condition

DRAFT SUMMARY (DIMENSIONS IN METRES)	Maximum	Actual
Draft forward (about USK at FP)	3.572	2.313
Draft midships (about USK)	3.183	2.875
Draft aft (about USK at AP)	3.600	3.440

FREEBOARD SUMMARY (DIMENSIONS IN METRES)	Minimum	Actual
Freeboard forward at FP to shelter deck (HB)	1.958	2.986
Freeboard amidships to main deck	0.300	0.251
Freeboard aft at AP to main deck (HDA)	0.648	0.360

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	0.207 by bow	3.356	-0.064	0.000	-7.412	-0.064
5	0.244 ''	3.358	0.256	0.324	-3.212	-0.028
10	0.249 ''	3.313	0.653	0.645	0.956	0.008
15	0.257 ''	3.238	1.004	0.961	4.984	0.043
20	0.256 ''	3.134	1.343	1.270	8.473	0.073
25	0.245 ''	3.000	1.670	1.569	11.732	0.101
30	0.234 ''	2.835	1.987	1.857	15.095	0.130
35	0.221 ''	2.639	2.289	2.130	18.483	0.159
40	0.208 ''	2.415	2.575	2.387	21.879	0.188
45	0.196 ''	2.162	2.845	2.626	25.519	0.220
50	0.183 ''	1.885	3.095	2.845	29.153	0.251
55	0.168 ''	1.593	3.313	3.042	31.465	0.271
60	0.149 ''	1.290	3.495	3.216	32.385	0.279
65	0.130 ''	0.979	3.643	3.365	32.204	0.277
70	0.103 ''	0.666	3.762	3.489	31.638	0.272
75	0.057 ''	0.359	3.865	3.587	32.353	0.278
80	0.030 by stern	0.062	3.960	3.657	35.227	0.303
85	0.115 ''	-0.247	4.002	3.699	35.182	0.303
90	0.170 ''	-0.578	3.976	3.713	30.524	0.263

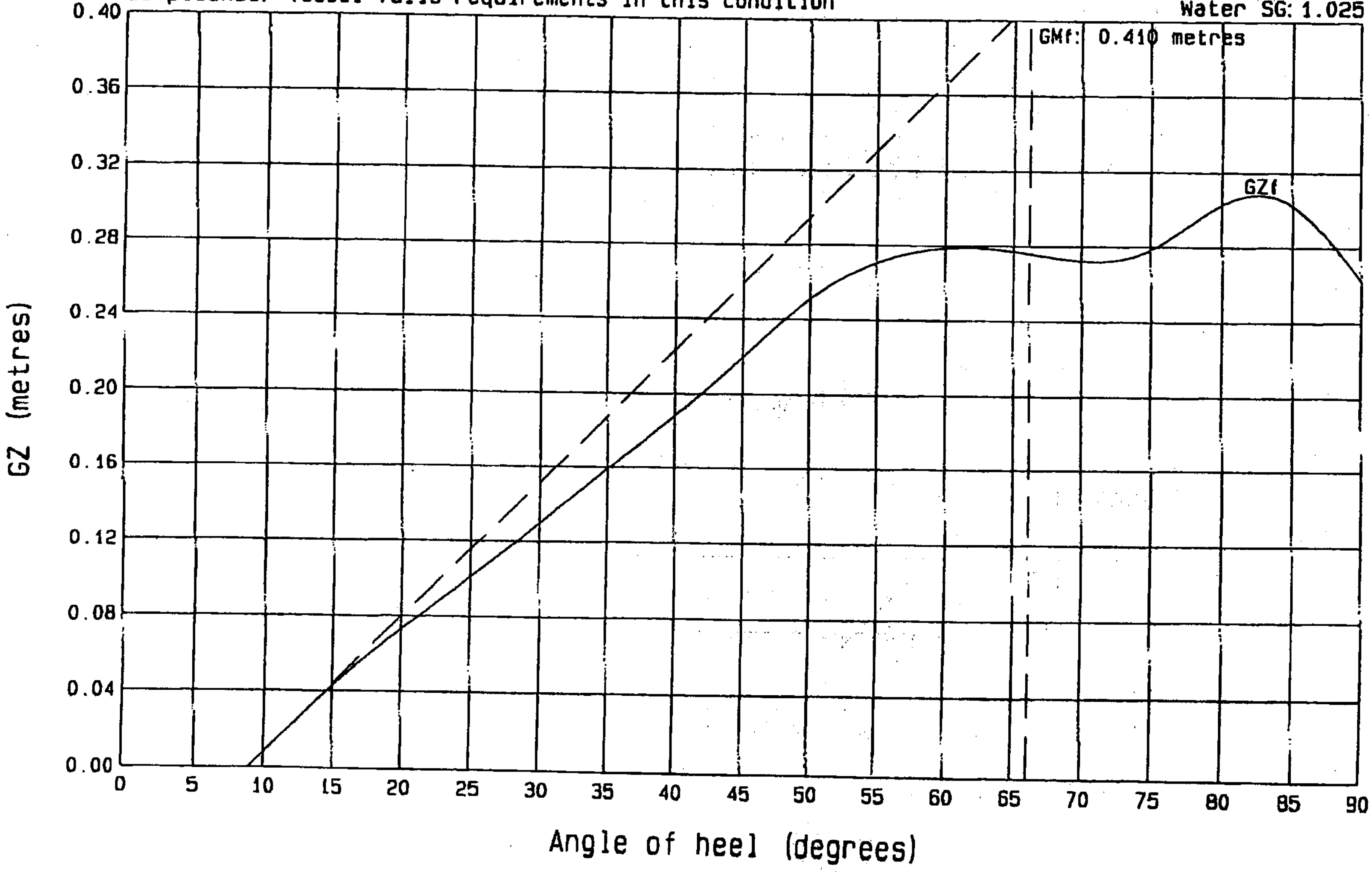
STABILITY SUMMARY	Minimum	Actual
Area under GZ curve between 8.85 and 30.00 degrees (metre.radians)	0.055	0.025
Area under GZ curve between 8.85 and 40.00 degrees (metre.radians)	0.090	0.053
Area under GZ curve between 30.00 and 40.00 degrees (metre.radians)	0.030	0.028
Maximum GZ (metres)	0.200	0.306
Angle of heel at which maximum GZ occurs (degrees)	25.000	82.424
Area under GZ curve to angle of maximum GZ (metre.radians)	0.000	0.248
Maximum GZ between 29 and 90 degrees (metres)	0.200	0.308
Positive GZ heel range (degrees)	45.000	81.150
GM solid (metres) (at angle of equilibrium)	-	0.430
Free Surface correction (metres)	-	0.020
GM fluid (metres) (at angle of equilibrium)	0.350	0.410

STABILITY SUMMARY (CONTINUED)	Maximum	Actual
Angle of equilibrium (degrees)	-	8.850

GZ PLOT

ANGELA - WITH WT SHELTER

Condition.: 8: ANGELA PO 400 - CAPSIZE CONDITION - 6/2/00
State.....: Hull without added appendages
Compliance: Vessel fails requirements in this condition



ANNEX C - Vessel's stability condition - with watertight shelter and 4 tonnes of seawater

DEADWEIGHT TABLE

Vessel....: ANGELA - WITH WT SHELTER
Condition.: 8:ANGELA PD 400 - CAPSIZE CONDITION - 6/2/00
State.....: Hull without added appendages
Water SG..: 1.025
Compliance: Vessel fails requirements in this condition

Longitudinal dimensions about AFT PERP (STN 0) (-ve aft, +ve forward)
Vertical dimensions about LINESPLAN BASE (+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	O.F WING TANK PORT	0.955	7.915	7.559	0.812	0.775	1.301	1.242	1.515
2	O.F WING TANK STBD	0.955	7.915	7.559	-0.812	-0.775	1.301	1.242	0.502
3	FRESHWATER TANK AFT STBD	0.301	0.197	0.059	1.507	0.454	2.648	0.797	0.284
4	STORES	0.380	11.500	4.370	0.000	0.000	4.500	1.710	-
5	FISHING GEAR	7.175	3.793	27.215	0.000	0.000	4.978	35.717	-
6	160 BOXES OF FISH & PRAWNS	6.500	6.400	41.600	0.000	0.000	2.320	15.080	-
7	CREW	0.370	6.860	2.538	2.590	0.958	4.700	1.739	-
8	FISH & PRAWNS IN HOPPER	3.000	4.270	12.810	2.000	6.000	5.180	15.540	-
9	WATERTIGHT SHELTER AREA	4.000	4.153	16.612	0.000	0.000	3.993	15.972	79.632
	DEADWEIGHT TOTAL	23.636	5.091	120.322	0.314	7.412	3.767	89.040	81.933
	LIGHTSHIP	96.599	6.604	637.940	0.000	0.000	3.688	356.257	-
	DISPLACEMENT	120.235	6.306	758.262	0.062	7.412	3.704	445.297	81.933

Free Surface Correction (Total Free Surface Moment/Displacement)	0.681
VCG fluid	4.385

SAILING STATE

Vessel....: ANGELA - WITH WT SHELTER
Condition.: 8:ANGELA PD 400 - CAPSIZE CONDITION - 6/2/00
State.....: Hull without added appendages
Water SG..: 1.025
Compliance: Vessel fails requirements in this condition

DRAFT SUMMARY (DIMENSIONS IN METRES)	Maximum	Actual
Draft forward (about USK at FP)	3.572	2.157
Draft midships (about USK)	3.183	2.725
Draft aft (about USK at AP)	3.600	3.294

FREEBOARD SUMMARY (DIMENSIONS IN METRES)	Minimum	Actual
Freeboard forward at FP to shelter deck (HB)	1.958	2.618
Freeboard amidships to main deck	0.300	-0.428
Freeboard aft at AP to main deck (HDA)	0.648	-0.262

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	0.144 by bow	3.400	-0.062	0.000	-7.412	-0.062
5	0.180 ''	3.402	0.297	0.382	-10.199	-0.085
10	0.184 ''	3.357	0.701	0.761	-7.286	-0.061
15	0.184 ''	3.282	1.102	1.135	-3.926	-0.033
20	0.173 ''	3.179	1.494	1.500	-0.715	-0.006
25	0.153 ''	3.045	1.874	1.853	2.563	0.021
30	0.133 ''	2.880	2.244	2.192	6.150	0.051
35	0.112 ''	2.686	2.597	2.515	9.884	0.082
40	0.091 ''	2.461	2.933	2.819	13.716	0.114
45	0.073 ''	2.209	3.250	3.101	17.898	0.149
50	0.054 ''	1.934	3.541	3.359	21.898	0.182
55	0.032 ''	1.644	3.795	3.592	24.398	0.203
60	0.006 ''	1.343	4.010	3.798	25.497	0.212
65	0.018 by stern	1.033	4.186	3.974	25.491	0.212
70	0.044 ''	0.720	4.328	4.121	24.886	0.207
75	0.089 ''	0.409	4.444	4.236	25.085	0.209
80	0.167 ''	0.110	4.547	4.318	27.519	0.229
85	0.268 ''	-0.192	4.613	4.368	29.363	0.244
90	0.329 ''	-0.519	4.599	4.385	25.771	0.214

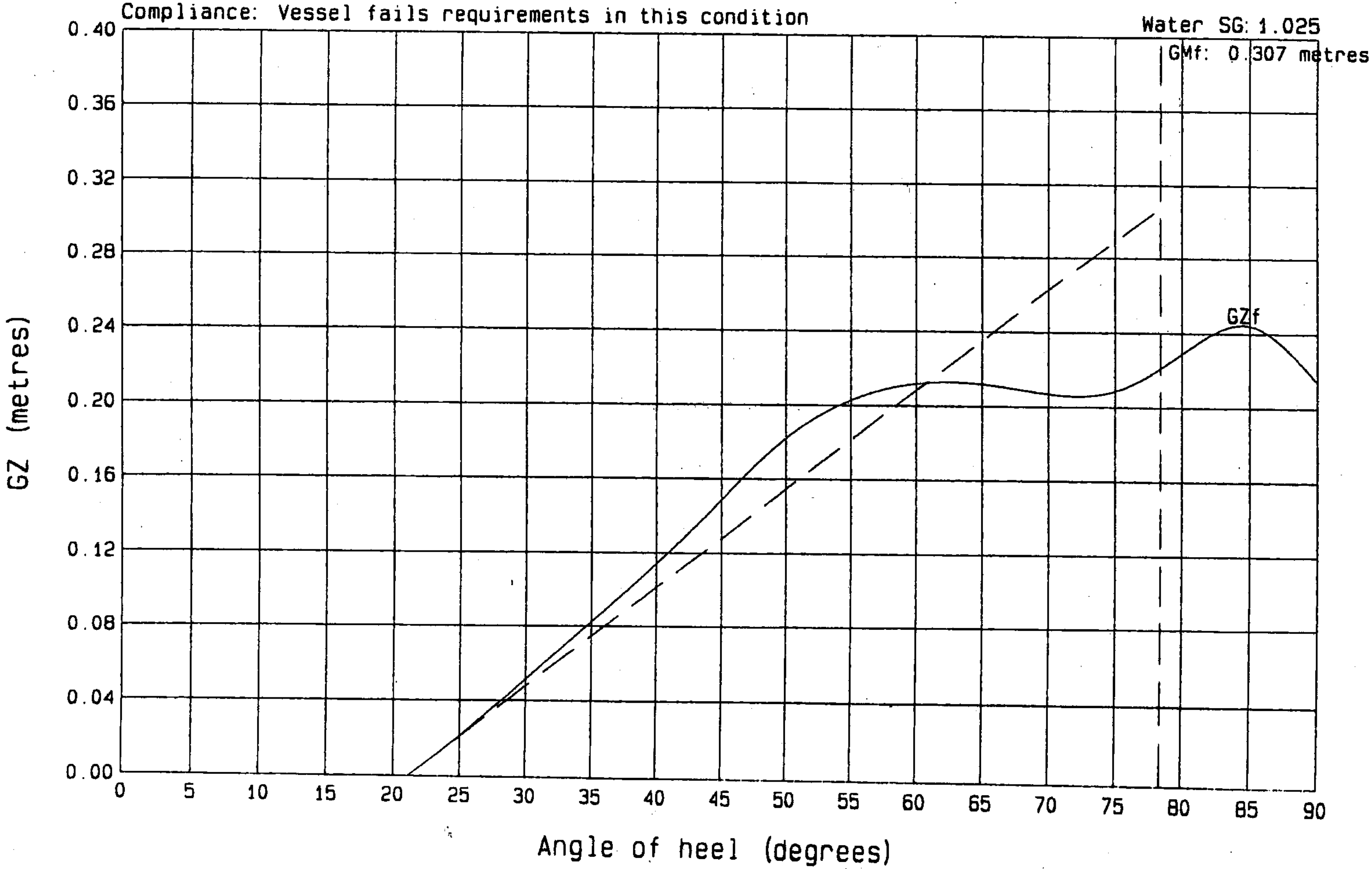
STABILITY SUMMARY	Minimum	Actual
Area under GZ curve between 21.11 and 30.00 degrees (metre.radians)	0.055	0.004
Area under GZ curve between 21.11 and 40.00 degrees (metre.radians)	0.090	0.018
Area under GZ curve between 30.00 and 40.00 degrees (metre.radians)	0.030	0.014
Maximum GZ (metres)	0.200	0.245
Angle of heel at which maximum GZ occurs (degrees)	25.000	84.196
Area under GZ curve to angle of maximum GZ (metre.radians)	0.000	0.171
Maximum GZ between 29 and 90 degrees (metres)	0.200	0.245
Positive GZ heel range (degrees)	45.000	68.890
GM solid (metres) (at angle of equilibrium)	-	0.989
Free Surface correction (metres)	-	0.681
GM fluid (metres) (at angle of equilibrium)	0.350	0.307

STABILITY SUMMARY (CONTINUED)	Maximum	Actual
Angle of equilibrium (degrees)	-	21.110

GZ PLOT

ANGELA - WITH WT SHELTER

Condition.: 8: ANGELA PD 400 - CAPSIZE CONDITION - 6/2/00
State.....: Hull without added appendages
Compliance: Vessel fails requirements in this condition



ANNEX D - Vessel's stability condition - with watertight shelter and 10 tonnes *of* seawater

DEADWEIGHT TABLE

Vessel....: ANGELA - WITH WT SHELTER
Condition.: 8:ANGELA PD 400 - CAPSIZE CONDITION - 6/2/00
State.....: Hull without added appendages
Water SG..: 1.025
Compliance: Vessel fails requirements in this condition

Longitudinal dimensions about AFT PERP (STN 0) (-ve aft, +ve forward)
Vertical dimensions about LINESPLAN BASE (+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 Surfac moment t.m
1	O.F WING TANK PORT	0.955	7.915	7.559	0.812	0.775	1.301	1.242	1.515
2	O.F WING TANK STBD	0.955	7.915	7.559	-0.812	-0.775	1.301	1.242	0.502
3	FRESHWATER TANK AFT STBD	0.301	0.197	0.059	1.507	0.454	2.648	0.797	0.284
4	STORES	0.380	11.500	4.370	0.000	0.000	4.500	1.710	-
5	FISHING GEAR	7.175	3.793	27.215	0.000	0.000	4.978	35.717	-
6	160 BOXES OF FISH & PRAWNS	6.500	6.400	41.600	0.000	0.000	2.320	15.080	-
7	CREW	0.370	6.860	2.538	2.590	0.958	4.700	1.739	-
8	FISH & PRAWNS IN HOPPER	3.000	4.270	12.810	2.000	6.000	5.180	15.540	-
9	WATERTIGHT SHELTER AREA	10.000	4.501	45.010	0.000	0.000	4.068	40.680	119.281
	DEADWEIGHT TOTAL	29.636	5.018	148.720	0.250	7.412	3.838	113.748	121.582
	LIGHTSHIP	96.599	6.604	637.940	0.000	0.000	3.688	356.257	-
	DISPLACEMENT	126.235	6.232	786.660	0.059	7.412	3.723	470.005	121.582
	Free Surface Correction (Total Free Surface Moment/Displacement)						0.963		
	VCG fluid						4.686		

SAILING STATE

Vessel....: ANGELA - WITH WT SHELTER
Condition.: 8:ANGELA PD 400 - CAPSIZE CONDITION - 6/2/00
State.....: Hull without added appendages
Water SG..: 1.025
Compliance: Vessel fails requirements in this condition

DRAFT SUMMARY (DIMENSIONS IN METRES)	Maximum	Actual
Draft forward (about USK at FP)	3.572	1.734
Draft midships (about USK)	3.183	2.294
Draft aft (about USK at AP)	3.600	2.856

FREEBOARD SUMMARY (DIMENSIONS IN METRES)	Minimum	Actual
Freeboard forward at FP to shelter deck (HB)	1.958	2.023
Freeboard amidships to main deck	0.300	-1.242
Freeboard aft at AP to main deck (HDA)	0.648	-1.038

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	0.093 by bow	3.469	-0.059	0.000	-7.412	-0.059
5	0.127 ''	3.471	0.299	0.408	-13.769	-0.109
10	0.126 ''	3.426	0.695	0.814	-14.995	-0.119
15	0.115 ''	3.352	1.103	1.213	-13.853	-0.110
20	0.088 ''	3.248	1.509	1.603	-11.895	-0.094
25	0.057 ''	3.115	1.908	1.981	-9.108	-0.072
30	0.025 ''	2.951	2.299	2.343	-5.630	-0.045
35	0.008 by stern	2.756	2.674	2.688	-1.813	-0.014
40	0.039 ''	2.533	3.031	3.012	2.348	0.019
45	0.067 ''	2.282	3.368	3.314	6.897	0.055
50	0.096 ''	2.008	3.677	3.590	10.953	0.087
55	0.130 ''	1.721	3.945	3.839	13.342	0.106
60	0.164 ''	1.422	4.173	4.059	14.395	0.114
65	0.197 ''	1.119	4.362	4.247	14.424	0.114
70	0.225 ''	0.802	4.513	4.404	13.815	0.109
75	0.268 ''	0.488	4.635	4.527	13.618	0.108
80	0.340 ''	0.186	4.741	4.615	15.928	0.126
85	0.446 ''	-0.112	4.821	4.669	19.223	0.152
90	0.519 ''	-0.431	4.827	4.686	17.799	0.141

STABILITY SUMMARY	Minimum	Actual
Area under GZ curve between 37.24 and 30.00 degrees (metre.radians)	0.055	0.000
Area under GZ curve between 37.24 and 40.00 degrees (metre.radians)	0.090	0.000
Area under GZ curve between 30.00 and 40.00 degrees (metre.radians)	0.030	0.000
Maximum GZ (metres)	0.200	0.153
Angle of heel at which maximum GZ occurs (degrees)	25.000	85.991
Area under GZ curve to angle of maximum GZ (metre.radians)	0.000	0.082
Maximum GZ between 29 and 90 degrees (metres)	0.200	0.153
Positive GZ heel range (degrees)	45.000	52.758
GM solid (metres) (at angle of equilibrium)	-	1.339
Free Surface correction (metres)	-	0.963
GM fluid (metres) (at angle of equilibrium)	0.350	0.375

STABILITY SUMMARY (CONTINUED)	Maximum	Actual
Angle of equilibrium (degrees)	-	37.242

GZ PLOT

ANGELA - WITH WT SHELTER

Condition.: 8: ANGELA PD 400 - CAPSIZE CONDITION - 6/2/00
State.....: Hull without added appendages
Compliance: Vessel fails requirements in this condition