DEPLOYMENT OF LIFERAFTS FROM CAPSIZED OR SINKING VESSELS

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SUMMARY
In a number of fishing vessel capsize incidents which have resulted in loss of life, liferafts have not deployed satisfactorily, sometimes because of fouling of the canister or its painter. The following paper describes the findings of a programme of tests, using models of two types of fishing vessel, to study the release and subsequent behaviour of liferaft canisters following capsize and sinking. It includes a summary of the principal recommendations arising from the work, and these are equally relevant to other vessel types.

1. INTRODUCTION

A research contract was placed by the Maritime & Coastguard Agency in response to recommendations by the Marine Accident Investigation Branch. The contract was awarded to the Wolfson Unit in October 1998, and the final report was submitted in January 1999 [1]. The objectives of the work were to ensure that liferafts, through correct operation of their hydrostatic release units, can be deployed automatically in the event of a vessel capsizing, and to find the optimum positions for liferaft stowage. The tests revealed a number of difficulties with deployment which had not been appreciated fully by the authorities, liferaft manufacturers, or fishermen, and they have prompted discussions between representatives of their organisations.

2. BACKGROUND TO THE PROBLEM

UK registered fishing vessels over 12 metres in length are required to carry one or more liferafts, depending on their length. These are required to be stowed such that they can be readily transferred to the water on either side of the vessel, and so they are normally located on top of a deckhouse where they will not hinder the fishing operations. The liferaft canister is held in a cradle by restraining straps which, for manual launching, are released by a stenhouse slip or similar mechanism. The liferaft must be secured to the vessel by a strong painter to prevent loss if launched in heavy weather, and tension in this line triggers the liferaft inflation system.

To enable automatic deployment from a sinking vessel a hydrostatic release mechanism, HRU, is fitted. These devices are designed to cut a loop holding the restraining strap at a depth of between 1.5 and 4 metres. The liferaft should float free from a sinking vessel with its painter attached to the vessel and paying out from the canister. When the painter is fully extended the tension should trigger the liferaft inflation, and the increased buoyancy should then break the weak link remaining between the painter and the vessel.

There have been a number of incidents where liferafts have not deployed from sinking fishing vessels, and in some recent instances the availability of remotely operated underwater vehicles with video cameras have enabled surveys of the wrecks. These have revealed liferaft canisters restrained in their cradles or trapped by the vessel's structure, and partially inflated liferafts with their painters attached to the vessel's structure, or fouled on the vessel or its fishing gear.

Surveys of fishing vessels have revealed a high incidence of incorrect installation of the HRU, such that the liferaft could not deploy correctly in the event of sinking. This problem is of great concern to the UK authorities, and has been brought to the attention of the IMO by the Danish Maritime Authority [2], but it does not fully explain all of the failures.

The problem is particularly acute in a capsizing incident because the crew will not have the opportunity to release a liferaft manually, will not have time to raise the alarm, or collect lifejackets or distress flares, and will be unlikely to have any other significant floatation aids. Whilst capsizes may not represent a large proportion of marine incidents, they do expose the crew to a very high risk of death.

3. MODELLING ARRANGEMENTS

3.1 Trawler Models

Two fishing vessel models were used for the tests, one represented a typical beam trawler of 24 metres in length, and the other a 20 metre Scottish trawler. Both were constructed at a scale of 1:15.

The beam trawler model had been constructed for a previous programme of work conducted for the Marine Accident Investigation Branch in 1993. That work involved tests to study the behaviour of the vessel during capsize and sinking in a number of different scenarios [3]. The model was intended to be representative of a typical beam trawler of about 24 metres overall length, and similar to the F.V. Pescado which capsized and sank with the loss of all six crew in 1991 [4]. The second model was based on the Scottish F.V. Westhaven which capsized and sank with the loss of all four crew in 1997 [5]. In both cases the information available on the arrangement and outfit of the vessels was limited, and the models should be regarded as being typical of a type of fishing vessel rather than an accurate model of a specific vessel.

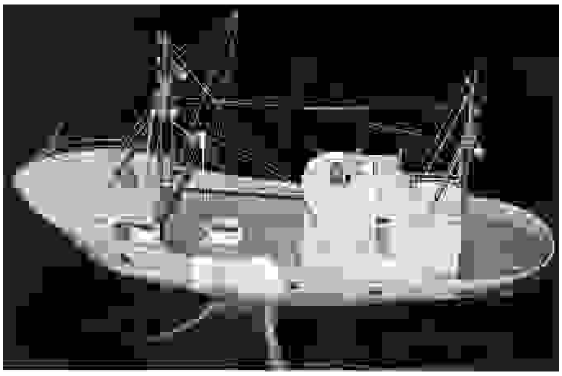

Figure 1. Beam trawler model prepared for testing with the port trawl raised, and liferafts located on the focsle and wheelhouse.

Figure 2. Westhaven model prepared for testing, with liferafts on the focsle and shelter.

The models incorporated watertight bulkheads, hatches, doors and vents in order that the flooding process, and therefore the sinking attitude, would be representative. The Westhaven model was ballasted to represent the estimated condition of the vessel prior to sinking, and the beam trawler was ballasted to a condition which just met the UK stability requirements.

Previous tests demonstrated that if a vessel capsizes to an angle of 90 degrees or greater, venting of the air from the hull may be very slow, and dependent on minor leaks or wave action. Since the models incorporated a totally watertight hull, and the aim was to conduct a large number of sinking tests, each principal compartment was vented with two 5 mm holes in the hull, one each to port and starboard. These were fitted with a polythene cover hinged to one side of the hole on the outer surface of the hull. These formed simple one way valves enabling air to vent from the models but with minimal leakage of water when upright. For some tests two or more valves were closed to ensure that the model would sink with the required bow or stern trim, enabling some variation of the sinking attitude.

3.2 Liferaft Models and Release Mechanism

Two models were constructed in accordance with drawings of a six man Dunlop Beaufort Seafarer Mk.4 liferaft canister. The model canisters were released manually by using a lanyard to withdraw retaining pins from the restraining straps. This method enabled the liferafts to be released as desired, for a range of situations with the model inverted, on its side, or upright, during the capsize or the sinking phase of the test.

Each liferaft was equipped with a painter fixed to the canister, and stowed inside a plastic container positioned alongside the liferaft. The system differed from that at full scale because the model painter payed out from the ship structure, whereas the full scale painter is fixed to the structure and pays out from the canister. This change sometimes led to fouling of the painter on the structure which prevented full deployment of the painter.

3.3 Fishing Gear Models

Models of appropriate fishing gear were supplied by the Sea Fish Industry Authority. The Westhaven model was equipped with the components of the twin rig gear believed to be aboard when it sank. This comprised a net wound on the drum, the starboard trawl door slung from the gallows, and the clump weight on the aft deck. The beam trawler was equipped with twin trawls complete with 8 metre beams, tickler chains and nets. One or both of these were suspended from the booms as required, to represent a variety of situations.

4. TEST PROGRAMME

The tests were conducted in the flume tank operated by the Sea Fish Industry Authority in Hull. The working section of the tank is 17 metres long by 5 metres wide by 2.5 metres deep. It incorporates large viewing windows on one side, enabling good underwater views of the models' behaviour while sinking.

For most of the tests the requirement was to simulate capsizing as a result of hauling on a trawl warp in an attempt to release fishing gear from a fastener. To simulate this a line was led from the appropriate block on the model, through a pulley attached to a weight on the tank bottom, and back to the tank side where an experimenter tensioned the line as required. On the Westhaven model the trawl warp was led through the gallows block. On the beam trawler the block was at the end of the boom, the location normally used when attempting to free a fastener, except in four of the tests, when the lead was brought inboard to the block on the side of the whaleback to simulate the recommended procedure.

Other simulations included hauling the trawl warp taught then using the main engine to break the gear free, and the loss of one loaded beam trawl when both had been raised to the surface supported by the horizontal booms. The former was simulated by pulling the model with a painter, and the latter by releasing the trawl from the boom by pulling a retaining pin in a similar way to the liferaft release.

Table 1 summarises the tests and presents data showing the number of occurrences of the canister becoming jammed or the painter snagged with respect to the number of releases of the liferafts. These are tabulated by vessel and attitude of sinking for each stowage location tested. The last column summarises as a percentage the failures per number of releases.

5. FISHING VESSEL BEHAVIOUR

Following capsize the beam trawler typically lay on its side while sinking slowly, whereas the Westhaven model turned upside down. The different behaviour is due to the air trapped in the deckhouses, which have a greater volume and lever on the beam trawler. The Westhaven's shelter appears to have a large volume but has large openings forward and no aft bulkhead. When the models sank they turned and released substantial volumes of air from the deckhouses and hull.

If the retained air was predominantly at one end of the model it would start to sink vertically stern or bow down, and the air would be released progressively with the changing attitude. As the models sank further they generally rotated such that they would settle upright on the bottom, albeit resting finally on the keel and one bilge. The limited tank depth of about 1.7 times the ship length was not always sufficient for the model to adopt the upright attitude, but the model trajectories, and previous tests in deeper water, indicate that these types of vessel will tend to turn upright as they sink.

Apparently small changes to the loading condition or to the venting, and hence the flooded buoyancy configuration, can result in very different attitudes when sinking. This is because the trim and stability of the flooded vessel is more sensitive than when intact, and this sensitivity increases further when the vessel submerges and has no waterplane.

These observations imply that attempts to predict the attitude which a particular vessel will adopt if it capsizes or sinks will be unreliable, as will attempts to place liferafts in such a position that they can be guaranteed a clear trajectory through the ship's structure and rig when sinking.

The beam trawler capsized at about 30 degrees of heel, with a tension in the trawl warp of about 3 tonnes. Westhaven capsized at about 24 degrees, with a trawl warp tension of about 10 tonnes, as suggested in the MAIB report [5]. It is worth comparing these angles with their ranges of intact stability, of 54 and 57 degrees.

In both instances the trawler crew would have little indication that they were heeling the vessel to the point of capsize since the heel angle would increase slowly as the warp tension was increased, until the point of capsize.

Table 1. Summary of Liferaft Deployments

Attitude of sinking	Number of releases: By bow or even keel	Number of releases: By stern	Canister snagged: By bow or even keel	Canister snagged: By stern	Painter snagged: By bow or even keel	Painter snagged: By stern	Failure rate
Liferaft Position	WESTHAVEN						
Galley	12	10	1	2	3	0	27%
Gallows	4	10	0	0	0	1	7%
Shelter aft	0	4	0	1	0	0	25%
Shelter fwd	3	4	0	0	0	2	29%
Focsle	3	4	0	0	0	0	0%
All locations	22	32	1	3	3	3	19%
	BEAM TRAWLER						
Galley aft	0	5	0	0	0	4	80%
Galley fwd	6	2	1	2	1	0	50%
Outboard of galley	0	17	0	3	0	6	53%
Focsle	3	3	0	0	0	0	0%
Wheelhouse	3	3	0	0	2	1	50%
All locations	12	30	1	5	3	11	48%

6. LIFERAFT BEHAVIOUR

6.1 Liferaft Canister Deployment

In some notable instances a liferaft canister was prevented from floating free of the model because it became fouled against the structure, for example the aft face of the wheelhouse or adjacent guard-rails, or in the trawl net.

These instances were in a small minority but warrant consideration to minimise the problem. The location of the liferaft adjacent to a bulkhead, guard-rails, or other vertical structures, or beneath some structural element such as a gantry or shelter, may hinder deployment of the liferaft temporarily or completely, depending on the attitude while sinking. Even if the fouling is only temporary the canister may be taken down to a depth at which inflation will be affected.

In one test a liferaft floated into the forecastle as the model sank by the stern, and was carried into the forward net store by the water flowing through the hatch.

6.2 Liferaft Painter Deployment

A substantial proportion of the tests resulted in fouling of the painter to the extent that it did not deploy fully from the container. In the full scale arrangement the painter deployment from the canister would not be affected by such fouling, but this aspect of the model tests provided valuable information on painter fouling.

The force required to pull the model painters from their stowage was equal to half the buoyancy force of the canister. When the painter did not deploy because it passed around elements of rigging or structure therefore, the friction had reduced the tension in the painter by at least 50%. The result demonstrates the significant effect of passing the painter over other items, and the serious implications for the breakage of the weak link. The six man liferaft modelled would have a net buoyancy of 4748 N, at full size, when inflated. A representative of the liferaft industry advised that the breaking strength of the weak link is 1.5 kN. Assuming that this value is correct, a reduction in the painter tension of more than 68% would prevent breakage of the weak link by the inflated six man liferaft. These values of percentage reduction in the tension due to friction are sufficiently close to suggest that, when a model liferaft did not deploy because of friction on the painter, deployment of the full scale liferaft would be affected or prevented.

The model painters were terminated with two links of chain in an attempt to model the hard eye and shackle which would be fitted on the full scale painter at its connection to the weak link. There were no instances of this component snagging, but it is envisaged that this might be a problem at full scale, if the painter is drawn into a small opening or an acute angle such as where a warp passes around a block, or if the painter passes beneath a net.

6.3 Liferaft Deployment Failures

The results presented in Table 1 demonstrate that the likelihood of failure increases with the amount of gear and structure around the stowage location. The Beam trawler suffered a 48% failure rate compared to 19% on the Westhaven, and on both models the liferafts deployed successfully from the relatively uncluttered focsle decks. The highest failure rate of 80% resulted from stowage of the liferafts on the beam trawler galley roof, where the wheelhouse, side railings, aft gantry, ladder and engine exhaust all contributed to a very cluttered environment.

Stowage of the liferafts on the gallows of the Westhaven model proved relatively successful with a failure rate of only 7%, but in a similar position outboard aft of the galley on the beam trawler resulted in a 53% failure rate. In most cases the liferaft on the high side of the capsized beam trawler deployed without hindrance, but the one on the low side became snagged. The overall failure rate for both models was 31%, with 30 failures in 96 liferaft deployments.

7. POSSIBLE ALTERNATIVE METHODS OF DEPLOYMENT

These tests prompted much discussion regarding the relative merits of alternative deployment arrangements. It was suggested that the weak link in the painter might be incorporated at the liferaft rather than the vessel, or that the painter should not be attached to the vessel. These options would prevent problems associated with fouling of the painter, but would adversely affect the success rate when manually launching the liferaft. With the weak link at the liferaft, it might break under the wind or wave induced loads prior to boarding, and if the crew were required to attach the painter prior to launching, this might be overlooked in the stressful process of abandoning ship.

Apparently it is much more common for liferafts to be launched manually from a slowly sinking vessel than to be launched automatically after sinking. Any modification to the system therefore must be made with care to ensure that it is not detrimental to manual launching.

It is possible that the system might be reconfigured so that the HRU would cut the painter and canister restraint together, or a link to which they were both attached. The canister would then be deployed from a sinking vessel without a painter, and would require manual triggering of the inflation by a survivor on the surface. This could be achieved by pulling on the short painter tail protruding from the canister. It is possible that the canister would be less likely to blow out of range of survivors than the inflated liferaft, but would present a smaller target for them to locate in rough weather or darkness.

A similar arrangement could be configured to inflate the liferaft automatically, with a light triggering line attached between the liferaft and the vessel. When deployed automatically by the HRU, the painter would be cut but the trigger line would remain intact. When it was fully payed out, or if it fouled on the vessel, it would inflate the liferaft which would then break it.

Perhaps the most important finding of the work was that the weak link appears to be considerably stronger than necessary for inflation triggering purposes, and is the same strength for all sizes of liferaft because it is supplied by the HRU manufacturers for use with any liferaft.

Another important consideration is ease of correct installation by untrained personnel, to improve on the current situation where many HRU installations are unsatisfactory.

Typically the painters are manufactured from an open braided nylon, and are terminated at the vessel with a hard eye and a shackle. These properties make them particularly vulnerable to fouling, and a significant improvement might be made if a smoother material and end termination could be incorporated.

8. CONCLUSIONS AND RECOMMENDATIONS

Capsize is a serious threat to life on board fishing vessels and some common practices, in particular methods of attempting to retrieve gear from fasteners, are extremely hazardous. It is apparent that many fishermen are unaware of the extent to which they reduce their margin of safety during such operations. On some vessels capsize may be induced at heel angles as low as 25 degrees, and this will come as a surprise to many fishermen, and perhaps the authorities. Capsize is a rapid event which does not enable manual deployment of lifesaving equipment.

In a small number of cases the liferaft canister may become jammed in such a way that it cannot deploy from the vessel. In some cases it may become snagged temporarily so that it might be taken to such a depth that inflation is affected or prevented. Due to the variability and unpredictability of the attitude of a vessel when sinking, it is not possible to site liferaft stowage with confidence that deployment will be unhindered.

The liferaft stowage locations should be as far apart as practical. This may entail port and starboard, or fore and aft locations. The liferafts should be stowed in a location which is free from overhead obstructions, and as far from bulkheads, railings and other vertical structures as practicable. The possibility of local structures hindering the canister deployment should be minimised by careful local detailing. For example, where a liferaft is stowed alongside guard-rails, the cradle or rails should incorporate angled stanchions to guide the canister's trajectory clear of the rails.

It is likely that one of the two liferafts will be released while beneath the capsized or sinking vessel, and its trajectory will pass around or through several items of structure, rigging or gear during its deployment. A capsized vessel may remain at the surface for a significant period, when it is likely that at least one of the liferafts will be released by the HRU. In this situation the painter will be susceptible to fouling by wave action on the painter and canister. Thus in many cases the painter may become fouled to the extent that inflation is affected or prevented, or breakage of the weak link is prevented.

If the existing system of painter and weak link are used, the painter should be manufactured from as smooth a material as possible commensurate with its other requirements, the joint between the painter and the weak link should be as smooth as possible, and the strength of the weak link should be reduced. If a system of automatic inflation is incorporated, the painter or trigger line should be of sufficient length to ensure that inflation occurs clear of the vessel, bearing in mind that the vessel may sink with a vertical attitude.

Consideration should be given to an alternative system of deployment, perhaps using the HRU to cut the painter, and to the benefits of deploying the uninflated canister for manual inflation at the surface, compared to those of deploying the inflated liferaft.

Every effort should be made to simplify the deployment mechanism in order to eliminate the possibility of deployment failure resulting from incorrect installation by untrained personnel. To this end, and as a direct result of this project, the HRU manufacturers have been asked to fit suitable labels to the three connecting points, and five of the principal liferaft manufacturers propose to offer an installation service from January 2000.

The author believes that these findings are relevant to all types of vessel with structure around or above the liferaft stowage locations. In particular, the work has worrying implications for sailing vessels.

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