ACCIDENT REPORT

Report on the investigations of the flooding and foundering of the fishing vessel

Audacious

45 miles east of Aberdeen

on 10 August 2012

and

the flooding and foundering of the fishing vessel

Chloe T

17 miles south west of Bolt Head, Devon

on 1 September 2012

MAIB
MARINE ACCIDENT INVESTIGATION BRANCH

VERY SERIOUS MARINE CASUALTY REPORT NO 27/2013 DECEMBER 2013

Extract from

The United Kingdom Merchant Shipping

(Accident Reporting and Investigation)

Regulations 2012 – Regulation 5:

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

NOTE

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

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Audacious cover image courtesy of Trawler Photos

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GLOSSARY OF ABBREVIATIONS AND ACRONYMS

15-24m Code		Code of Safe Working Practice for the Construction and Use of 15m length overall (LOA) to 24m registered length (RL) fishing vessels
AC	-	Alternating Current
AIS	-	Automatic Identification System
CM	-	Consultative Marine
CoC	-	Certificate of Competency
COLREGS	-	International Regulations for Preventing Collisions at Sea 1972 (as amended)
DC	-	Direct Current
EPIRB	-	Emergency Position Indicating Radio Beacon
FSM	-	Free Surface Moment
knots	-	Measurement of speed: 1 knot = 1 nautical mile per hour
LOA	-	Length overall
m	-	metre
MCA	-	Maritime and Coastguard Agency
MDI	-	Marine Data International
MGN	-	Marine Guidance Note
mm	-	millimetre
MRCC	-	Maritime Rescue Co-ordination Centre
MSF	-	Marine Survey Form
MSIS	-	Marine Survey Instructions to Surveyors
MSN	-	Merchant Shipping Notice
RL	-	Registered Length
RNLI	-	Royal National Lifeboat Institution
SI	-	Statutory Instrument
SIAS	-	Ship Inspection and Survey
t	-	tonnes

tm	-	tonne metre
UKFVC	-	United Kingdom Fishing Vessel Certificate
UTC	-	Universal Co-ordinated Time
VHF	-	Very High Frequency

Times: All times used in this report are UTC+1 unless otherwise stated


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INTRODUCTION BY THE CHIEF INSPECTOR OF MARINE ACCIDENTS

The Buckie based twin rigged stern trawler “*Audacious*” and the Brixham based beam trawler “*Chloe T*” suffered flooding and foundered during August and September 2012 respectively. Fortunately both crews survived their ordeals and it has been possible for MAIB inspectors to gain a comprehensive understanding of the causes and circumstances of the accidents, notwithstanding the loss of both vessels. The outcomes of these investigations have been combined into a single report.

The safety issues that have been identified during the MAIB investigations are remarkably similar: the engine room of both vessels flooded rapidly and the bilge pumps were unable to cope with the ingress; it is likely that both accidents were caused by the failure of the vessels’ seawater cooling systems; the crews were unable to close seawater inlet valves because they became quickly submerged by flood water; on *Audacious*, the bilge alarm activated but this was not detected at an early stage because the wheelhouse was unmanned for a period; on board *Chloe T*, it is likely that the bilge alarms fitted to the vessel were inoperative.

The responsibility for ensuring that the structural integrity and safe operation of fishing vessels, together with the safety of their crews, rests firmly with vessel owners. However, the Maritime and Coastguard Agency’s (MCA) inspection and survey regime is intended to provide an appropriate level of oversight and scrutiny to ensure that vessel owners are discharging their safety responsibilities. Both investigations reach the conclusion that the instructions provided to MCA surveyors with respect to important issues such as the testing and inspection of seawater pipework systems need to be improved. Of more concern is that both investigations also identified that the record keeping and management systems used by MCA surveyors require significant improvement. Missing intermediate inspections, and delays in the renewal survey process were noted in both cases; it is unlikely that either vessel received the level of oversight that was intended by the MCA’s instructions to its surveyors.

It is disappointing to note that similar observations were made by the MAIB following the loss of the fishing vessel *Harvest Hope*[1] in August 2005. At that time the MCA undertook to conduct an internal inquiry into the identified shortfalls but, nonetheless these weaknesses appear to remain more than 7 years later. Accordingly, recommendations have been made to the MCA which seek to improve the scope, scheduling, application and record keeping for surveys and inspections of fishing vessels. That MCA surveyors are provided with effective management support tools, and apply well considered survey and inspection procedures in a uniform way is important for the safety of our fishing fleet but is also a prerequisite to maintaining the Agency’s authority amongst its fishing industry stakeholders.

Steve Clinch

Chief Inspector of Marine Accidents

[1] MAIB Report 21/2006

FLOODING AND FOUNDERING OF FV *AUDACIOUS* - SYNOPSIS

On 10 August 2012, the engine room of the 23.7m twin-rig stern trawler *Audacious* flooded while the vessel was fishing, in calm weather conditions, 45 miles east of Aberdeen. The crew were unable to stop the ingress of water and abandoned ship shortly before the vessel sank at 1554.

The skipper, who was the sole bridge watchkeeper, was in the galley when he heard the tone of the vessel's engine alter and returned to the wheelhouse to find that the engine room bilge alarm had activated.

It was discovered that water had entered the engine room and was level with the top of the main engine. A bilge pump was started but the sea inlet valves could not be closed as they were underwater and it was evident to the crew that nothing could be done to stop the ingress of water.

The skipper broadcast a "Mayday" distress message and activated the vessel's Emergency Position Indicating Radio Beacon. The crew abandoned to a liferaft a few minutes before the vessel sank and were subsequently rescued, unharmed, by a vessel that had responded to the "Mayday".

The MAIB investigation of the accident found that the flooding was probably due to the failure of the sea inlet pipework in the engine room, and that the wheelhouse had been unmanned for periods prior to the accident. It was also found that statutory surveys and inspections had not been undertaken in accordance with the terms and conditions of the vessel's UK fishing vessel certificate.

Recommendations have been made to the vessel's owner regarding bridge watchkeeping standards.

SECTION 1 - FACTUAL INFORMATION

1.1 PARTICULARS OF *AUDACIOUS* AND ACCIDENT

SHIP PARTICULARS	
Vessel's name	*Audacious*
Flag	British
Classification society	Not applicable
Fishing numbers	BF 83
Type	Twin rig stern trawler
Registered owner	Deveron Fishing Company, Buckie
Manager(s)	Deveron Fishing Company, Buckie
Construction	Steel, built Navia, Spain, 1999
Length overall	27.60m
Registered length	23.95m
Gross tonnage	437
Minimum safe manning	Not applicable
Authorised cargo	No
VOYAGE PARTICULARS	
Port of departure	Lerwick, Scotland
Intended Port of arrival	Fraserburgh, Scotland
Type of voyage	Commercial fishing
Cargo information	Fish
Manning	6
MARINE CASUALTY INFORMATION	
Date and time	10 August 2012, 1554
Type of marine casualty or incident	Very Serious Marine Casualty
Location of incident	45nm east of Aberdeen, Scotland
Place on board	Complete vessel
Injuries/fatalities	Nil
Damage/environmental impact	Vessel lost
Ship operation	Trawling
Voyage segment	Midwater
Environment	Daylight, light airs, calm sea, good visibility
Persons on board	6

Image courtesy of Trawler Photos

Audacious

1.2 BACKGROUND

Audacious, a twin rig stern trawler was purchased by her current owner in 2007. The vessel, originally named *Endurance,* was built in 1999 to Seafish[1] construction standards by Astilleros Armon, Navia, Spain. The Maritime and Coastguard Agency (MCA) issued the vessel with its first UK Fishing Vessel Certificate (UKFVC) in May 1999.

[1] Seafish - The Sea Fish Industry Authority, a non-Departmental Public Body which works with the UK seafood industry to promote good quality and sustainable seafood, and to improve the safety and standards of training for fishermen. Fishermen are required to complete training in, sea survival, fire-fighting, first aid and safety awareness.

In May 2008 a replacement main engine was installed in the vessel and in August 2008 an engine fire resulted in the vessel being out of service for several months. The most recent UKFVC was issued by the MCA in December 2008; it was due to expire in December 2013.

The owner employed two crews, which enabled the vessel to remain at sea for the majority of the year. The vessel had been used to fish in northern Scottish waters for several weeks prior to the accident.

1.3 NARRATIVE

1.3.1 Events prior to the accident

On 29 July 2012 *Audacious* arrived in Ullapool, Scotland to land her catch. While in port the vessel's engineer replaced a 50mm diameter gearbox cooling pipe which, due to difficulty of access, had to be welded in-situ.

Audacious departed Ullapool at 0300 on 31 July to resume fishing; the catch was subsequently landed in Lerwick, Shetland Islands, on 5 August. After sailing from Lerwick, the crew fished the vessel to the east of the Shetland Islands until 9 August. The skipper then decided to reposition the vessel to fish the Aberdeen Bank, where she arrived at 0600 on 10 August 2012. The skipper knew the seabed in the area was very weedy and chose to fish with a single trawl net; the port trawl net was shot away at 0630.

The engineer was the sole bridge watchkeeper from 0700 until he was relieved by the skipper just before the net was hauled at 1130. When the net was recovered it was found to have been badly torn and the fishing gear was transferred to the starboard net for the next trawl, which began at 1230.

At about 1300, after cleaning and stowing the catch of fish, the damaged net was spread out over the upper and main decks and the crew began to make repairs **(Figure 1)**. The skipper was the sole bridge watchkeeper; at the same time he oversaw the four crewmen who were mending the net. The engineer washed down and cleaned the fish processing deck throughout this period.

At 1430 the skipper disengaged the auto-trawl setting on the trawl winch to allow the repairs on the port net to be completed.

At about 1445 the engineer completed cleaning the fish processing area and went to the engine room, where he stopped the bilge pump which had been set to drain the fish hold bilge. He then spent a few minutes checking the engine room and confirmed that the bilge was dry before leaving the space and going to the galley.

At 1450 the skipper engaged the auto-trawl function and went to the galley, where he informed the engineer that the trawl would be hauled at about 1730. The engineer then went to his cabin to rest and the skipper, who was still the sole bridge watchkeeper, turned on the galley cooker and made his way back to the wheelhouse via the main deck to check on progress with the net repairs.

Images courtesy of Caledonia TV

Figure 1: Torn net spread over the upper and main decks (taken on an earlier fishing trip)

1.3.2 Engine room flooding

At 1514 the skipper was in the wheelhouse and he used his mobile telephone to send a text message to the skipper of another vessel. He returned to the galley, two decks below the wheelhouse, and was preparing a meal for the crew when, at about 1520, he heard the tone of the vessel's main engine change.

The skipper returned to the wheelhouse and saw lit warning lamps on the main engine display panel; he noted that the engine room bilge alarm lamp was also illuminated.

The propeller pitch, which had been at its normal setting of 60% ahead while trawling, then moved to 30% astern without any user input. The skipper attempted to adjust the pitch and stop the engine, both without success. He then called the engineer, using the vessel's intercom, and advised him that he had lost control of the engine.

The vessel began to make sternway, and the skipper noted that its speed had reached 2 knots astern when he left the wheelhouse to make sure that the engineer was dealing with the problem.

The engineer entered the engine room at about 1525 to investigate. He saw that water had entered the compartment and was almost level with the top of the main engine **(Figure 2)**. He immediately started a bilge pump, rated at 25 tonnes per hour, to pump out floodwater from the compartment.

Figure 2: Engine room

Water began to spray from the flywheel onto the turbocharger and intercooler; the resultant steam began to fill the machinery space and the main engine stopped. The auxiliary engines **(Figure 3)**, which provided power to the bilge pump, were still above the water level and continued to operate.

The engineer advised the skipper, via the intercom, that the water in the engine room was flooding in faster than the bilge pump could pump it out.

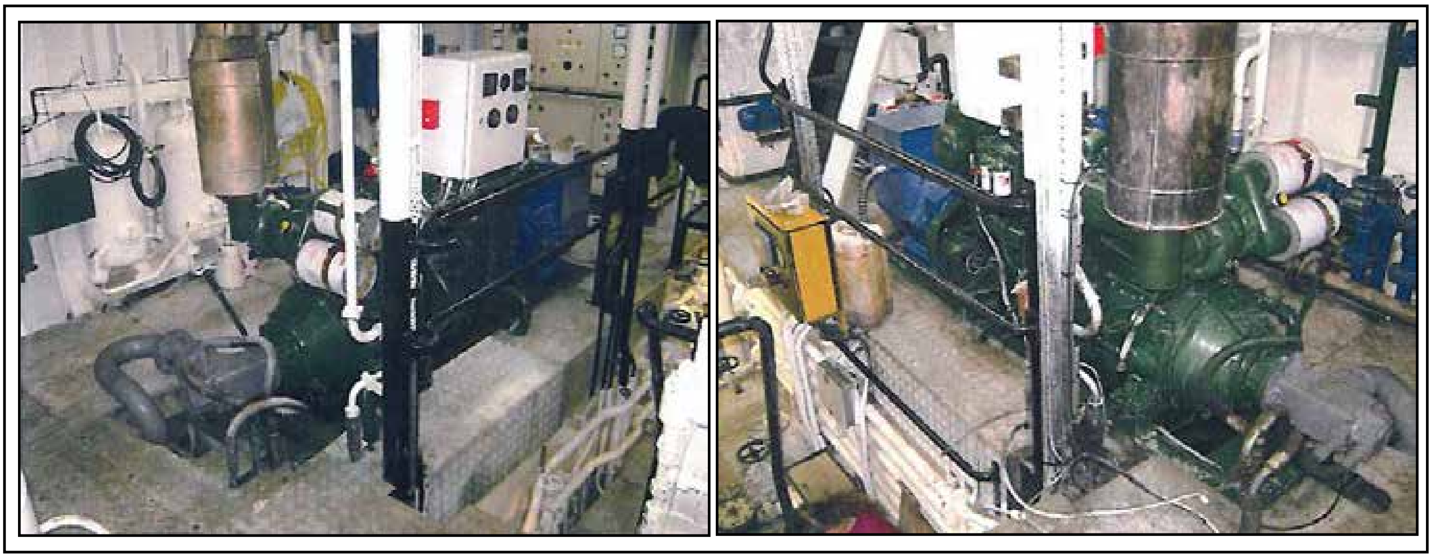

Figure 3: Engine room showing auxiliary engines

The engine room smoke alarm activated and the skipper, who needed to confirm the situation in the engine room, sent a crewman to investigate. The crewman went to the engine room via the main deck accommodation alleyway **(Figure 4)**, which was beginning to fill with steam and smoke. He opened the engine room door, observed that the space was full of steam and smoke and then closed the door and returned to the wheelhouse.

Image courtesy of Caledonia TV

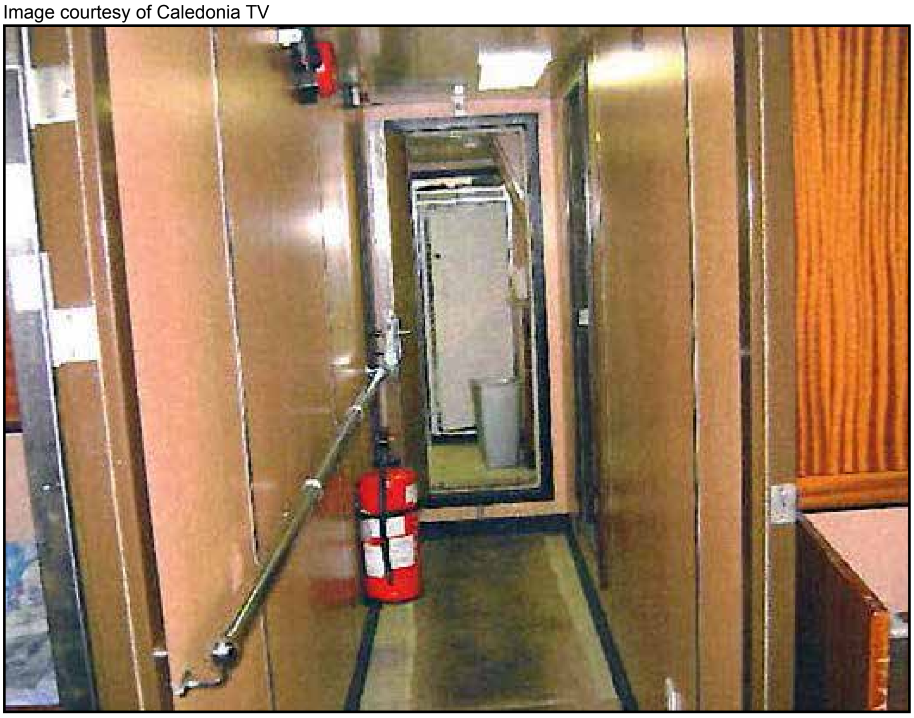

Figure 4: Accommodation alleyway

To gain a better understanding of the situation, the skipper decided to proceed to the engine room himself, via the internal accommodation. As the skipper opened the engine room door he met the engineer emerging through steam and smoke. The engineer told the skipper that the flooding was out of control and that they should evacuate immediately. The skipper asked if the sea inlet valves had been closed, and was advised that they were still open as they were more than a metre under water and were inaccessible.

The skipper, engineer and crewman returned to the wheelhouse; the remaining three crew members were still mending the net on the main deck and were not aware of the situation in the engine room.

1.3.3 Abandonment and rescue

The skipper instructed the crewman to tell the other crew members to collect lifejackets from their cabins and prepare the vessel's two liferafts for abandoning ship. At 1530 the skipper broadcast a "Mayday" message using a Very High Frequency (VHF) radio set, powered by the vessel's emergency batteries.

Coastguard officers at Aberdeen Maritime Rescue Co-ordination Centre (MRCC) replied immediately, asked the skipper for the vessel's position and number of persons on board, and relayed the distress message to all vessels in the area. Several vessels responded, including the merchant vessel *Ocean Observer*, which was 12 nautical miles from *Audacious,* and proceeded towards the fishing vessel to assist.

The crew on board *Audacious* mustered in the wheelhouse. They had collected personal effects from their cabins but not their lifejackets or survival suits, which were also stowed in the accommodation. The skipper, who was wearing a flotation jacket, instructed the crew to launch the liferafts and abandon ship. He then collected and activated the vessel's Emergency Position Indicating Radio Beacon (EPIRB), the first transmission from which was recorded by the coastguard at 1539. The skipper made a further VHF radio call at 1541 to advise the coastguard that the crew were abandoning into a liferaft.

The crew launched both liferafts, but the painter of the port liferaft was inadvertently released during the launch process and the raft drifted away from the vessel before it could be secured. The remaining liferaft was made fast to the starboard hull ladder **(Figure 5)**, from where the crew boarded it.

Figure 5: Starboard side hull ladder

The skipper remained on the upper deck and, at about 1542, he looked down the engine room emergency escape trunk and noted that the water level in the engine room had covered the lower two rungs of the escape ladder.

At about 1545 the skipper passed the EPIRB and several trawl sensors into the liferaft and then joined the rest of the crew in the liferaft. The painter was cut and the liferaft drifted away from the vessel; the crew photographed *Audacious* as she settled in the water **(Figure 6)** until she sank at 1554.

Figure 6: *Audacious* sinking sequence

At 1645 *Ocean Observer* arrived at the scene, her crew launched their fast rescue craft and recovered *Audacious*'s crew from the liferaft. Both liferafts, fishing gear and other flotsam, which had floated free from *Audacious* as she sank, were also subsequently recovered by the crew of *Ocean Observer*.

At 1730 a search and rescue helicopter, which had been mobilised by the coastguard, arrived at the scene. The crew of *Audacious* were lifted from the deck of *Ocean Observer* into the helicopter and were subsequently landed ashore, unharmed, in Aberdeen.

The vessel was not salvaged and no underwater surveys were conducted due to the remote location of the wreck.

1.4 ENVIRONMENTAL CONDITIONS

Wind: Lights airs

Sea State: Slight

Visibility: Good

1.5 CREW

There were six crewmen on board *Audacious* at the time of the accident:

The skipper was 26 years old, had been a fisherman for 10 years and had been in charge of *Audacious* for 5 years. He achieved a Deck Officer (Fishing Vessel) Class 1 Certificate of Competency (CoC) in 2007. He had attended the mandatory Seafish safety training courses: sea survival, fire fighting, first-aid and health & safety, in 2002, and a safety awareness course in 2006.

The engineer was 57 years old and held an Engineer Officer (Fishing Vessel) Class 1 CoC. He was an experienced fisherman, had worked for the owner of *Audacious* for 16 years and had been engineer on the vessel since 2007. He had also worked as a marine engineer with a Scottish shipyard for 15 years. He had not attended the Seafish safety awareness course.

Of the four remaining crew, one was a UK national who had attended a sea survival training course in 1989 and had been on *Audacious* for 18 months. The other three crewmen were Filipino nationals who had been with the vessel for 3 years, 7 months and 5 months respectively and had completed safety training in the Philippines. They had not completed the mandatory Seafish safety awareness training course before commencing work on board *Audacious*.

1.6 GENERAL DESCRIPTION OF VESSEL

The vessel was a steel twin rig trawler with a deep bilge, bulbous forefoot and transom stern, incorporating a full length working area at upper deck level **(Figure 7)**. Two gear hatches were fitted in the transom which gave access to a full length twin trawl track, the two trawl line winches (port and starboard) and the sweep line winch, forward.

The wheelhouse was fitted with a full width console forward which incorporated the electronic fishing and navigational aids **(Figure 8)**. The winch controls and auto-trawl system were located at the aft end of the wheelhouse, overlooking the stern area.

Images courtesy of Caledonia TV

Figure 7: Upper deck showing full length working area (taken on an earlier fishing trip)

Image courtesy of Caledonia TV

Figure 8: Wheelhouse – view at forward console

1.6.1 Engine room

The engine room and fish hold were located below the main deck, the steering flat/ workshop were accessed via a watertight door in the aft engine room bulkhead, which was routinely left open.

Audacious was fitted with a Caterpillar 3516 main engine, which developed 1200kW at 1200rpm, turning a four bladed variable pitch propeller inside an Armon nozzle, through a Volda gearbox. The vessel was capable of a top speed of 12.2 knots. Two Volvo Penta auxiliary engines developing 210kW at 1500rpm were installed in the engine room on top of the fresh water tanks **(Figure 3)**. The fresh water tanks formed a 'well' around the main engine.

1.6.2 Seawater cooling system

The pipework for the seawater cooling system consisted of 150mm diameter galvanised steel pipe connected to two cast iron bronze screw-down sea inlet valves in cast iron sea chests. These were located at the forward end of the engine room, to port and starboard of the engine in the well formed by the fresh water tanks.

The cooling pipes for the main engine were 100mm in diameter and for the auxiliary engines were 50mm in diameter which were connected to the main seawater intake pipe. The two seawater valves were the only valves in the engine room that were beneath the waterline.

1.6.3 Bilge pumping system

The bilge pumping system in the engine room consisted of 65mm pipework connected through two, electrically-operated general service pumps, each rated at $25m^3$/hour. A third general service pump, rated at $30m^3$/hour, was located in the main deck fish handling area.

1.6.4 Bilge alarms

Audacious was fitted with two bilge alarms in the engine room, each activated by float switch sensors. The alarms were connected to an audible/visual alarm panel in the wheelhouse and to a flashing beacon in the engine room. A general alarm was fitted in the crew mess which was designed to activate if the wheelhouse alarm went unanswered.

The flashing beacon was operating when the engineer entered the engine room, and the wheelhouse bilge alarm had activated when the skipper returned to the wheelhouse. There was no evidence that the alarm in the crew mess had activated.

1.7 STABILITY AND FLOODING RATE INVESTIGATION

The MAIB commissioned Marine Data International (MDI) to determine the stability condition of *Audacious* at the time of the accident **(Annex A)**.

MDI reported that, once the floodwater in the engine room rose above the top of the engine and the fresh water tanks **(Annex B)** located on either side of the engine, there was a very large increase in free surface moment (FSM); "*The FSM increased from about 45.13 tonnes metres (tm) to 229.17tm once above the engine which took the vessel from a stable (albeit sinking) condition to an unstable condition*".

MDI was able to calculate from the reported floodwater levels that about 32t of water would have entered the engine room when the engineer first saw it at 1525. A further 40t would have entered the compartment by the time the skipper looked down the escape shaft at 1542.

1.8 REGULATORY REQUIREMENTS

1.8.1 Statutory framework

The UK government's maritime regulator, the MCA, issues statutory certification relating to the construction and maintenance of fishing vessels. This covers the general areas of the hull, machinery and safety equipment (including navigation and radio equipment). MCA staff conduct the majority of surveys of fishing vessels under 24m length; the survey of hull and machinery is not normally delegated to Recognised Organisations or Certifying Authorities as is frequently the case for merchant and small commercial vessels.

The statutory requirements for fishing vessels such as *Audacious* are set out in the MCA's Merchant Shipping Notice (MSN) 1770, titled, '*The Fishing Vessels Code of Safe Working Practice for the Construction and Use of 15 metre length overall (LOA) to less than 24 metre registered length (RL) Fishing Vessels*', referred to hereafter as the 15-24m Code. The 15-24m Code is a successor to the Fishing Vessels (Safety

Provisions) Rules 1975 (hereafter referred to as the 1975 Rules). The 15-24m Code is given statutory force by The Fishing Vessels (Safety of 15-24 Metre Vessels) Regulations 2002 (SI 2002:2201) which entered into force in November 2002.

1.8.2 15-24m Code

The 15-24m Code requires that vessels be surveyed '*in order to verify that the vessel complies with the requirements of the Code and such regulations as may apply to it. The surveyor may require the vessel and any of its machinery, fittings, equipment or arrangements to be submitted to such tests and examinations as are considered necessary to demonstrate compliance with the requirements of the Code.*'

The 15-24m Code states that it is the owner's responsibility to present his vessel for survey and inspection. Every fishing vessel that is subject to the 15-24m Code should be surveyed and inspected as follows:

- An initial survey during, and on completion of construction, or on transfer to the UK register prior to the issue of a UKFVC.

- Surveys for the renewal of the UKFVC at intervals not exceeding 5 years.

- An inspection (normally referred to as an 'intermediate inspection') not less than 24 months and not more than 36 months from the recorded date of the vessel's initial or previous renewal survey. This is to verify that the vessel continues to comply with the requirements of the Code.

- Surveys during major repairs or modifications.

- Annual self-certification by the owner or a delegated representative that the vessel continues to meet the major requirements of the Code.

The UKFVC should be endorsed by the surveyor after the intermediate inspection has been completed. It is permitted to extend a UKFVC beyond its 5-year validity for a period not exceeding 2 months in exceptional circumstances. Interim, or short term UKFVCs may also be issued if necessary.

The owner is also required to ensure that the crew's training and certification are valid.

1.8.3 Technical requirements

The 15-24m Code covers a broad scope, including most aspects of the vessel's construction and operation.

<u>Inlets and discharges</u>

The 1975 Rules stated that sea inlets and discharges in machinery spaces '*shall be readily accessible and be provided with indicators showing whether the valves are open or closed*'.

The 15-24m Code builds on this and requires that if inlet and discharge overboard valves are not fitted above the level of the floor plates, a rapid and practical means should be provided to allow for the valve to be operated from the floor plate level. Arrangements on vessels pre-dating the introduction of the Code are accepted provided that '*the valves fitted at hull penetrations remain both accessible and efficient in service*'.

Cooling water and other seawater systems

Seawater piping should be of aluminium bronze, cupro-nickel or similar corrosion resistant material. Galvanic corrosion between dissimilar metals should be prevented by the use of isolation packing, washers and sleeves between the flanges and fasteners joining pipes.

Bilge alarms

The 1975 Rules required that unmanned machinery spaces be provided with '*warning devices*' which indicate the leakage of water into the compartment. This was further reinforced in the 15-24m Code, which states that bilge alarm sensors should be fitted in the '*propulsion machinery space and fish hold of the vessel*'. The bilge alarm should provide an audible and visual warning at the control position. In addition, the Code states that engine room bilge alarm systems should be provided with a secondary, independent bilge alarm system, or a fail-safe warning that shows if the bilge alarm circuit becomes faulty.

1.9 REQUIREMENTS AND GUIDANCE FOR THE CONDUCT OF STATUTORY SURVEYS AND INSPECTIONS

While the 15-24m Code lists the technical requirements that a vessel must meet, there is no guidance on how the survey or inspection should be conducted. This is provided elsewhere.

1.9.1 Guidance to surveyors

Survey and Certification Policy (MSIS 23)

Chapter 2 of the MCA's guidance to surveyors on Survey and Certification Policy (Marine Survey Instructions to Surveyors - MSIS 23) relates to the UKFVC. The guidance states that the purpose of the survey is to '*ensure that the hull structure, main and auxiliary machinery boilers and other pressure vessels, the electrical system, … are in compliance with the code of practice and are in all respects, satisfactory.*

MSIS 23 also provides guidance on the specific items to be considered to help prevent flooding incidents. Most relevant is the advice in part 8.2.6.2 regarding ship side valves, which states that *'Valve closing devices must be in accessible positions and where valves are located below engine floor plate level, extended spindles (or equivalent remote closing) should be provided. Pressure testing can be useful to prove sealing arrangements.*

Guidance is also provided on bilge alarms and pipework. Regarding bilge alarms, MSIS 23 states that alarms should be tested and that owners should be encouraged to fit secondary or fail-safe alarms. A significant amount of advice is provided about surveying pipework. Surveyors are advised to use sampling techniques and record what has and has not been examined. It is emphasised that it is the owner's responsibility to demonstrate that pipework is in a satisfactory condition. Examination techniques, such as hammer testing[2], ultrasonic measurement and pressure testing are recommended. Surveyors are recommended to have representative samples in high risk areas of pipework removed for detailed inspection.

Survey and Inspection of Fishing Vessels (MSIS 27)

The MCA's guidance on the Survey and Inspection of Fishing Vessels (MSIS 27) states that intermediate inspections of 15-24m fishing vessels are required to maintain the validity of the UKFVC. Any exemptions from the applicable rules (the 1975 Rules in this instance) which have previously been granted should be reviewed at each renewal survey with the aim of deleting them wherever possible.

MSIS 27 Section 1.9 states that a schedule for surveying hull and machinery items over a 5-year cycle (to a similar standard as a classification society would apply to a larger merchant vessel) should be agreed with the owner. The owner should compile a survey schedule and submit it to MCA surveyors for approval. Examples of typical schedules for machinery and hull surveys are provided in Annexes 10 and 11 respectively of MSIS 27 and are discussed in more detail later in this section.

Section 1.9.14 of MSIS 27 states that intermediate inspections should be carried out between the second and third anniversaries of the issue of the UKFVC. The guidance goes on to state that the UKFVC is '*rendered invalid*' if the intermediate inspection is not done, and that the vessel should be detained. It is an offence to take a fishing vessel to sea without the appropriate certificate being in force.

Section 1.17 of MSIS 27 describes how the conduct and results of renewal surveys are to be recorded in the MCA's filing system. Form MSF 1327, attached as Annex 12 to the guidance, lists the documents which should be seen (and assessed) as part of the survey process. This includes a document titled '*machinery maintenance*'; however, the document itself did not need to be filed.

Chapter 5 of MSIS 27 provides detailed guidance on surveying machinery on fishing vessels. Section 5.7.6 is most relevant and states that '*sea water pipes should be accessible for inspection and maintenance.*' The section goes on to state that surveyors should thoroughly check pipework strainers and isolation valves, and encourages the '*liberal use of hammer testing*'. After the first renewal survey (5 years) the guidance says that seawater systems should be subjected to a 3 bar pressure test – no advice is given on how this should be done. Of most relevance, however, is a requirement that seawater valves must be capable of being closed from above the floorplate level.

Regarding bilge pumping systems, Chapter 6 of MSIS 27 states that valves should be operable from above floor plate level and that seacocks should operate freely. Valve handles should not be located solely in areas which are difficult to access or where they may quickly become inaccessible in the event of rapid flooding.

[2] 'Hammer testing' describes the technique of determining whether an object is 'sound' or has corroded. A pipe in good condition will make a clear ringing sound when struck; a dull thud indicates that the pipe has corroded.

Annex 10 of MSIS 27, relating to machinery surveys, provides a detailed list of main and auxiliary machinery to be surveyed. The items to be surveyed which were of most relevance to this accident are listed as follows:

- *Seawater / ballast / bilge pipes*
- *Main S W cooler* (main engine salt to fresh water heat exchanger)
- *Sea Connections: suctions and discharges* [sic]

Annex 11 refers to the items to be considered during hull surveys; these include the thickness of shell plating (particularly in way of inlets and outlets) and the condition of engine room bilges.

<u>Fishing Vessels Survey / Inspection Aide Mémoire (MSF 5550)</u>

The MCA has produced a series of aides mémoire to help remind owners and surveyors of the scope of the various fishing vessel codes. MSF 5550[3] covers the requirements of the 15-24m Code.

MSF 5550 divides the requirements into those that should be considered during:

- Survey or inspection
- Inspection
- Out of water survey.

A list of the necessary certificates and records is also provided.

MSF 5550 states that the condition of pipework, skin (hull) fittings, sea cocks and their ease of operation should be assessed during surveys and inspections. A reminder is given that valves should be accessible from above the floor or deck plates. The condition of sea inlets and discharge valves and cocks should also be checked when vessels are being surveyed out of the water. Bilge pumps and alarms should be checked whenever vessels are inspected.

When completing MSF 5550, the form reminds surveyors to check that the UKFVC is valid and that the intermediate inspection has been carried out.

1.9.2 Other guidance

Marine Guidance Note (MGN) 165 (Fishing) titled 'The Risk of Flooding' was published by the MCA in 2001. It refers to a series of investigations conducted by the MAIB in which uncontrollable flooding caused fishing vessels to be lost. Among several recommendations, the guidance encourages fishing vessel operators to:

- Fit supplementary bilge alarms and carry additional pumps to mitigate the effects of flooding.

[3] MSF 5550 Revision 2 dated 16/09/09 was in force at the time of the accident. The MCA drafted a number of updates to this and the related aides mémoire while this report was being prepared.

- Position seawater inlet valves where they can be easily and quickly closed – fitting extended spindles to valve handles where necessary to ensure that valves fitted beneath the floor plates can be shut in an emergency.

- Open and close sea inlet valves regularly (at least monthly) to ensure that they do not seize.

- Test bilge alarms daily.

- Ensure that crew members are familiar with how to operate bilge pumping systems.

MGN 165 (F) advises that all sea valves should be closed in an emergency.

1.10 CERTIFICATION AND SURVEY HISTORY

The vessel's Consultative Marine (CM) files were obtained from the MCA and were studied together with information held in the Ship Inspection and Survey (SIAS) database to provide information on the vessel's certification and survey history. The CM file, available specifically for the survey of machinery (02 suffix), had not been created.

1.10.1 Certification history

Audacious's initial UKFVC, issued in accordance with the 1975 Rules, was valid until 1 May 2003. The vessel was first surveyed under the 15-24m Code on 27 March 2003. A short term UKFVC was issued on 5 August 2003 valid until 31 October 2003.

A copy of a fax sent from the MCA surveyor to the owner's representative dated 14 October 2003 referred to an inclining experiment having been conducted on 27 June 2003. The fax stated that no further short term certificates would be issued until a programme to resolve concerns over the vessel's stability, and completion of a stability book, had been agreed. There was no specific evidence in the CM file to show that such a programme was agreed, but a further short term UKFVC was issued on 30 October 2003, based on the previous survey completed on 27 March 2003. It was valid until 31 December 2003. A third short term UKFVC was issued on 17 December 2003, again based on the survey completed on 27 March 2003. It was valid until 31 March 2004.

The first full term UKFVC under the 15-24m Code was issued on 29 April 2004. This certificate was based on the survey completed on 27 March 2003 and was valid until 31 December 2008, 5 years and 9 months after the survey had been completed. The UKFVC states that an intermediate inspection should be completed between 31 December 2005 and 31 December 2006. There was no record to show that this took place.

The vessel's most recent UKFVC **(Annex C)** was issued on 10 December 2008 and was valid until 31 December 2013. It was based on a survey carried out on 14 August 2008.

The continued validity of the UKFVC was subject to the completion of annual self-certification documentation by the owner and an intermediate inspection being carried out by the MCA between 31 December 2010 and 31 December 2011.

There was no evidence to indicate that, by the time of the accident, the owner's annual self-certification documentation had been completed or that the intermediate inspection had taken place.

A summary of the relevant findings from *Audacious*'s survey history are presented in the table below:

Date of Survey/Inspection	Survey/Inspection details
May 1999	Building survey: Astilleros Armon, Navia, Spain
18, December 2002	Radio Survey
14, January 2003	Targeted Inspection (9 deficiencies recorded)
17, March 2003	UK FVC Renewal Survey (18 deficiencies recorded) "*Engine Room pipe work hammer tested*" Ultrasonic inspection of hull thickness carried out
10, August 2004	Targeted Inspection (7 deficiencies)
29, October 2004	Radio Survey
10, October 2006	Targeted Inspection (2 deficiencies)
3, July 2007 (Vessel under new ownership)	UK FVC Intermediate survey (19 deficiencies including reference to signs required on watertight doors to "*keep closed at sea*")
January/February 2008	FV Additional (Renewal) survey (20 deficiencies including reference to signs required on watertight doors to "*keep closed at sea*") Survey undertaken following engine removal after catastrophic failure Ultrasonic inspection of hull, engine room bulkhead and slush well thickness carried out.
1, August 2008	Radio Survey
14, August 2008	Survey undertaken following engine fire
20, July 2011	UK Load Line Exemption inspection carried out (for carriage of film crew) (n.b. surveyor's written comment: "*Reminder-Interim inspection due by 31/12/11*")

Table 1: Summary of relevant findings from *Audacious*'s survey history

1.10.2 Hull thickness measurements

Ultrasonic thickness measurements of the hull were undertaken in March 2003 and February 2008. In the lower part of the engine room the measurements showed an average thickness of 12mm in 2003 and 10mm in 2008.

1.11 MAINTENANCE HISTORY

There was documentary evidence that *Audacious* had received regular maintenance throughout her life. Annual refits had been completed when sea inlet valves and suctions were cleaned of marine growth and fabric maintenance was undertaken as and when required.

Records showed that work to replace various sections of pipework in the vessel's engine room had been carried out over several years by a reputable Scottish shipyard. The size of the pipework replaced was between 25 and 100mm in diameter, there was no record that any work had been carried out, at any time, on the 150mm main engine seawater cooling pipe.

1.12 KEEPING A SAFE NAVIGATIONAL WATCH ON FISHING VESSELS

In 2006 the MCA issued MGN 313 (F)[4] following a number of vessel losses, to highlight the importance of keeping a safe navigational watch on fishing vessels. This MGN states that the wheelhouse must not be left unattended at any time.

In relation to navigation, MGN 313 (F) states that the person in charge of the navigational watch should keep watch in the wheelhouse and not undertake any other duties that would interfere with the safe navigation of the vessel.

Rule 5 of the COLREGS[5] requires that every vessel shall at all times maintain a proper and effective lookout.

1.13 FISHING VESSELS: CREW CERTIFICATION, TRAINING AND DRILLS

The Fishing Vessels (Safety Training) Regulations 1989 (as amended) state that: "*no experienced fisherman shall act as master of a fishing vessel or be employed or engaged on a fishing vessel unless he is the holder of a certificate or certificates certifying that he has undergone an Approved Training Course in Safety Awareness*".

The duty to comply with these regulations rests with the owner and skipper of a fishing vessel, as well as with the fisherman himself.

The 15-24m Code (Section 8.1.2.1) requires skippers to ensure that the crew of fishing vessels are trained in the use of all lifesaving appliances carried on board. Such training should be carried out in drills, at intervals of not more than 1 month.

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[4] MGN 313 (F): http://www.dft.gov.uk/mca/313_a.pdf

[5] COLREGS = International Regulations for Preventing Collisions at Sea, 1972 (as amended)

1.13.1 Training and certification requirements for the crew of fishing vessels

MGN 411[6], issued by the MCA in March 2010, states (2.3.4) that, in relation to the Safety Awareness Training course: "*Any fishermen [sic] coming from outside the UK must, regardless of whether he has undertaken the Merchant Navy STCW*[7] *basic safety training, undertake this Course before commencing work for the first time on a UK Registered fishing vessel. Any fisherman with two years experience must also undertake the Safety Awareness and Risk Assessment Course*".

1.13.2 Fishing vessels: Checks on crew certification and drills

MGN 430[8] was issued by the MCA in January 2011 and provides guidance to owners, skippers and crews regarding the checks that MCA surveyors will make to ensure that the crew have undertaken approved safety training courses.

1.13.3 Safety Awareness (Managing Safety at Sea) course

The syllabus for the Safety Awareness course, specified by Seafish, includes the legal principles and risk control measures for the management of safety on board fishing vessels. The course emphasises the importance of crews undertaking drills and musters, and of wearing the correct personal protective equipment in emergency situations.

[6] MGN 411 http://www.dft.gov.uk/mca/mgn_411.pdf

[7] STCW = Seafarers Training Certification and Watchkeeping

[8] MGN 430 (F) http://www.dft.gov.uk/mca/mgn_430.pdf

SECTION 2 - ANALYSIS

2.1 AIM

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

2.2 SUMMARY

It was not possible to inspect *Audacious* due to the remote location of the wreck. Analysis of the available evidence indicated that the vessel sank due to rapid water ingress to its engine room that, initially, went undetected. The rate of water ingress indicates that it was due to the failure of seawater cooling pipework. There was no evidence to suggest that the vessel had been sunk deliberately.

2.3 WATCHKEEPING/LOOKOUT

The skipper left the wheelhouse unattended on several occasions during the 30-minute period before he noticed the change in tone of the main engine. He had gone onto deck to check the progress of the net repairs and had also spent time in the galley, preparing and cooking a meal for the crew.

Rule 5 of the COLREGS requires that every vessel shall at all times maintain a proper lookout. MGN 313 (F) states that no other duties should be undertaken which may interfere with the task of lookout. This MGN was issued following several collisions, groundings and near misses involving fishing vessels, all of which occurred as a result of poor watchkeeping.

This accident reinforces the importance of ensuring the wheelhouse is manned at all times to monitor equipment and alarms, as well as to maintain a proper lookout. As no continuous wheelhouse watch was kept, the initial activation of the engine room bilge alarm went unnoticed, and by the time the crew were alerted to the flooding it was too late to save the vessel.

2.4 FLOODING OF ENGINE ROOM/STABILITY

2.4.1 Source and rate of flooding

The time between the engineer's inspection of the engine room when he saw that the bilge was dry, until he returned to find water close to the top of the engine, was approximately 30 minutes. Calculations made by MDI indicate that approximately 32 tonnes of water entered the engine room during this period.

At about 1542 the skipper, while on his way to the liferaft, looked down the engine room escape hatch and saw water at a level of about 0.5m above the bottom of the escape ladder. Based on this observation MDI calculated that a further 40 tonnes had entered the engine room by this time. The actual rate of water ingress at this time would have been greater than the calculated volume in the space, as a 25 tonnes per hour bilge pump was pumping water out for most of the time between the two observations.

The flooding rate between the two observations was calculated to be approximately 160 tonnes per hour. Flow rate calculations **(Annex H)** show that, with a head of 4m representing the position of the seawater cooling pipework below the waterline, water must have been entering the engine room through a hole of at least 100mm in diameter.

The steel thickness measurements of the hull taken in 2003 and 2008 showed that the corrosion rate was not excessive; consequently there was no reason to suspect that the vessel's hull plating had failed. It is therefore reasonable to conclude that the flooding was probably caused by the failure of either the main sea water inlet pipe or the main engine seawater cooling system.

2.4.2 Stability

MDI found that there was an increase in free surface moment (FSM) from about 45.13tm to 229.17tm once the flood water in the engine room had covered the fresh water tanks on either side of the engine. This took the vessel from a stable (albeit sinking) condition to an unstable condition.

This very large and sudden increase in FSM with the consequent reduction in stability, demonstrates the vulnerability of the well-type of engine room design to flooding **(Annex B)**. A relatively small amount of water can rapidly overwhelm the main engine and disable the vessel. If the weather had not been so calm this sudden loss of stability could have led to the vessel's capsize.

The crew had not appreciated the speed at which the vessel could lose stability when the engine room became flooded, and their subsequent actions took no account of this risk when reacting to the developing emergency.

2.4.3 Extended spindles

When the engineer returned to the engine room the sea intake valves were more than a metre under water and were inaccessible, so he was unable to close the valves and prevent further flooding.

MGN 165 (F) provides guidance on measures to prevent flooding on fishing vessels. It recommends the positioning of sea valves where they can be easily and quickly closed, and recommends that extended spindles be fitted '*if necessary*' so that valves can be closed without the floor plates having to be removed.

The sea valves on *Audacious* were above floor plate level, but this accident demonstrates that in cases of rapid or undetected flooding it can quickly become impossible to access them. If the valves had been fitted with extended spindles, level with the top of the engine, the engineer might have been able to shut them and stop the water ingress.

While the guidance in MGN 165 (F) identifies the need for seawater inlet valves to be accessible, this may not be sufficient if the rate of flooding is rapid and occurs in a well-type engine room. Longer extended spindles were needed to enable the sea inlet valves to be closed.

2.4.4 Watertight doors

The watertight door between the engine room and the steering flat/workshop was left permanently open and was not labelled to indicate that it should be "*closed at sea*".

The requirement to keep watertight doors closed at sea and to label them accordingly had been noted by the MCA during statutory surveys, but was not complied with. As a result, water was able to flood through *Audacious* more quickly, and the time available to the crew for abandonment was reduced.

Watertight doors are designed to improve a vessel's survivability in the event of flooding, but can only be effective if they are routinely closed when the vessel is at sea.

2.5 ABANDONMENT

The crew were instructed to return to their cabins to collect lifejackets and to then prepare the liferafts. Although they went back to their cabins, the crew only collected personal effects and subsequently boarded the liferaft without lifejackets.

Survival suits, which were stowed in a locker near the cabins, were not collected during the abandonment although several valuable trawl sensors were taken from the wheelhouse and placed in the liferaft.

The majority of the crew had not undertaken safety awareness training, contrary to the requirements of the Fishing Vessels (Safety Training) Regulations 1995. The crew were fortunate that they were able to abandon and be rescued without having to enter the water. In different circumstances their chances of survival, without wearing lifejackets and survival suits, could have been significantly reduced.

The owner had not ensured that the crew held the required qualifications, and this omission was not detected during the MCA's surveys or inspections of the vessel.

2.6 UKFVC – SCHEDULING OF SURVEYS AND INSPECTIONS

It was evident from the CM file and SIAS records that *Audacious* did not have a UKFVC for 3 months from May to August 2003. It was then apparent that this situation was rectified by issuing a series of three short term certificates, all based on the same survey date of 27 March 2003. This was almost certainly due to a delay in the preparation and approval of the vessel's stability book. A full term certificate was finally issued in April 2004, again based on the 27 March survey. This was valid until 31 December 2008, by which time it would have been 5 years and 9 months since the last renewal survey. This exceeded the requirement in the 15-24m Code for vessels to have a '*renewal survey at intervals not exceeding 5 years*'.

Targeted inspections were conducted in August 2004 and October 2006, but the intermediate inspection was not completed until 7 July 2007 – by which time it was 7 months overdue. The validity of a UKFVC is dependent upon an intermediate inspection being undertaken, not less than 24 and not more than 36 months after the issue of the certificate. The MCA's instructions state clearly that vessels operating without valid UKFVCs are liable to immediate detention. However, there was no record of a detention, and it is likely that *Audacious* continued to operate during this period without a valid UKFVC.

Audacious was surveyed by the MCA in August 2008, and a UKFVC was issued in December 2008 which was valid until December 2013. As no intermediate inspection was carried out on *Audacious*, it must be concluded that the UKFVC was not valid after 31 December 2011.

The 15-24m Code states that a vessel's owner is responsible for ensuring that the vessel is surveyed in accordance with the relevant provisions of the Code. The vessel was inspected by the MCA in July 2011 for the issue of a Load Line exemption certificate and the MCA surveyor noted, on the report of inspection **(Annex D)**, that a UKFVC interim inspection was due before the end of 2011. Despite this reminder, no intermediate inspection for her UKFVC was undertaken. However, despite the MCA's instructions to surveyors stating that vessels should be detained when interim inspections became overdue, there was no mechanism to identify that *Audacious* was overdue.

Poor management and communication between *Audacious*'s owner and the MCA led to the vessel not being inspected as required and the UKFVC being '*rendered invalid*'. While this was contrary to the regulations, of far greater practical significance was that the vessel's material condition fell outside the system of scrutiny provided by the MCA.

2.7 ANNUAL SELF-CERTIFICATION

The 15-24m Code states that a vessel's owner is responsible for ensuring the vessel is self-certified annually to confirm that safety, navigational and lifesaving equipment is in date and operating correctly, and that the crew's training and certification are valid.

The fact that some of the crew had not undertaken the requisite fishing vessel safety training courses indicates that the owner's annual self-certification procedures were not sufficiently robust.

2.8 MCA INSTRUCTIONS TO SURVEYORS

2.8.1 Survey of cooling water pipework

The MCA's Instructions for the Guidance of Surveyors MSIS 27 (Section 5.7.6), states that seawater pipes should be thoroughly checked at periodic surveys with the "*liberal use of hammer testing*". It also requires that, after the first renewal survey, "seawater systems should be subject to a 3 bar pressure test".

In March 2003, at the renewal survey for her UK FVC, the surveyor recorded "*Engine Room pipe work hammer tested*". This was the only reference in the vessel's CM file to the hammer testing of engine room pipework, and there is no record that the seawater system pipework had ever been pressure tested.

The lack of a systematic plan to inspect the seawater cooling pipework on board *Audacious*, and the lack of detailed records, means that it was possible for sections of the pipework to have not been checked or replaced. It was therefore possible that some were original, i.e. 13 years old, at the time of the accident. This was contrary to the MCA's survey and inspection requirements and its 'instructions to surveyors'.

2.8.2 Aide-mémoire

The aide-mémoire MSF 5550 **(Annex E)**, issued by the MCA to guide its surveyors during a survey, included a reference to the condition of pipework on a vessel but did not refer to any particular test method.

While an aide-mémoir can, by definition, contain only a summary of the detailed information held in the 'instructions to surveyors', it would be helpful to incorporate into this document a reminder of how seawater pipes should be tested.

The aide-mémoire included columns where a surveyor could quickly record what had been included in the scope of the survey or inspection, and whether the necessary standard was met. These are not currently kept on file, so useful background information, which could guide and inform subsequent surveys, is lost.

2.9 MCA RECORD KEEPING

During the MAIB investigation extensive reference was made to the vessel's CM file and to the SIAS database.

The CM file was not indexed and several reports of surveys carried out on the vessel were missing from the file. The file's poor layout prevented a reader from being able to readily recognise that the vessel's UKFVC was no longer valid.

The survey records held for the vessel on SIAS were also incomplete; not all the surveys undertaken on the vessel had been recorded on the database.

The MCA's records on the survey and inspection of *Audacious* were incomplete and would have made it difficult for MCA staff to determine the validity of the vessel's certificates, its condition or history.

FLOODING AND FOUNDERING OF FV *CHLOE T* - SYNOPSIS

On 1 September 2012 *Chloe T* suffered uncontrollable engine room flooding and sank 17 miles south west of Bolt Head, Devon. The crew were alerted to the flooding at about 1545 by a fire alarm, indicating that there was smoke in the engine room. The crew investigated immediately and found that floodwater was spraying off the main engine flywheel onto the turbocharger casing and turning into steam.

The engine room flooded rapidly and the bilge pump was unable to cope; the crew could not find the source of the flooding. *Chloe T*'s engineer/deckhand suspected that the flooding could be due to a failure in the main engine seawater cooling system. He was unable to close the seawater inlet valve because it was quickly covered by flood water.

The skipper realised that there was little that could be done to save *Chloe T* and made an early decision for the crew to abandon the vessel into liferafts. The crew all wore lifejackets and abandoned *Chloe T* safely and efficiently. A number of vessels responded to the skipper's "Mayday" broadcast and the crew were rescued by a search and rescue helicopter.

It was not possible to determine the exact cause of the flooding, but it was concluded that it was likely to have been caused by a failure of the main engine seawater cooling system pipework due to corrosion. There was insufficient documentation to show that the pipework had been surveyed or inspected as required by the regulations or the MCA's survey instructions.

There was no evidence to show that the engine room bilge alarm activated during the emergency. The alarm sensor had been defective some weeks before the accident, but was cleaned and found to work. It was not tested again and was considered unlikely to have been wholly reliable.

The Scottish Fishermen's Federation, the National Federation of Fishermen's Organisations and the Northern Ireland Fish Producers Organisation have been recommended to promulgate the lessons learned from this accident and that of *Audacious*, and particularly the need for fishing vessel operators to thoroughly inspect seawater pipework, to their members. In view of the actions taken by the owner, and the machinery arrangement on board his other vessels, no further recommendations have been made to the owner.

SECTION 3 - FACTUAL INFORMATION

3.1 PARTICULARS OF *CHLOE T* AND ACCIDENT

SHIP PARTICULARS	
Vessel's name	*Chloe T*
Flag	UK
Classification society	Not applicable
Fishing numbers	PZ 1186
Type	Beam trawler
Registered owner	Langdon and Philip
Manager(s)	Langdon and Philip
Construction	Steel
Length overall	26.44
Registered length	23.55
Gross tonnage	136
Minimum safe manning	Not applicable
Authorised cargo	No
VOYAGE PARTICULARS	
Port of departure	Brixham
Intended Port of arrival	Brixham
Type of voyage	Short – international
Cargo information	Fish
Manning	6
MARINE CASUALTY INFORMATION	
Date and time	1 September 2012, 1545
Type of marine casualty or incident	Very Serious Marine Casualty
Location of incident	17 miles south west of Bolt Head, Devon
Place on board	Complete vessel
Injuries/fatalities	Nil
Damage/environmental impact	Vessel lost
Ship operation	Trawling
Voyage segment	Midwater
Environment	Daylight, good visibility, wind force 4, sea state 4
Persons on board	6

3.2 BACKGROUND

Chloe T was built in 1968 in The Netherlands as a beam trawler. Originally named *Martha Lela*, the vessel was brought to the UK in 1989 and renamed *Angel Emiel*. The vessel was sold again in 2000 and renamed *Chloe T*. The owner of the vessel at the time of the accident had purchased it only a few weeks beforehand on 3 August 2012. *Chloe T* had completed two successful fishing trips under new ownership; the accident occurred 3 days into the third fishing trip.

Chloe T

3.3 NARRATIVE

3.3.1 Purchase and familiarisation

Chloe T was first advertised in 2011 but no sale was agreed. Langdon and Philip already operated six beam trawlers from the port of Brixham, and decided to add *Chloe T* to its fleet. The company employed a team of technical staff experienced in operating and maintaining fishing vessels, and carried out their own pre-purchase surveys. The sale was completed on 3 August 2012.

Other vessels operated by Langdon and Philip were undergoing refit periods over the summer period, and the manager identified crew from these vessels who could operate *Chloe T* in the short term. In addition, an engineer/deckhand was invited to join Langdon and Philip from a different fishing company. He agreed and, before joining, spent most of a weekend with the previous operators of *Chloe T* learning about the vessel’s machinery.

3.3.2 Preparation and fishing

Chloe T was fitted with new towing warps, nets and other associated fishing gear in preparation for its first trip under Langdon and Philip's ownership. The engineer/deckhand was provided with an outfit of tools and spare parts to support the effective operation of the vessel.

The engineer/deckhand began a process of investigating the machinery to develop his understanding of the systems on board. At some point during the week commencing 21 August, the engineer/deckhand found a bilge alarm sensor on the port side of the main engine, close to the flywheel. The bilge alarm sensor was fouled with dirt and debris and did not work. The engineer/deckhand cleaned the sensor and confirmed that the alarm worked.

A number of false alarms were produced by the bilge alarm sensor in *Chloe T*'s fish hold. The engineer/deckhand found that the securing bracket had broken, allowing the alarm sensor to fall deeper into the bilge. He re-secured the alarm sensor and checked that the unit worked correctly.

The first two fishing trips were reported to be successful. There had been no significant problems with the vessel or its machinery and the crew were pleased with the catches and vessel operating costs.

3.3.3 Final voyage

Chloe T sailed from Brixham on Thursday 30 August. Soon after leaving harbour, a problem was identified with the vessel's auto-pilot. *Chloe T* was brought back into Brixham harbour and the shore-based technical team rectified the problem. The vessel sailed soon afterwards on the 3 hour passage to the fishing grounds.

The engineer/deckhand had developed a routine of spending an hour of his afternoon/evening watch, from 1900-2000, in the engine room. He used this time to refill the fuel day-tanks, top up oil levels and conduct general checks of the machinery. He also pumped out any water that had accumulated in the engine room bilge. It was reported that a small amount of water had gathered and this was pumped overboard using the vessel's bilge pumping system.

3.3.4 Fishing

Chloe T's crew fished throughout Friday 31 August. The engineer/deckhand conducted his routine checks in the early evening; the machinery was running correctly and there was no discernible increase in the bilge level.

Although *Chloe T* was not being used primarily to fish for crabs, some were caught in the nets, and these were kept in a tank at the forward end of the vessel under the whaleback. A hose from the deck wash manifold was put into the tank to provide a supply of fresh seawater to keep the crabs in good condition. The deck wash system was supplied by the general service pump in the engine room.

3.3.5 Alarm

At 1400 on Saturday 1 September, the skipper handed over the watch to the mate and went below to rest. Unable to sleep, the skipper returned to the wheelhouse at around 1530-1535. The mate kept the watch and the two men chatted.

About 10 minutes later, at approximately 1545, the alarm on the fire detection system activated, indicating that there was smoke in the engine room. The alarm sounded throughout *Chloe T* and the engineer/deckhand came from the mess room to the wheelhouse to ask what was happening. Realising that it was unlikely to be a false alarm, the engineer/deckhand went to the engine room to investigate.

The engineer/deckhand found that there was a considerable amount of steam in the engine room. Flood water in the bilge was being picked up by the main engine flywheel and sprayed around the compartment. Water was then landing on the turbocharger casing above the flywheel and being turned into steam. None of the crew had seen or heard the engine room bilge alarm activate.

3.3.6 Emergency actions

The engineer/deckhand entered the engine room from the main door at the starboard, aft end of the engine room **(Figure 9)**. He closed a valve on the bilge system, which allowed the pump to suck water from the fish hold bilge well, and opened the valve which allowed the pump to draw water from the engine room bilge. He then started the bilge pump using the starter panel that was fixed to the forward engine room bulkhead.

The skipper checked that the fire alarm indication was for the engine room alone and instructed the mate to begin hauling in the fishing gear. The skipper then followed the engineer/deckhand into the engine room. The deckhand who was on watch woke the remaining deckhand, who was asleep in his bunk, and both men mustered in the wheelhouse.

The engineer/deckhand suspected that the most likely cause of the flooding was a failure in one of the seawater pipes, and he moved round to the port side of the main engine to try and find the problem. The rate of flooding was considerable, and the engineer/deckhand thought that it had been caused by a failure in the largest diameter pipework – the main engine seawater cooling system. However, the water was by now too deep to tell where it was flooding from. There were no obvious jets of water or other disturbances to indicate what the cause of the flooding might be.

The engineer/deckhand moved past the valves controlling the seawater inlets for the auxiliary machinery systems to the port-aft corner of the engine room where the main engine seawater cooling inlet valve and strainer were situated. While there were small access holes the valve handle and strainer were beneath the engine room floor plates. Many of the surrounding floor plates were screwed down, and the engineer/deckhand attempted to lift these in order to gain better access to the pipework and valve handle.

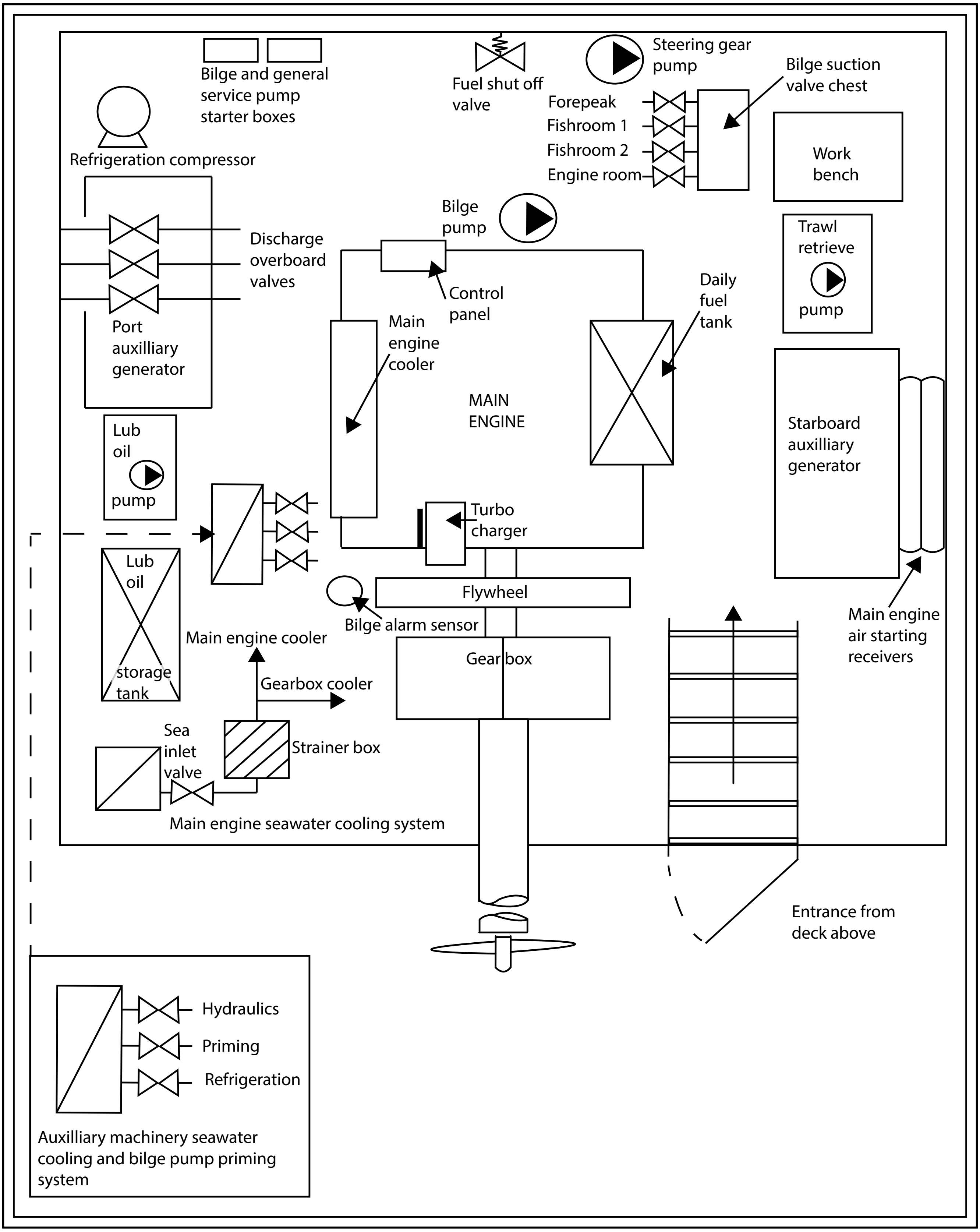

Figure 9: *Chloe T'*s engine room layout - schematic diagram based on crew recollections

The water level continued to rise quickly and was soon at deck plate level. The arrangement of the crew accommodation, above the after part of the engine room, reduced the space available in the area of the main engine seawater cooling inlet valve **(Figure 10)**. Consequently, the engineer/deckhand would have needed to crawl into this low space, with flood water rising around him, in order to reach the valve. Deciding not to stay in this potentially hazardous area, the engineer/deckhand abandoned his attempts to reach the main engine seawater cooling inlet valve and withdrew to the main part of the engine room.

3.3.7 Deterioration

Water had been spraying from the main engine flywheel for some time; a combination of the spray and the steam produced from contact with hot machinery caused the running (port) generator to shut down. *Chloe T* lost main electrical power and the bilge and general service pumps stopped. The engineer/deckhand moved back over to the starboard side of the engine room and started the starboard generator. With electrical power restored, he re-started the bilge pump.

The skipper saw that the situation was deteriorating, and left the engine room to go back to the wheelhouse to make a VHF radio call to the coastguard. At about the same time, the fishing gear was starting to be hauled off the seabed and its full weight came onto the vessel's lifting beams. *Chloe T* began to roll slowly, and it was evident to the crew that the vessel's margin of stability had reduced significantly. The skipper instructed the mate to lower the gear back to the seabed; the mate allowed the winch to pay out until the end of the towing wires ran off the winch drums.

At 1618, coastguard officers in the Maritime Rescue Co-ordination Centre (MRCC) at Brixham recorded a VHF call made by *Chloe T*'s skipper reporting that the vessel was '*taking water in the engine room*'. Two minutes later, the log was updated stating that the vessel had lost power, and the water level in the engine room had risen above the propeller shaft. The skipper also reported that the crew had lifejackets on and were preparing *Chloe T*'s liferafts. At 1622, the coastguard recorded that a "Mayday" message had been broadcast.

3.3.8 Abandonment

The water level in the engine room continued to rise, and the starboard generator stopped due to the ingress of water spray and steam. With the fishing gear run off, there was no longer any need to have power for the winch, which was driven by the main engine. The engineer/deckhand stopped the main engine and re-started the port generator. He then re-started the bilge pump.

The engineer/deckhand came onto the upper deck to discuss the situation with the skipper and crew. At the same time, he was able to confirm that water was being pumped out from the bilge pump discharge overboard.

The engineer/deckhand returned to the engine room. By now the water was reported to be waist deep, having risen approximately 6 inches in a 10-minute period. There was still no indication of the cause of the flooding. The emergency hand-operated bilge pump fitted to *Chloe T* was not considered by the crew to be of much help, and a portable, independently-powered salvage pump, as recommended by the MCA[9],

[9] The MCA recommends in both Merchant Shipping Notice (MSN) 1770F '*The Fishing Vessel Code of Safe Working Practice for the Construction and Use of 15 metre length overall (LOA) to less than 24 metre registered length (RL) Fishing vessels'* and Marine Guidance Note (MGN) 165 (Fishing Vessels) *'The Risk of Flooding'* for an independently powered salvage pump to be carried on board fishing vessels.

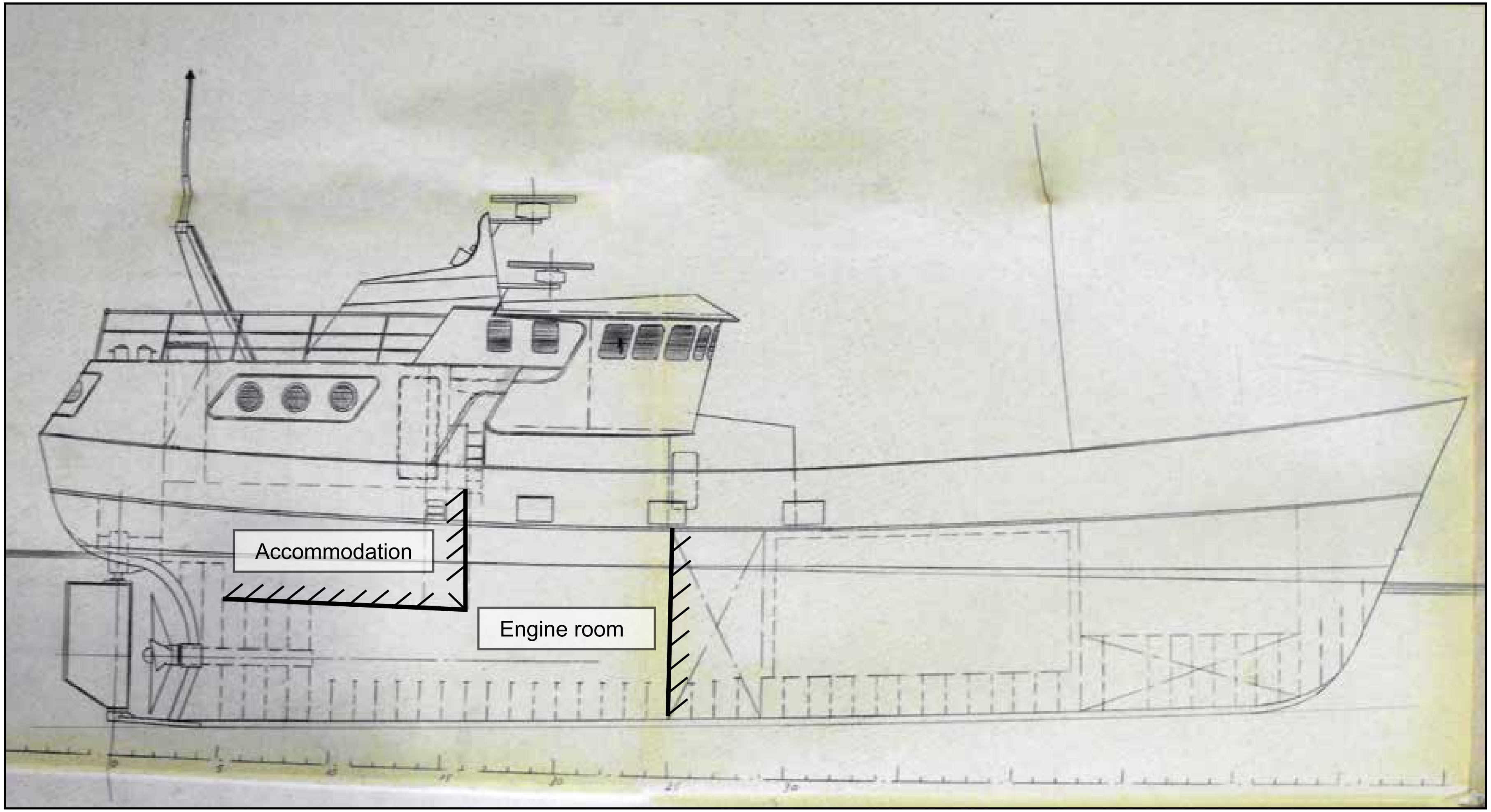

Figure 11: *Chloe T* — general arrangement

had not yet been purchased. Similarly, the engineer/deckhand had not yet identified if, or how, the general service pump could be made to draw suction from the engine room bilge. He did not know if the main engine seawater cooling pump could take its suction from the bilge.

The skipper concluded that there was little he or the crew could do to save the vessel. He instructed the mate and remaining deckhands to launch the two, 6-person capacity, liferafts over the stern. They both inflated correctly and were secured in the lee on the port side of *Chloe T*. At 1634, coastguard officers recorded that the skipper had reported that the liferafts were inflated, and the crew were mustered at *Chloe T*'s stern. The door to the engine room, and the majority of the doors on the upper deck, were closed.

The mate and one of the deckhands boarded the first of the two liferafts. The engineer and the other deckhand boarded the second liferaft. Finally, the skipper boarded the first liferaft. The deckhand and the engineer/deckhand, who had been on watch before the accident, both wore their personal flotation devices, which were routinely worn during fishing operations. The remaining crew wore fixed buoyancy abandonment lifejackets. There were no immersion suits on board.

The vessel's EPIRB was carried in one liferaft and a hand-held VHF radio in the other. The crew cut the painters, lashed the liferafts together and allowed them to drift away from *Chloe T*.

3.3.9 Rescue

A number of vessels responded to the "Mayday" broadcast, including *Maersk Patras*, the Brittany ferry *Armourique*, M/V *Mair* (on charter to Trinity House), *Dart Angler* and the fishing vessels *Amber J* and *Lady Maureen*. The search and rescue helicopter R193 arrived on scene and, by 1721, was reported to be winching *Chloe T*'s crew from the liferafts. Salcombe Royal National Lifeboat Institution (RNLI) All Weather Lifeboat reached *Chloe T*'s position at 1726.

The skipper of *Lady Maureen*, another vessel operated by Langdon and Philip, volunteered to board *Chloe T* and attempt to rig a salvage pump. He was advised against boarding in case the vessel suddenly capsized, and no further attempts to salvage the vessel were made. *Chloe T* sank at 2226 **(Figures 11-14)**.

Figure 11: *Chloe T* (picture taken at 1757)

Figure 12: *Chloe T* (picture taken at 1855)

Figure 13: *Chloe T* (picture taken at 2013)

Figure 14: *Chloe T* (picture taken at 2020)

3.4 CREW AND KEY PERSONNEL

3.4.1 Crew

All five of *Chloe T*'s crew were UK nationals and each had completed the four mandatory Seafish training courses.

Chloe T's skipper was aged 39 and had held a Class 2 fishing certificate[10] since 2000. The skipper had been working for Langdon and Philip for about one year and was the regular skipper of another vessel, which was out of service being refitted. He was to skipper *Chloe T* for about 1 week, while the vessel's regular skipper took a holiday. The regular skipper had shown him the fishing operation of *Chloe T*, but the skipper had not yet studied the detail of the bilge alarm or pumping arrangements. The skipper kept wheelhouse watches from 0800-1400 and from 2000-0200.

The mate was aged 30 and had been fishing all his working life. He was part way through his studies to gain a Class 2 fishing certificate. The mate normally worked as a deckhand on another of Langdon and Philip's vessels. This vessel was also being refitted and he was standing in for the regular mate who was on sick leave.

[10] Deck Officer Certificate of Competency (Fishing Vessel) Class 2

The mate had visited *Chloe T*'s engine room only once, while the vessel was on passage to the fishing grounds. He kept wheelhouse watches from 0200-0800 and from 1400-2000.

The engineer/deckhand was 47 years old. Although he did not have any formal engineering qualifications, he had worked at sea on board fishing vessels for the last 30 years, 25 of which as an engineer. He had also spent a 3-year period working ashore running his own business, before deciding to return to fishing. He had been on board *Chloe T* since it was purchased by Langdon and Philip. He had also spent time learning about the vessel's machinery and systems with the previous owner's crew during the weekend before the sale was completed.

The engineer/deckhand kept watches from 0400-1200 and from 1600-0000. *Chloe T*'s nets were hauled every 2 hours and the engineer/deckhand had a routine of checking the engine room after each haul. He also spent from around 1900-2000 each day in the engine room, making more detailed checks of it, refilling the fuel day tank, adding lubrication oil and emptying water from the bilges.

The two other deckhands were both very experienced fishermen and kept watches of 8 hours on duty, followed by 4 hours off duty. Neither was involved with the operation of the vessel's main machinery.

3.4.2 Other key personnel

Langdon and Philip operated a fleet of six other fishing vessels. The company employed three shore-based technical staff to support and maintain the vessels when they were alongside.

3.5 MACHINERY ARRANGEMENT

3.5.1 Main engine

The main engine was a Stork 6FHD240 driving a fixed pitch propeller through a reversing gearbox. The engine turbocharger was positioned at the aft end of the engine, above the flywheel. A power-take-off at the forward end of the engine drove hydraulic pumps which provided power to the main towing winch and steering gear respectively. The engine was arranged to start with compressed air.

Main engine cooling was provided by a closed circuit fresh water system which passed through a heat exchanger to an open circuit seawater system. Both the pumps for the fresh and seawater systems were mechanically driven from the engine. The main engine cooling seawater inlet was a through-hull fitting positioned at the after end of the engine room on the port side. The vessel's Record of Particulars held in the MCA's CM file indicated that the main engine seawater cooling pipework was 85mm diameter and the seacock was a screw down non-return type. A strum box strainer was fitted after the seacock. There were no additional valves to isolate the strainer for cleaning.

The type of material used for the seawater pipework on *Chloe T* was not recorded in the MCA's records. The material used for the valves was identified as NF – assumed to mean non-ferrous, and therefore probably a copper-nickel alloy.

3.5.2 Generators

Two diesel engine-driven generators were fitted, one to each side of the main engine. The generators were keel-cooled; fresh water in a closed circuit system was pumped through the engine block and then into a sealed heat exchanger mounted on the outside of the hull where it was cooled by the surrounding seawater. The vessel's original direct current (DC) system was replaced with a 415V alternating current (AC) system in 1997.

3.5.3 Bilge pumping

There were no details relating to the type or capacity of the bilge pumps in the vessel's Record of Particulars, contained in the CM file. However, an un-dated maintenance report from the then owner, which was attached to other papers relating to surveys for the renewal of the UKFVC in 2002, stated that there were two, 3 inch electrically-driven Stork pumps. One of these was to be renewed during a planned refit in 2002 due to wear on its casing. The pipework was recorded as being mild steel, of 85mm diameter consistent (though not identical) with the pumps having 3 inch suction and discharge connections. Pumps of this type were estimated to be capable of pumping about 1000 litres of water per minute or 60 tonnes per hour.

A seawater inlet was provided to prime the pump. The bilge suction valve chest was situated towards the forward end of the engine room on the starboard side. Bilge suctions could be taken from the fore peak, fish hold forward store, and engine room. The discharge overboard was above the waterline through a non-return valve on the vessel's port side.

A hand-operated pump was also fitted as an emergency bilge pump. It was not used during the accident. Other vessels operated by Langdon and Philip were provided with portable petrol-powered pumps, as recommended by the MCA, for use as emergency salvage pumps. *Chloe T* did not have one of these pumps when it was sold and the new owners had yet to purchase one.

3.5.4 Deck wash

A second electrically-driven '3 inch' Stork pump attached to 85mm diameter pipework was provided as a general service pump. This was configured as a deck wash system. A manifold on the main working deck diverted the main flow of water to the crab tank at *Chloe T*'s forward end. Water overflowed from the tank onto the deck and overboard through the scuppers. The pump was only turned off while the catch was landed on deck to prevent fish being washed overboard.

Although it was likely that the general service pump could be reconfigured to work as a bilge pump, none of the crew on board *Chloe T* at the time of the accident had identified if, or how, this could be done.

3.5.5 Other seawater systems

A sea chest to the port side of the main engine provided seawater to the refrigeration system condenser, and priming for the bilge pump and the hydraulic system cooler.

3.5.6 Bilge alarms

Chloe T's crew were able to confirm that there were bilge alarm sensors in both the fish hold and the engine room. The alarm panel was in the wheelhouse and gave an audible alarm if any of the sensors were activated. A set of lights indicated which alarm sensor had been activated. The panel was also fitted with a test function which was reported to have shown that all the bilge alarms functioned correctly.

The fish hold alarm sensor had initially given a number of premature alarms, caused by it becoming detached from its mounting and falling into the bilge. This was repaired by the engineer/deckhand, and the alarm worked correctly thereafter.

The engineer/deckhand had found one bilge alarm sensor in the engine room. This was situated on the port side of the main engine, close to the flywheel. It was initially reported not to have worked, however after cleaning, it functioned correctly. The engineer/deckhand did not know if there were any other secondary or high level bilge alarm sensors fitted in the engine room.

3.6 MAINTENANCE AND SURVEY HISTORY

Langdon and Philip had no survey or maintenance history for *Chloe T*, beyond the statutory certificates, having owned the vessel for only a short time. Very few documents were passed over with the sale of the vessel.

3.6.1 Official records

The Consultative Marine (CM) files which were held by the MCA for *Chloe T* were studied to provide an indication of the vessel's survey and maintenance history. CM files are kept to provide documentary evidence to support the issue of statutory certificates – principally, the UK Fishing Vessel Certificate (UKFVC). The CM file was not required or intended to represent the complete maintenance history of the vessel. A number of separate files, each for a specific topic, may be created for each vessel. *Chloe T* files had CM files relating to its construction (01 suffix) and stability (04 suffix). There was no record of a file relating to the vessel's machinery (02 suffix) ever having been created.

3.6.2 Early history of the vessel

Chloe T was first surveyed when it was brought onto the UK fishing vessel register in 1989. In 1994, a shelter deck was added at the stern to improve the vessel's stability characteristics and to ensure that it met the requirements of The Fishing Vessels (Safety Provisions) Rules 1975 (hereafter referred to as the 1975 rules). The vessel had a major refit in 1997/98 when the main engine was overhauled, and a significant amount of the seawater system pipework was renewed.

The vessel changed ownership in 2000; the next record of any work on the seawater system was in 2002, when it was noted that all the sea valves were removed, overhauled and replaced. Although there was no specific mention of the seawater pipework having been checked, it is likely that at least some parts of the pipework were seen when the valves were removed. The owner's report to the MCA, regarding engine room maintenance at about that time, stated that the bilge pumps were serviced annually.

3.6.3 Surveys for the renewal of the UKFVC - 2002

The surveys for the renewal of the UKFVC in 2002 took place from March to July 2002.

The MCA's records showed that a hull survey (with ultrasound thickness measurements) and a light ship displacement check had been completed.

A review of the Record of Particulars (MSF 1301) showed that:

- No sketch of general layout, plan and profile had been completed as required by the instructions on MSF 1301.

- The section relating to bilge pumps was partly completed. There was no record of the compartment in which the pump was situated or the pump's capacity. In the column '*Source of power and its position in vessel*' was written '*Audible and visible in W'house from E.R.*'

- There was no record of the bilge pumps being tested as required by the instructions on MSF 1301.

- An exemption was granted from the 1975 Rules Section 37(1)(b)(7): *Every vessel of 12 metres in length and over but less than 24.4 metres in length to which these Rules apply shall be provided with:*

  - *(1)(b) not less than two bilge pumps*

    - *(i) having a total capacity of not less than 455 litres per minute if the vessel is 20 metres in length and over but less than 24.4 metres in length. At least one such pump shall be a power pump having a capacity of not less than 230 litres per minute. Where two power pumps are provided each pump shall be independently driven;*

  - *(3) In any such vessel a general service pump of sufficient capacity may be used as an independent bilge pump.*

  - *(7) In every such vessel –*

    - *(a) if the vessel is 15 metres in length and over but less than 24.4 metres in length bilge branch suction pipes shall be not less than 50 millimetres inside diameter;*

The UKFVC was issued on 8 November 2002, valid until 24 February 2006. The previous UKFVC had expired over 8 months previously, on 24 February 2002. There was no evidence of any interim certificates or extensions being granted during this period.

3.6.4 Surveys for the renewal of the UKFVC - 2006

The surveys for the renewal of the UKFVC, due on 24 February 2006, began in November 2005. The renewal survey (conducted 25 November 2005); included the following deficiencies:

- *Gear box cooling pipe to renew as discuss and ME suction strum to SW pump*
- *Fit 2nd independent bilge alarm in engine room*
- *Prove E.R* (engine room) *and F.R.* (fish hold) *bilge alarms*
- *Mark location of sea-cocks in engine room* [sic]

A surveyor from the MCA's marine office local to *Chloe T*'s home port wrote to the vessel's owner on 14 February 2006 reminding him that the UKFVC would expire on 24 February, and that the vessel would need to be taken out of the water for a hull survey. The owner replied on 16 February and requested that the hull survey be deferred until an unspecified date when the local slip became available. A series of six short-term certificates was provided to cover the period from 22 February 2006 until 1 February 2007. These were held locally and were not included in the vessel's CM file or on SIAS. The Report of Hull Condition of a Fishing Vessel (MSF 1328) stated that an ultrasound hull survey was carried out on 10 July 2006.

A full term UKFVC was issued on 1 February 2007, valid until 24 February 2011. The certificate and the accompanying documents recorded that:

- The exemption from 1975 Rules Section 37(1)(b)(7) was continued. Exemption 62 was removed; the vessel had been fitted with a fire detection system.
- The fish hold bilge well was cleaned and lined with screed (having been found to be thinning due to erosion).
- All seacocks and discharge overboard valves were removed, cleaned, inspected and returned to the vessel. All external gratings were removed and cleaned.
- The CM file document checklist (fishing vessels) MSF 1327 dated 30/01/07 included sighting of a machinery maintenance survey report.

The record of particulars (form MSF 1301) was not completed in accordance with the requirements stated on the form:

- No photograph of the vessel was attached.
- There was no sketch: general layout; plan and profile.
- The section on bilge pumps was partly completed. There was no record of the compartment in which the pump was situated or the pump's capacity. Under the column 'Source of power and its position in vessel' was written '*Audible and visible in W'house from E.R.*' The bilge pumps were recorded as having been tested in September 2006.

The covering letter dated 1 February 2007 stated that the UKFVC would only remain valid if the owner completed annual self-certification checks, and an intermediate inspection was held between February 2008 and February 2009.

3.6.5 Inspections between 2007 and 2011

The MCA's SIAS database **(Annex F)** recorded that targeted inspections were conducted on *Chloe T* on 8 November 2007 and 28 May 2008. The nature of the targets was not identified, but deficiencies were recorded. Each of the deficiencies (from both inspections) were noted on SIAS as '*Relates to survey - I'*. There was no specific record, in either SIAS or the CM file, confirming that the annual self-certification checks or the intermediate inspection had been conducted.

The copy of the UKFVC held in the CM file was not updated to record that inspections had been conducted. Similarly, there was no record that the annual self-certification declarations had been completed by the owner.

A copy of a document reporting the maintenance carried out on *Chloe T* during 2010 was obtained from the MCA's informal local 'working' file. The document was unsigned, but appeared to have been provided on the owner's behalf. The list of maintenance included a statement that the '*port and starboard bilge and general service pumps'* had been overhauled and that '*various*' pipes had been renewed as necessary.

3.6.6 Surveys for the renewal of the UKFVC – 2011

The surveys for the renewal of the UKFVC in 2011 began on 19 January 2011. The MCA's local surveyor identified a number of deficiencies, of which the most relevant to the accident was to '*Prove all machinery alarms*'. Other survey deficiencies indicated that the surveyor had paid particular attention to checking emergency drills, crew certification and risk assessments. The surveyor had ticked off and dated when each deficiency had been rectified. In addition, the surveyor had also signed the survey report stating that all the deficiencies had been rectified by 26 April 2011.

A hull condition survey was conducted on 21 February 2011 with the vessel slipped. The hull was found to have not deteriorated significantly since the previous survey 5 years before. Sea chests, bilge suction wells and the soil pipe were all found to be in an acceptable condition. A lightship survey was conducted on 24 February 2011 and the results were found to compare well with previous checks, and no further review of *Chloe T*'s stability information was required.

The UKFVC expired on 24 February 2011. Three short-term certificates were issued to cover the period from 28 February 2011 to 1 August 2011.

An unofficial form, titled '*Fishing Vessels (Safety Provisions) Rules 1975 – Exemption required from the application of the following Rules: Steel Hull Vessels: Under 24.4m length Reg.*' listed a number of references to different parts of the 1975 Rules. The majority of these references (including Section 37(1)(b)(7), relating to bilge pumping) had been highlighted. The form had been signed where it was labelled '*signature of owner*' and was dated 18 March 2011.

A report of an electrical survey, dated 25 February 2011, stated that *Chloe T*'s electrical systems were all in good condition. No earth faults were detected and the cables were identified as being double insulated and of good quality. It was also reported that the vessel's switchboard was fitted with a built-in meter allowing operators to check for earth faults easily.

The MCA form 'CM File Documents Checklist (Fishing Vessels) MSF 1327' indicated that a '*Service Report – Machinery*' had been sighted. However the checklist form was not signed or dated.

The Record of Particulars (MSF 1301) was updated, based on a final survey date of 18 July 2011 **(Annex G)**. It was not completed in accordance with the requirements stated on the form:

- No photograph of the vessel was attached.
- There was no Sketch: General layout; plan and profile.
- The section on bilge pumps was partly completed. There was no record of the compartment in which the pump was situated or the pumps' capacities. Under the column 'Source of power and its position in vessel' was written 'Audible and visible in W'house from E.R.'. The bilge pumps were recorded as being tested in March 2011.

The Record of Particulars stated that the engine room had been fitted with a 'secondary' bilge alarm and that the system had been tested by an MCA surveyor, and found to be satisfactory, in March 2011.

A full-term UKFVC was issued on 21 July 2011, valid until 26 February 2016. The exemption from the 1975 Rules regarding bilge pumping (Section 37(1)(b)(7)) was granted. The covering letter attached to the UKFVC reminded the owner that annual self-certification needed to be conducted and an intermediate survey must take place between February 2013 and February 2014.

3.6.7 Other surveys and inspections

A valuation survey of *Chloe T* was conducted on behalf of the vessel's owners on 30 September 2011. The bilge and general service pumps were identified in the list of machinery, but there were no comments relating to the condition or age of the sea inlet valves or salt water pipework. The survey concluded that the engine room '*appeared to be in very good condition with evidence of recent and effective maintenance. The main, auxiliary and ancillary machinery appeared to be in a fully operational and well-maintained condition.*'

MCA surveyors conducted two further targeted inspections on board *Chloe T*. The first, on 2 February 2012, was related to the fitting of a new trawling winch. The second required the vessel to be fitted with an Automatic Identification System (AIS).

SECTION 4 - ANALYSIS

4.1 AIM

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

4.2 ENGINE ROOM FLOODING

By the time the crew were aware of the water flooding into the engine room, the level was already too high to allow them to see where it was flooding in from. The level continued to rise and it never became possible to confirm the cause of the flood. The possibility of *Chloe T* being deliberately flooded for financial reasons was considered, but was dismissed because:

- The vessel was reported to be operating successfully and profitably.
- There was a substantial period before the next renewal survey was due.
- Additional tools, spares and fishing gear had been purchased and put on board.
- The vessel was part way through a fishing trip and already had a valuable catch on board.

4.2.1 Potential sources of flooding

There were two principal ways that water could have flooded into *Chloe T*'s engine room: the first was a failure of the hull plating, and the second was a failure in one of the seawater systems.

Flooding through the propeller shaft seal can be discounted because the water level was below the propeller shaft when the engineer/deckhand first entered the engine room, and no sign of water ingress was seen in this area.

Back-flooding through the bilge pumping system can also be ruled out as the valve had been left open to pump from the fish hold. The valves were reconfigured by the engineer/deckhand as soon as he entered the engine room after hearing the alarm. Any back-flooding would therefore have flooded the fish hold and not the engine room.

Similarly, a failure in the general service pump discharge (deckwash) system can be discounted. The system was set up to pump water into the crab tank on the deck near *Chloe T*'s bow. The engine room still continued to flood even though the general service pump was not restarted after the diesel generator tripped.

4.2.2 Hull plating failure

There was no evidence to indicate that *Chloe T* had collided with any objects in the water or that its hull plating had become damaged while the fishing gear was being handled.

The two most recent hull surveys (2007 and 2011) recorded that the hull plating was of an acceptable thickness. More importantly, there was little difference in the results from the two surveys, indicating that there was not much active corrosion. While there can be no guarantee that this stable situation continued through the 19 months from the last hull survey until the accident, such a rapid increase in the rate of corrosion could only be caused by a significant change and would probably have been noticed.

One reason for a significant increase in the rate of hull plating corrosion could be electrolytic action caused by a fault in *Chloe T*'s electrical system. Typically, a result of electrical insulation breaking down or other earth leakage faults, is that areas of hull plating can become anodic and can corrode rapidly. However, the most recent electrical survey report concluded that *Chloe T*'s electrical systems had been installed to a high standard and were maintained in a good condition. Consequently, this potential cause is considered to be less likely.

Another cause of hull plating failure is localised erosion, normally occurring over several years close to bilge suction points. This problem had been found in *Chloe T*'s fish hold bilge well during the hull survey in 2007. The bilge well was repaired and no further deterioration was recorded. The condition of the hull plating close to the engine room bilge suctions was not specifically noted in either of the most recent hull surveys. However, ultrasound thickness readings of the hull plating did not show any concerns.

4.2.3 Seawater system failure

All the most recent survey reports recorded that the hull suction and discharge valves had been removed, overhauled and replaced. It is therefore reasonable to expect that these were in an acceptable condition at the time of the accident. The plating of the sea box was also in reasonable condition.

The seawater systems consisted of inlet and discharge pipework for main engine cooling, refrigeration and hydraulic cooling and the general service pumping system. Discharge overboard pipes were all recorded as being fitted with non-return valves.

There were references, in working notes or from records of deficiencies, that some sections of pipework had been renewed from time to time. However, there was no record of the layout of the seawater systems or, importantly, exactly which sections of pipework had been renewed. It is notoriously difficult to get access to every section of pipework in vessels of *Chloe T*'s style and age; the systems are extensive and complex by modern standards and many are placed low down in the bilge, often obstructed by major components. It is not surprising therefore that the records in the CM file often referred to replacing pipework 'as required'. All these factors strongly suggest that there was no methodical plan to inspect or replace the seawater system pipework.

Pipework failure, due to some form of undetected corrosion, is a common cause of engine room flooding; *Chloe T*'s construction and history suggest that the vessel would have been particularly vulnerable to this problem. Consequently, the most likely source of the flooding is considered to be from the failure in part of the seawater system pipework.

4.2.4 Flooding rate

By the time the engineer/deckhand entered the engine room, enough water had flooded in to prevent him from seeing where the water had come from. He then started the bilge pump, which was estimated to have had a capacity of 60 tonnes/hour. The water level continued to rise above the floor plates and was later estimated as having risen '*6 inches in 10 minutes*'. At this stage, the sides of the engine room (formed by the hull plating and bulkheads) would have been largely vertical. If viewed from above, the surface of the water would have appeared to be roughly square in shape, with each side approximately 6.5m long. If the volume occupied by the main engine and other machinery is ignored[11] to simplify the calculation, the rate of flooding can be estimated as being 39 tonnes / hour. Assuming that the pump was working at its maximum capacity, the total rate of flooding would have been 39 plus 60 tonnes / hour. Given the obvious limitations of this estimation, the total rate of flooding can be approximated to 100 tonnes / hour.

Chloe T was reported to have had a draught of 2.8m. The seawater systems would have been close to the hull plating, so it has been assumed that they would have been about 2.7m below the waterline. Using Bernoulli's theory for steady flow through an orifice, it is possible to determine that a hole of about 88mm (3 ½ inches) diameter, 2.7m below the waterline, will cause a flooding rate of about 100 tonnes / hour **(Annex H)**.

A similar rate of flooding could also have been caused by a failure in pipework on the discharge side of the main engine sea water cooling pump. In these circumstances the water would be forced out by the sea water cooling pump and the same rate of flooding could have come from a smaller sized hole.

4.2.5 Most likely cause

The estimation in the previous section suggests that the rate of flooding could only have been caused by a substantially sized hole; this must have been caused by a significant failure. As previously discussed, the most likely cause of such a significant failure was a failure in part of the seawater system, due to corrosion. Given the likely size of hole required, the failure probably occurred in part of the main engine cooling water system. The flooding continued, at much the same rate, even after the main engine was shut down. It is therefore more likely that the hole was in pipework on the inlet side of the sea water cooling pump and that the flooding was due to static sea water pressure alone, without the additional effect of the pump discharge.

4.3 FLOODING WARNINGS

4.3.1 General principle

Flooding can only be controlled if water is pumped out faster than it can leak in. This can be done either by adding more pumps, or by finding the source of the flood and restricting the rate of flooding. While this sounds obvious, in practice there is always a maximum rate at which any vessel can pump out water even if every pump on board is used. Flooding can then only be stemmed if the source can be found. This

[11] The volume of the engine room occupied by the machinery would be a relatively small proportion compared with the total volume of the engine room.

is extremely difficult once the depth of the flood is beyond a few tens of centimetres. It is therefore essential that crew are alerted as soon as flooding starts – reliable, correctly positioned bilge alarms are essential.

4.3.2 Bilge alarms on board *Chloe T*

Chloe T was fitted with one bilge alarm sensor close to the main engine flywheel. The bilge alarm sensor was dirty and did not work when it was found by the engineer/deckhand. He cleaned it and found that this made it work again. However, there was no guarantee that the sensor would stay clean or keep working. It might easily have become coated in engine oil again and prevented from operating; any oil leaking from the crankshaft oil seal would soon have found its way onto the flywheel. The MSF 1301 form from July 2011 records that *Chloe T* was fitted with a secondary bilge alarm sensor. However, the crew did not know where this was located, or if it worked correctly. The bilge alarm close to the main engine flywheel was not tested at the beginning of the final voyage and it did not operate during the accident; there can be little confidence that it worked reliably.

4.3.3 Secondary bilge alarms

Bilge alarm sensors need to be capable of operating in harsh conditions. However, there is a limit to what the sensors can withstand, and they need to be checked and replaced periodically. This time period will reduce on board vessels which routinely have wet or oily bilges, and *Chloe T* will have suffered from both these problems during her working life. There was no record of when the bilge alarm sensors were last replaced and, potentially, they could have failed at any time.

4.4 EMERGENCY RESPONSE

4.4.1 Response to flooding

The skipper, mate and engineer/deckhand responded promptly to the smoke alarm. They realised that there was no obvious explanation for the alarm and went to investigate. Other crew were alerted and mustered. The flooding was obvious and the engineer/deckhand immediately started the bilge pump and configured the valves to draw water from the engine room. He, and latterly the skipper, then searched the engine room to determine the source of the flood.

With the source of the flood obscured, there was no immediate action that could be taken to reduce the rate of water ingress. The engineer/deckhand sensibly concluded that a seawater system pipework might be the cause, and attempted to shut the main engine seawater inlet valve. This was not easily accessible with the increasing level of the floodwater. Locating and operating the valve would have put the engineer/deckhand into an extremely hazardous situation, and he wisely decided not to take the risk. However, the situation faced by the engineer/deckhand was entirely foreseeable and could have been avoided. The MCA and other organisations have published guidance over many years which advises that there should be some means of closing valves once they are submerged under flood water and are otherwise inaccessible.

Other options were available even though the main engine seawater inlet valve was inaccessible. The general service pump probably could have been reconfigured to pump from the engine room, however none of the crew on board at the time knew how to do this. This pump was identical to the bilge pump and, if it is assumed that both were capable of pumping 60 tonnes per hour, it is possible that the flood could have been contained by using both pumps together[12].

The inlet valves for the other seawater systems were more accessible and could have been shut. Even if this had not affected the rate of flooding, it might have helped improve the chances of later salvaging the vessel.

Hauling the nets, while an understandable reaction to any emergency on a fishing vessel, unnecessarily reduced *Chloe T*'s margins of stability even further. The crew were quick to recognise this and resolved the problem by running the towing wires off the winches.

4.4.2 Abandonment

The skipper informed the coastguard about the flooding very quickly, and subsequently broadcast a "Mayday" message as soon as he realised that the flood could not be controlled. A number of vessels responded to the "Mayday" and stood by to offer assistance. As soon as the skipper identified that there was little more that could be done to control the flooding, and that *Chloe T*'s margin of stability was reducing, he took the decision for the crew to abandon the vessel.

Crew members had already been instructed to prepare the liferafts; these had been inflated and secured in the lee of the vessel. All the crew wore lifejackets, either their PFDs which were routinely worn when working on deck, or their abandonment lifejackets. Each crew member was able to board a liferaft without entering the water. A portable VHF radio was taken on board one liferaft, and the EPIRB on the other. This meant that if the liferafts had subsequently become separated, each had a way of attracting attention over a long range.

There was evidence, both from crew reports and the MCA surveyor's records, that emergency drills had been conducted on *Chloe T*. This was extremely commendable and no doubt helped the crew's response during the emergency. The skipper's early decision to abandon *Chloe T* and the crew's well-considered response meant that the risks to them and any potential rescuers were minimised.

4.5 ROLE OF THE OWNER AND CREW

4.5.1 Responsibility

The 15-24m Code makes it clear that it is the owner's responsibility to present his vessel for surveys and intermediate inspections. The owner (or his delegated representative) also has a responsibility to complete the annual self-declarations, confirming that the vessel still meets the requirements of the Code.

Apart from these obligations, the owner and skipper also have more practical responsibilities to ensure that the vessel is seaworthy and can be operated safely.

[12] The flooding rate was estimated to be about 100 tonnes per hour. If the bilge and general service pump were 3 inch Stork pumps, each with a capacity of 60 tonnes per hour, the potential maximum pumping rate was 120 tonnes per hour.

4.5.2 Purchasing and familiarisation

The owner of Langdon and Philip, and his staff, had a great deal of experience of operating and maintaining fishing vessels. They were not obliged, by insurance or other financial reasons, to obtain a formal pre-purchase survey. They were reassured that *Chloe T* had completed its statutory renewal survey relatively recently and felt sufficiently confident to assess the condition of *Chloe T* for themselves. They would have needed to conduct a very detailed survey to be certain that none of the seawater pipes were corroded and liable to fail suddenly.

The engineer/deckhand spent a good deal of his own time learning about *Chloe T* from the previous operators. While this was commendable, unfortunately, key features were missed. These included: the existence of any supplementary bilge alarms; proving the reliability of the bilge alarm sensor, which was mounted close to the main engine flywheel; and, checking what other methods could be used to pump out the engine room bilges in an emergency. Each of these issues, while crucial in the accident, were not necessary to *Chloe T*'s normal operation. It is likely that they were considered to have a lower priority – useful things to know once the basic operation of the vessel had been mastered.

4.5.3 Operation

The last time the bilge alarm sensor in the engine room was proved to have worked was over a week before the accident. It was quite likely that it became fouled again and did not work during the accident. Bilge alarm sensors need to be checked regularly. Certainly before the beginning of each fishing trip and, ideally, every day at sea.

The engineer/deckhand had a good working routine for checking the running machinery. However, this was focused on the normal operation of *Chloe T*. Far less attention was given to checking alarms or learning more about reconfiguring systems to cope with an emergency.

4.6 EFFECTIVENESS OF THE STATUTORY SURVEY REGIME

The MCA publishes detailed requirements for the scope and conduct of statutory surveys and inspections on fishing vessels. These requirements were not met on *Chloe T* in a number of areas.

4.6.1 Scheduling of surveys and inspections

The records of surveys for the renewal of *Chloe T*'s UKFVC in 2002, 2006 and 2011 were examined, as they were the most pertinent to this accident. In each case, there were delays in the process: 8 months in 2002, from February 2006 until February 2007 and from February to August 2011, which resulted in the vessel being issued with short-term certificates. This was contrary to the requirements of the 15-24m Code, which stated that an extension of up to 2 months could be granted in exceptional circumstances.

There were no records which showed that any interim inspections had been conducted between the renewal surveys in 2002 and 2006, and between 2006 and 2011. SIAS records showed that inspections had been conducted in 2007 and 2008 at around the time when an interim inspection would have been expected. However, both these were recorded as 'targeted' inspections, and it is impossible to determine from the records whether they met the requirements of an interim inspection. It is therefore possible that the vessel did not have interim inspections as required and that, in accordance with the statement in MSIS 27, the UKFVC was invalid from February 2009 until April 2011. *Chloe T* did, however, have a valid UKFVC at the time of the accident.

If the intermediate inspections were not done, as the MCA's records suggest, *Chloe T* would have operated without a valid UKFVC for about 12 months from February 2005 to February 2006, and again for 2 years from February 2009 to February 2011. Apart from being contrary to the regulations, it is unlikely that *Chloe T* received the level of survey and inspection that is stated in the MCA's documentation as being required over a sustained period.

While the 15-24m Code makes it clear that it is the owner's responsibility to present his vessel for survey, there was no evidence of the MCA having taken action to detain the vessel as stated in MSIS 27. Consequently, it must be concluded that the MCA's surveyors either did not know that surveys and inspections of *Chloe T* were overdue, or were willing to tolerate the situation.

4.6.2 Scope of surveys and compliance with standards

The MCA has set out an extensive scope for the surveys and inspections of fishing vessels. The standard is broadly equivalent to what would be done on a larger merchant ship. However, there was insufficient evidence to show that the whole scope had been applied.

Of most relevance to this accident were the requirements for seawater systems. This included requirements and guidance, in five different MCA documents, for:

- Systematic examination of seawater system pipework.
- Ensuring that seawater inlet and discharge valves are operable from a position above engine room floor plates.

Meeting the requirements relating to the operation of seawater valves and inspection of seawater system pipework were potentially challenging.

<u>Seawater valves</u>

Chloe T's seawater inlet and discharge valves were not all easily operable from above the engine room floor plates. The engineer/deckhand was unable to close the main engine cooling seawater inlet valve because it was covered by the rising floodwater, and he set about removing floor plates to improve access. The floodwater was at about the level of the floor plates at this time, so it can be concluded that the valve was not accessible as stated in the 15-24m Code, MSIS 23, MSIS 27, MSF 5550 or MGN 165. It was not possible to determine the precise reason for this. There was no evidence of this issue being addressed by an exemption, and *Chloe T* had been surveyed and inspected by a number of different MCA staff between1989 and the accident. The possibility of this requirement being simply overlooked is therefore unlikely. Moving the main engine cooling seawater valves to more accessible positions would have been a substantial job. New lengths of pipe would have been needed at the very least, perhaps with venting and priming arrangements to make sure the flow of water was not disrupted. It is highly likely that fitting all this in between the existing machinery would have been technically challenging and expensive.

An alternative method, recommended by the MCA, could have been to fit a remote operating device to the seawater inlet valve. In its simplest form, this could have been an extended spindle (perhaps a metre long) connected to a secondary valve handle. However, extended spindles can also be difficult to fit; the engineer/deckhand described how he would have had to crawl into a corner of the engine room to reach the seawater inlet valve, the height in this part of the engine room was restricted by the accommodation above. It is easy to imagine how an extended spindle might not be ideal in such a location.

It was evident that none of *Chloe T*'s operators had chosen to make the seawater inlet valves more accessible and that they had never been required to do so by surveyors. In the absence of any evidence to the contrary, it must be concluded that the most obvious reason for this was that the requirement was considered to be too difficult to achieve, and the case for making the modification was never made strongly enough.

<u>Seawater pipework</u>

Removing lengths of pipe from the bilge of a vessel of *Chloe T*'s style of construction is not an easy task and would only be done for a compelling reason or to deal with a known problem. Surveying the pipes in-situ would be equally difficult and would provide very limited information about their condition. The recommendation for the '*liberal use of hammer testing*' is questionable. There is a real chance in an older boat, of the surveyor breaching a pipe, leading to uncontrollable flooding if this is done while the vessel is afloat.

While theoretically sound, the advice to pressure test seawater systems is extremely difficult to achieve in practice. Apart from the need to supply appropriate equipment and fittings to conduct a test, there is a significant problem in applying the recommended pressure of 3 bar safely; there is a risk of damaging equipment – particularly ageing heat exchangers – or of fittings coming apart under pressure (3 bar pressure is roughly equivalent to the pressure exerted by seawater at a depth of 30m – 10 times *Chloe T*'s draught). However, the most likely outcome is that the pressure cannot be maintained and that the surveyor is then confronted with the challenge of determining whether the leak is from the system, the test equipment, or both.

The surveyor cannot afford to spend all his time on any given vessel looking at just one system. It seems unlikely that fishing vessel owners would have a systematic pipework inspection plan (of the sort kept by classification societies for larger vessels). Certainly there was no evidence of such a plan on *Chloe T*. Consequently, the surveyor is placed in the unenviable position of being obliged to reach a judgment without having enough time or information to make a considered decision.

4.6.3 Record keeping

The MCA's record keeping system is effectively spread over three systems: the official CM files, the SIAS database, and local paper and computer records. No system satisfies all the requirements on its own, and the quality of the interface between each is solely dependent on individual members of staff. The system is extremely vulnerable to errors, oversight and mistakes. This was evident in all the paperwork examined during the course of this investigation. There were several examples of the survey forms not being fully completed: there were no photographs or diagrams, descriptions of equipment were incomplete, and the results of tests were not recorded.

Of greatest concern, however, was that a CM file on the vessel's machinery had never been created. The lack of a file to record the results of machinery surveys is incompatible with the scope of the machinery surveys described in MSIS 27 and elsewhere. The result is that the MCA's records of the machinery fitted to *Chloe T*, its operation and condition are incomplete. While this was partially compensated by local working files and informal notes from the vessel's owner, the MCA and owner denied themselves a significant opportunity to monitor the vessel's condition. A serious failure was therefore far more likely to occur.

It is possible that the targeted inspections on *Chloe T* in 2007 and 2008, which were recorded on SIAS, could have been considered as being the intermediate inspections required to validate the UKFVC. However, unless this is specifically recorded, there will always be some doubt about their status and, therefore, the validity of the UKFVC.

4.6.4 Exemptions

Chloe T had been granted an exemption from the 1975 Rules regarding the performance of the bilge pumping system. This exemption was extended at each renewal survey, simply by the owner and surveyor highlighting the exemptions they wanted from a pre-prepared list of 'standard' exemptions. This was much the same from survey to survey (apart from the fitting of a fire detection system). When the validity of the exemption given for bilge pumping was examined as part of this investigation, it was found that there was not enough information in the CM file to be able to determine whether the exemption was valid, or not. When the information from the CM file was combined with other sources (including the purchase survey), it was considered likely that the bilge pumping system on *Chloe T* exceeded the requirements of the 1975 Rules.

It is quite possible that there was no need for an exemption, and that one had been given, on a safety critical system, for over 10 years without challenge.

4.6.5 Summary

Chloe T was not surveyed in accordance with the applicable requirements or guidance. As a result, it is likely that the vessel's UKFVC was invalid at times, and that the condition of safety critical systems was not checked as it should have been. Requirements for valve handles to be accessible were not enforced and the MCA's records were not completed in accordance with its own instructions.

It is impossible to know how much the shortcomings in the survey process contributed to the failure of the pipework. MSIS 23 emphasises that it is the owner's responsibility to demonstrate that pipework is in a satisfactory condition, and MSIS 27 states that owners should agree a 5-year cycle with MCA surveyors for surveying machinery systems. However, an accessible handle to close the main engine seawater cooling inlet valve might have made a significant difference to the outcome of this accident.

The MCA's surveyors face an extremely challenging task; they are presented with a very large scope of work to cover, and guidance that is, in parts, not credible. The systems for recording the results of surveys and inspections are inefficient and vulnerable to error. The records did not contain enough detail to determine whether exemptions from earlier rules should continue to apply, or that the vessel's condition was being systematically checked. It is inevitable that mistakes in the documentation were made and highly likely that parts of the vessel were not surveyed in as much detail or as frequently as intended.

SECTION 5 – AUDACIOUS/*CHLOE T* SIMILAR ACCIDENTS

5.1 FLOODING AND FOUNDERING OF FV *VELLEE*, 6 AUGUST 2011

The 19.8m trawler *Vellee* suffered a flooded engine room and foundered while on passage. The MAIB investigation report, No 1/2012, found that the crew discovered flood water in the engine room, above gearbox level, but were unable to access the sea inlet valves as they were underwater.

The report concluded that it was probable that the source of water ingress was as a result of a catastrophic failure of seawater piping or associated fittings arising from advanced electrolytic corrosion.

5.2 ANALYSIS OF UK FISHING VESSEL SAFETY 1992 - 2006

In November 2008 the MAIB published a fishing safety study which analysed the trends from UK fishing vessel accidents, losses, fatalities and injuries for the period 1992 -2006.

The study found that in the 15m–24m category 85 vessels were lost due to flooding/foundering. Progressive flooding and the failure of the main engine cooling systems were recorded in the MAIB database as being the most common causes of flooding incidents.

SECTION 6 – DISCUSSION

6.1 FLOODING

The precise reasons for the flooding of *Audacious* and *Chloe T* are not known. However, analysis of the circumstances of the accidents and the histories of each vessel strongly indicates that both floods were caused by seawater cooling system pipework failing due to undetected corrosion. While the rate and extent of corrosion in seawater pipes can be influenced by several different methods, some corrosion is inevitable.

6.2 PREVENTION

6.2.1 Pipework deterioration

The only way to prevent such failures is to have a methodical system for checking the condition of seawater pipework and to replace it before it fails. Pipework should normally be expected to deteriorate at a fairly constant rate; however, changes in electrical potential (due to earth faults, missing galvanic isolation, or lost anodes) and other metallurgical factors (such as laying up a vessel in polluted or stagnant water) can cause dramatic changes. Certain sections of pipework, where flow velocities are highest, will also be more vulnerable to corrosion damage than others. It is impractical to predict the effect of these factors precisely – regular inspections are essential.

6.2.2 Survey and inspection

There was evidence that some pipework was inspected and replaced on both *Audacious* and *Chloe T* from time to time. However, the accidents demonstrate that this was not sufficient.

The statutory requirements for the survey and inspection of fishing vessels are extensive. The owners of vessels also have considerable responsibilities for managing maintenance and arranging surveys. It is hard to imagine that both these accidents could have occurred if all the requirements previously described in this report had been met. It must therefore be concluded that shortcomings in the maintenance, survey and inspection of *Audacious* and *Chloe T* allowed deterioration in their seawater systems to go undetected.

There was evidence from both vessels to support this conclusion. Missing intermediate inspections and delays in the renewal survey process were noted in both cases; it is unlikely that either vessel received the level of oversight that was intended in the MCA's instructions to its surveyors. Neither vessel had the required maintenance plans, nor evidence of a systematic pipework inspection or replacement programme being agreed with MCA surveyors. The files to hold this sort of information (CM file series for machinery) had never been created.

It is impossible to know how much the shortcomings in the survey process contributed to the failure of the pipework. MSIS 23 emphasises that it is the owner's responsibility to demonstrate that pipework is in a satisfactory condition, and MSIS 27 states that owners should agree a 5-year cycle with MCA surveyors for surveying machinery systems. There was no evidence of this taking place in either the *Audacious* or *Chloe T* cases.

It is also extremely unlikely that the survey requirements could ever be rigorously and effectively applied. Both hammer and pressure testing carried some risk, and neither were likely to be wholly conclusive test methods. It is simply not credible that all the pipes could be adequately tested in this way, particularly in a vessel of the age and style of *Chloe T*.

Finally, the records of maintenance and surveys were incomplete. This made it impossible for anyone to know which pipes had been checked, when or by what method. Records did not show where important equipment was located or if exemptions from the rules should continue to apply.

Given all these factors, it is hardly surprising that the seawater pipework in *Audacious* and *Chloe T* could fail so suddenly. Unless every part of the pipework system is systematically checked and its condition recorded, there will always be a risk of it failing due to undetected corrosion.

6.3 DETECTION

6.3.1 Early warning

In both cases, the crew were alerted to flooding in the engine room by some other means than their bilge alarm; the unexpected behaviour of the CPP system in *Audacious* and the fire alarm in *Chloe T*. The result was the same in both accidents – by the time the crew were aware of the problem, it was too late to take action. Bilge alarms should have given the crew ample warning of flooding; these failed either because the signal was not heard, or because the alarm did not work when it was needed most.

6.3.2 Working practices

The watchkeeper on *Audacious* should have been in the wheelhouse at the time of the accident and ought to have been able to respond to the alarm immediately. The MAIB has investigated many cases where watchkeepers have not been present, and this is a consistent factor in fishing and smaller merchant vessel accidents. However, a bilge alarm might also activate when a vessel is alongside, perhaps while crew are sleeping on board. These possibilities strongly support a requirement for emergency alarms to be audible throughout a vessel, and of being capable of rousing a sleeping crewman in sufficient time for him to be able to find, and react to, the problem before it has developed into a major emergency[13].

One of the bilge alarm sensors in *Chloe T*'s engine room had been faulty, but was thought to have been working properly before the accident. However, it was not tested regularly enough for there to be much confidence that it continued to work reliably. Most alarm systems are likely to fail at some point and the only way to gain confidence and familiarity is to test the alarm regularly. This should mean before sailing, and daily when at sea.

[13] The MCA has previously accepted a recommendation from the MAIB to '*Introduce a mandatory requirement, for all vessels greater than 24m length and less than 500 gross tons, for the fitting of bilge alarms in engine rooms and other substantial compartments that could threaten the vessel's buoyancy and stability if flooded. These, and any other emergency alarms should sound in all accommodation spaces when the central control station is unmanned. In addition to functioning in the vessel's normal operational modes, alarms should be capable of operating when main power supplies are shut down, and be able to wake sleeping crew in sufficient time for them to react appropriately.*' following the flooding and foundering of the grab hopper dredger *Abigail H* in the Port of Heysham on 2 November 2008. Report No 15/2009.

The crew on board both *Audacious* and *Chloe T* had regular routines for checking on their engine rooms and running machinery. While this is good practice and may help in detecting leaks at an early stage, there is no guarantee that the machinery space will be manned exactly when a problem occurs. An efficient alarm is essential.

6.4 EMERGENCY REACTION

6.4.1 Immediate response to flooding

The crews of both vessels knew to try and shut their main engine seawater cooling inlet valves. Neither was able to do so because the layout of the engine rooms meant that the valve handles were quickly submerged.

There is ample guidance, published over many years, which advises that valve handles should be extended or otherwise capable of being remotely closed in a flooding emergency. However, this was not done either voluntarily, or through enforcement of a statutory requirement. It is quite likely that this single issue allowed the flooding to cause the loss of both vessels – seawater inlet valves must be accessible so that they can be closed if an engine room begins to flood.

6.4.2 Pumping

The fixed pumps were not able to cope with the rate of flooding. A powerful, independently-powered salvage pump might well have given the crew more time to react, or even contained the flood. However, other investigations conducted by the MAIB[14] have illustrated the fatal, unintended consequences of using such pumps. Salvage pumps on board fishing vessels are often petrol engine powered and, if used in a confined space, their exhaust can cause carbon monoxide poisoning. It is easy to imagine, if similar pumps had been used in *Audacious* or *Chloe T*, that they would have been set up in the engine rooms (or the accommodation above) and their exhaust fumes could well have caused further tragedy.

6.4.3 Stability

Audacious's and *Chloe T*'s margins of stability were quickly reduced by the flooding. In both cases, this was due to the effect of the increased free surface moment as water flooded across the breadth of the engine room. The margin of stability was further eroded as the nets were hauled in. Fortunately this was quickly appreciated by the skipper, and the nets were run off to prevent further problems.

The reductions in stability occurred very soon after the flooding was discovered and put further pressure on the crews. It is unlikely that any of those on board knew whether their vessels could remain upright or stay afloat if the engine rooms flooded, despite the requirement for stability books to be carried. *Chloe T* remained afloat for several hours after the crew had abandoned it, and it is possible that *Audacious* could also have stayed afloat for longer if watertight doors on the vessel had been shut.

Skippers need to understand the effect of major flooding on their vessels in order to help them make the best decisions regarding abandoning in an emergency.

[14] e.g. MAIB Report on the investigation of the fatal accident to a crewman on board the fishing vessel *Starlight Rays* 126nm NNE of Aberdeen on 25 August 2011. Report No 15/2012.

6.4.4 Abandonment

Chloe T's crew had completed their mandatory training (including sea survival), practised regular emergency drills and abandoned their vessel in a calm and efficient manner. They minimised the risk to themselves and, by making good use of their radio and EPIRB, made it as easy as they could for the emergency services and other seafarers to help them.

The crew of *Audacious* were less well prepared. Although the EPIRB was taken to the liferaft, the crew put themselves at unnecessary risk by returning to their cabins to collect personal effects and by gathering valuable trawl sensors. Lifejackets and immersion suits were ignored and one of the liferafts was lost because it was not secured properly. It was fortunate that none of these issues affected the safe rescue of the crew. The problems that were encountered underline the importance of all crew completing the appropriate training and practising regular drills to help them react properly in an emergency.

SECTION 7 – SAFETY ISSUES

7.1 CAUSE OF FLOODING

1. Although it was not possible to determine the precise causes of the flooding in *Audacious* and *Chloe T*, it was concluded that the most likely reason in both cases was a failure of the main engine seawater cooling pipework. [2.4.1 ***Audacious***, 4.2 ***Chloe T***]

2. It is impractical to predict the rate of corrosion damage in seawater pipework – regular inspections are essential. [6.2.1]

3. It must be concluded that shortcomings in the maintenance, survey and inspection of *Audacious* and *Chloe T* allowed deterioration in their seawater systems to go undetected. [6.2.2]

7.2 ASSESSING THE CONDTION OF SEAWATER PIPEWORK

1. Neither *Audacious* nor *Chloe T* had any evidence of the required maintenance plans or a systematic programme of pipework inspection and replacement. [6.2.2]

7.3 DETECTING FLOODING

1. In both cases, the crew were alerted to flooding in the engine room by means other than their bilge alarm. Bilge alarms should have given the crew ample warning of flooding; these failed either because the signal was not heard, or because the alarm did not work when it was needed most. [6.3.1]

2. Bilge alarms should be tested before sailing and, ideally, daily when at sea so that confidence can be assured that the alarm will work in an emergency. There is a strong case to support alarms being audible throughout the vessel and being capable of rousing a sleeping crewman in sufficient time for him to be able to react appropriately. [6.3.2]

7.4 RESPONDING TO FLOODING EMERGENCIES

1. Watertight doors are provided to improve a vessel's survivability if flooding occurs. The watertight doors on board *Audacious* did little to help the situation because they were not routinely shut. [2.4.4 ***Audacious***]

2. The general service pump was not reconfigured to help pump out water from *Chloe T*'s engine room because no-one on board knew how to do this. It is possible that the flood might have been contained by using both the bilge and general service pumps together. [4.4.1 ***Chloe T***]

3. The crews of both *Audacious* and *Chloe T* knew to try and shut their seawater inlet valves to reduce the rate of flooding. Neither was able to do so because the layout of the engine rooms meant that the valve handles were quickly submerged. Seawater inlet valves must be accessible so that they can be closed if an engine room begins to flood. [6.4.1]

4. The vessels' fixed pumps were not able to cope with the rate of flooding. An independently powered salvage pump might have assisted. However, these must be used with extreme care if they are powered by a petrol or diesel engine to avoid the exhaust fumes causing carbon monoxide poisoning. [6.4.2]

5. Fishing vessel skippers need to understand the effects of major flooding on board their vessels in order to help them make the best decisions regarding abandoning in an emergency. [6.4.3]

6. The majority of *Audacious*'s crew had not completed safety awareness training. They were fortunate that they were able to board the liferaft and be rescued without entering the water; in different circumstances, their chances of survival, without lifejackets and survival suits, could have been severely reduced. [2.5]

7. The differences in the way *Audacious* and *Chloe T* were abandoned underline the importance of all crew completing the appropriate training and practising regular drills to help them react properly in an emergency. [6.4.4]

7.5 EFFECTIVENESS OF STATUTORY SURVEYS AND INSPECTIONS

1. The 15-24m Code makes it clear that it is the owner's responsibility to present his vessel for surveys and intermediate inspections. The owner and skipper also have more practical responsibilities to ensure that the vessel is seaworthy and can be operated safely. [2.6, 4.5.1]

2. Missing intermediate inspections and delays in the renewal survey process were noted in both cases; it is unlikely that either vessel received the level of oversight that was intended in the MCA's instructions to its surveyors. [6.2.2]

3. It is extremely unlikely that the scope of the statutory survey requirements could ever be rigorously and effectively applied. [6.2.2]

4. The survey and inspection records were incomplete and made it impossible for anyone to routinely know which pipes had been checked, when or by what method. [6.2.2]

5. Records were incomplete and did not show where important equipment was located or if exemptions from the rules should continue to apply. [6.2.2]

6. Unless every part of the pipework system is systematically checked and its condition recorded, there will always be a risk of it failing due to undetected corrosion. [6.2.2]

SECTION 8 – ACTION TAKEN

8.1 ACTIONS TAKEN BY OTHER ORGANISATIONS

The **MCA** has:

- Issued 'Surveyor Advice Note' (SAN) 29 titled "Surveying Marine Engine Cooling and Salt Water Piping Systems in Ships" dated 22 March 2013 updating the advice available to surveyors on surveying pipework in fishing vessels.

Langdon and Philip has:

- Required crew on its other vessels to ensure that they test all bilge alarms before departure, and each day when at sea.

- Confirmed that its other vessels have much simpler seawater systems than those on *Chloe T* and that the inlet valves are more accessible in the event of seawater system failure.

SECTION 9 – RECOMMENDATIONS

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

2013/249 Review the conduct of its surveys and inspections of fishing vessels in order to ensure that:

- The scope is credible and that it can be achieved in practice.
- The whole scope is routinely applied.
- Records are accurate and complete.

2013/250 Implement a robust system to manage the scheduling of surveys and inspections on fishing vessels. Such a system should be capable of readily identifying vessels that are overdue for any surveys or inspections.

The **Deveron Fishing Company** (owner of *Audacious*) is recommended to:

2013/251 Improve the safety of any other fishing vessels it operates by ensuring that:

- Intermediate inspections are conducted.
- Crew have completed mandatory training.
- A continuous watch is maintained in the wheelhouse.

The **Scottish Fishermen's Federation**, the **National Federation of Fishermen's Organisations** and the **Northern Ireland Fish Producers Organisation** Limited are recommended to:

2013/252 Promulgate the lessons learned from these accidents to their members. Particular emphasis should be given to the need for fishing vessel operators to thoroughly inspect seawater pipework to identify corrosion/erosion at an early stage.

Marine Accident Investigation Branch
December 2013

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

Marine Accident Report

INVESTORS IN PEOPLE