Report on the investigation

of the flooding

of the UK charter fishing vessel

RANDOM HARVEST

south-west of Brighton

on 3 July 1999

Marine Accident Investigation Branch
First Floor Carlton House
Carlton Place
Southampton
SO15 2DZ

Report No 28/2000

Extract from

The Merchant Shipping

(Accident Reporting and Investigation)

Regulations 1999

The fundamental purpose of investigating an accident under these Regulations is to determine its circumstances and the causes with the aim of improving the safety of life at sea and the avoidance of accidents in the future. It is not the purpose to apportion liability, nor, except so far as is necessary to achieve the fundamental purpose, to apportion blame.

CONTENTS

ABBREVIATIONS AND ACRONYMS

BS	British Standard
Cu	Copper
CW	The ISO prefix identifying a copper alloy suitable for wrought and unwrought forging stock
DZR	Dezincification Resistant
ISO	International Organization for Standardization
MAIB	Marine Accident Investigation Branch
MCA	Maritime and Coastguard Agency
Pb	Lead
RNLI	Royal National Lifeboat Institution
Sn	Tin
Zn	Zinc

GLOSSARY OF TERMINOLOGY

Area category 2	Voyages up to 60 miles from a safe haven.
Dezincification	Dezincification was first identified as the cause of failure of condenser tubes on naval vessels in the 1920s. It is a form of corrosion in salt water (or fresh water containing other impurities), confined to brass, where the zinc is leached from the metal. The copper shell which remains is porous and fragile.
De-alloying	A form of corrosion where one of the constituent metals in the alloy is preferentially leached away.
Brass	Brass is an alloy of copper and zinc. It is usually manufactured in the proportions 60% copper, 40% zinc or 70% copper, 30% zinc.
60/40 leaded brass	This is an alloy of 60% copper and 38% zinc with the addition of about 2% lead to improve its machinability.
Tonval ATD	The trade name given to the 60/40 leaded brass used in the manufacture of through-hull fittings. The closest ISO material designation is CW619N and the material symbol designation is CuZn40Pb2Sn.
CW619N	A brass suitable for wrought and unwrought forging with the composition: copper 57-59%; aluminium 0-0.1%; Iron 0-0.4%; Nickel 0-0.3%; lead 1.6-2.5%; tin 0.2-0.5%; remainder zinc (approx. 38-40%).
Muntz metal	A brass with the composition 60% copper 40% zinc.
Naval brass	A 60/40 brass with the addition of 1% tin to improve its resistance to corrosion in seawater. It is not immune to dezincification.
DZR brass	In 1980 a BS specification was issued for a new type of brass, designated CZ132, which was resistant to dezincification; commonly known as dezincification resistant (DZR) brass it has been accepted by classification societies for through-hull underwater fittings.
Electrolytic corrosion	Corrosion caused by a stray electric current from an external source, such as the vessel's battery. Because greater currents are possible it can be much more destructive than galvanic corrosion.
Galvanic corrosion	Corrosion between two dissimilar metals immersed in an electrolyte which are electrically connected outside the electrolyte. The more noble metal is protected and the other is corroded. Metals can be arranged in a galvanic series according to their electrical potential relative to a reference cell. The greater a metal's positive potential, the more noble it is.

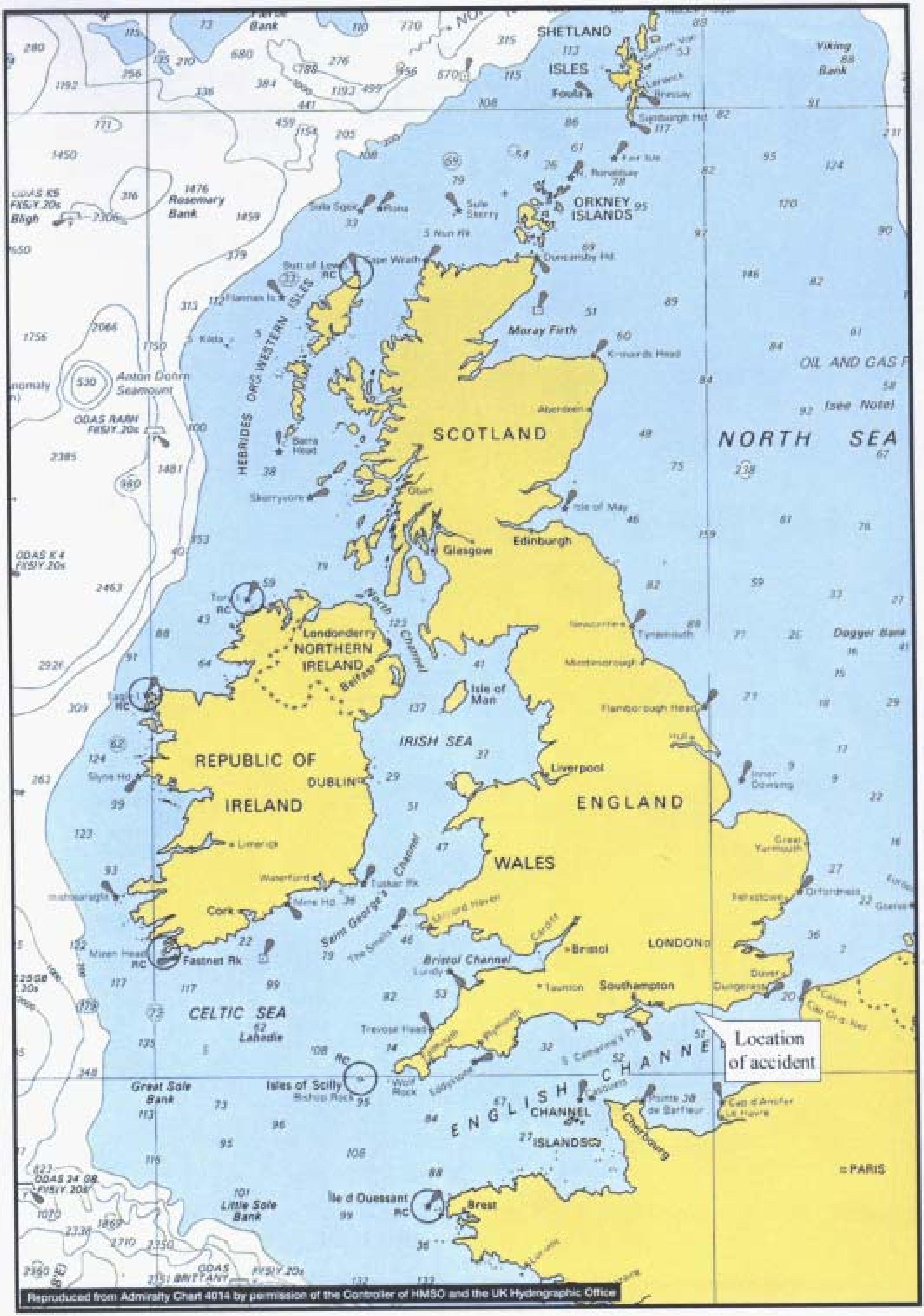
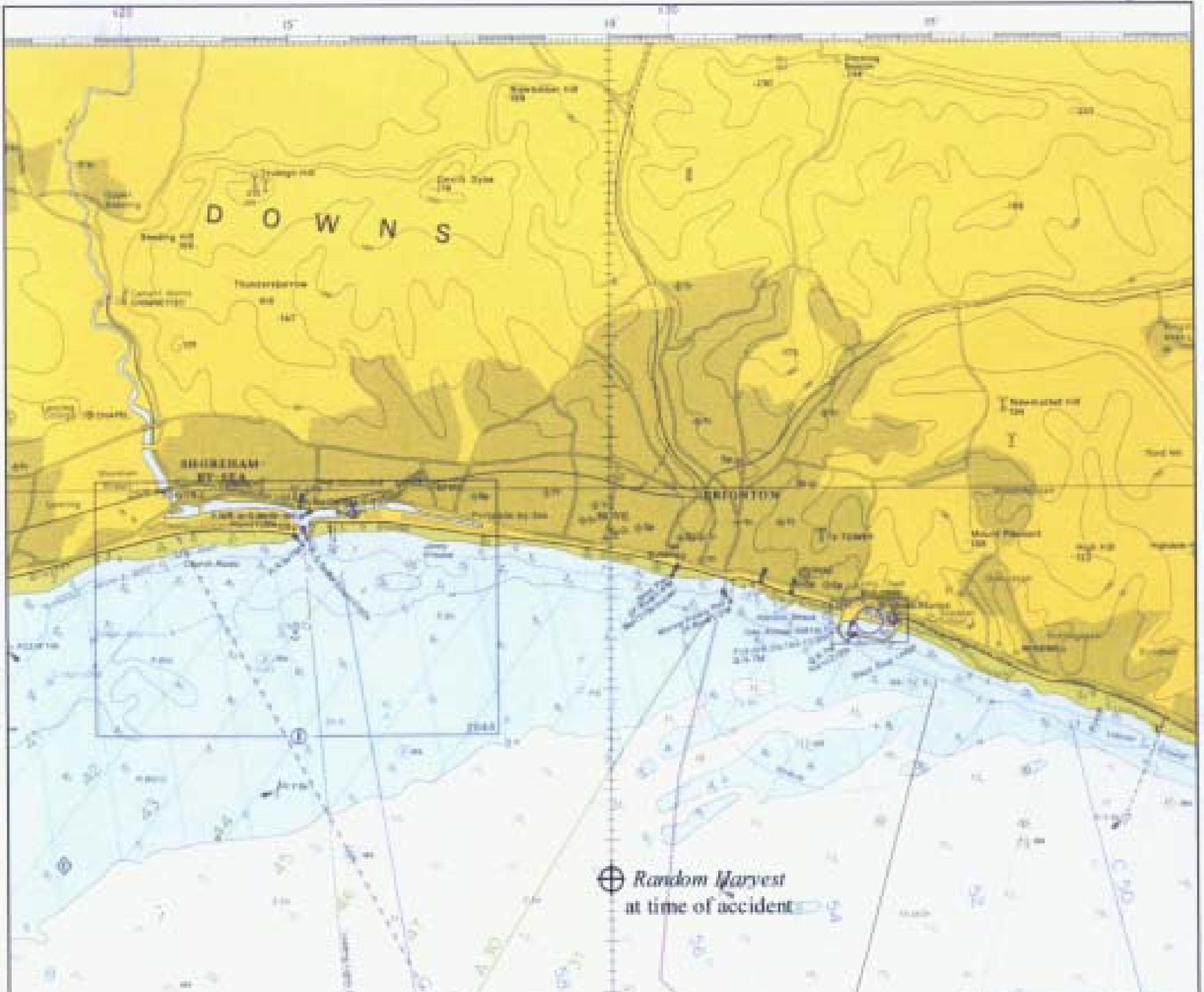

SHETLAND
ISLES
ORKNEY ISLANDS
Moray Firth
SCOTLAND
NORTH SEA
OIL AND GAS
Aberdeen
Edinburgh
Glasgow
HEBRIDES OR WESTERN ISLES
Isle of Man
IRISH SEA
Londonderry
NORTHERN IRELAND
Belfast
North Channel
REPUBLIC OF IRELAND
DUBLIN
Limerick
Waterford
Cork
Fastnet Rk
Saint George's Channel
Liverpool
ENGLAND
WALES
Bristol
Bristol Channel
LONDON
Southampton
Taunton
CELTIC SEA
Great Sole Bank
Little Sole Bank
Isles of Scilly
ENGLISH CHANNEL
CHANNEL ISLANDS
Cherbourg
Brest
PARIS
Dogger Bank
Rosemary Bank
Anton Dohrn Seamount
Location of accident
Reproduced from Admiralty Chart 4014 by permission of the Controller of HMSO and the UK Hydrographic Office

Figure 1



Reproduced from Admiralty Chart 1652 courtesy of the Controller of HMSO and the UK Hydrographic Office

SYNOPSIS

The accident was reported to the Marine Accident Investigation Branch in the late afternoon of Saturday 3 July 1999. The following Tuesday an MAIB inspector visited the vessel and began his investigation.

Random Harvest was returning from an angling trip in the English Channel on 3 July with eight people on board, including a party of six anglers. Four miles south-west of Brighton Marina she began flooding and the leak could not be stopped. Sea conditions were rough. *Random Harvest*'s emergency bilge pumping arrangements managed to contain the flooding, and she returned to Brighton where the water was pumped out.

The cause of the leak was found to be a failure of the brass 25mm diameter through-hull fitting to the toilet seawater inlet, which had broken close to its flange at the start of the screw thread. The fitting had failed from dezincification which had probably been accelerated by stray electric currents.

Seven recommendations have been made. One is to the owner concerning improvements to his vessel to reduce the likelihood of a similar failure occurring again. Two are to the MCA, on the European standard for through-hull fittings and seacocks and on the guidance to surveyors. Three are to UK suppliers of similar fittings concerning the descriptions of their products and one is to the British Marine Industries Federation to advise its members of the findings of this investigation.

Figure 2

Random Harvest alongside in Brighton Marina

VESSEL AND INCIDENT PARTICULARS

Vessel

Name	:	*Random Harvest*
Port of Registry	:	Brighton
Type	:	Charter fishing vessel, Lochin 33
Small Commercial Vessel Certificate	:	COP/LDR/98/023, Area category 2, expires 2 April 2003
Crew	:	2
Passengers	:	6
Overall length	:	9.86m
Construction	:	GRP
Built	:	In 1979 by Lochin Marine, Rye
Registered owners	:	Mr K Meredith, 40 Longhill Road, Ovingdean, Sussex
Position of accident	:	50° 46'N 000° 10'W
Date	:	3 July 1999
Casualties	:	None.

SECTION 1 - FACTUAL INFORMATION

All times are UTC+1.

1.1 Narrative

Random Harvest was returning from an angling trip in the English Channel. She had a charter party of six anglers onboard. When she was about 4 miles south-west of Brighton Marina, the bilge alarm sounded briefly then went silent. The skipper raised the hatch in the wheelhouse deck to investigate. He saw the bilges flooding rapidly, but could not see the source of the leak.

He started the electric bilge pump, and diverted the engine cooling water intake to direct bilge suction. The deckhand operated the manual bilge pump.

The skipper tried to call other fishing vessels in the vicinity on the VHF radio, but this was not working because the flooding had covered the battery to which it was connected. He managed to call the fishing vessel *Morning Breeze* using his mobile telephone, and informed them of the problem. This was relayed to the Maritime Rescue Sub-Centre (MRSC) Solent at 1217.

Random Harvest's emergency bilge pumping proved effective, and the flooding was contained. She kept her engine running and maintained her course towards Brighton Marina escorted by *Morning Breeze*. All on board donned lifejackets.

MRSC Solent tasked the Brighton Royal National Lifeboat Institution (RNLI) lifeboat *Vera Skilton*, and the coastguard rescue helicopter *India Juliet* at Lee-on-Solent to attend the casualty. The lifeboat was quickly on scene and escorted *Random Harvest* to the safety of Brighton Marina. The helicopter was stood down.

Once alongside in the marina the vessel was pumped dry. The cause of the leak was found to be a failure of the 25mm diameter through-hull fitting to the toilet seawater inlet **(Figure 3)**, which had broken close to its flange at the start of the screw thread. The owner replaced both this, and the nearby toilet seawater outlet fitting as a precaution.

1.2 Weather conditions

Winds were strong, south-westerly force 6 and sea conditions were rough with a 3m swell running.

Figure 3

Random Harvest's failed through-hull fitting

1.3 The vessel

Random Harvest has a certificate of compliance with the *Code of Practice for the Safety of Small Commercial Motor Vessels* for the carriage of up to 12 passengers, on trips up to 60 miles from a safe haven.

She was last surveyed on 2 April 1998 by Bureau Veritas. The toilet seawater inlet and outlet were renewed for this survey and were located on the port side underneath the wheelhouse deck.

The underwater metal fittings on the vessel were cathodically protected. Both toilet fittings were connected to the protective circuit.

Two banks of batteries supplied electrical power. Both banks were located under the wheelhouse deck, one sitting in the bottom of the bilge, the other on a bracket about 300mm above the bottom of the bilge. The owner usually isolated the batteries when the vessel was left at her marina berth. The isolation switch was connected to the negative pole of the battery.

Most of the electrical equipment did not have an insulated return to the negative pole of the battery, but used the engine frame as a common earth. Electronic equipment was grounded to an earth plate near the toilet fittings.

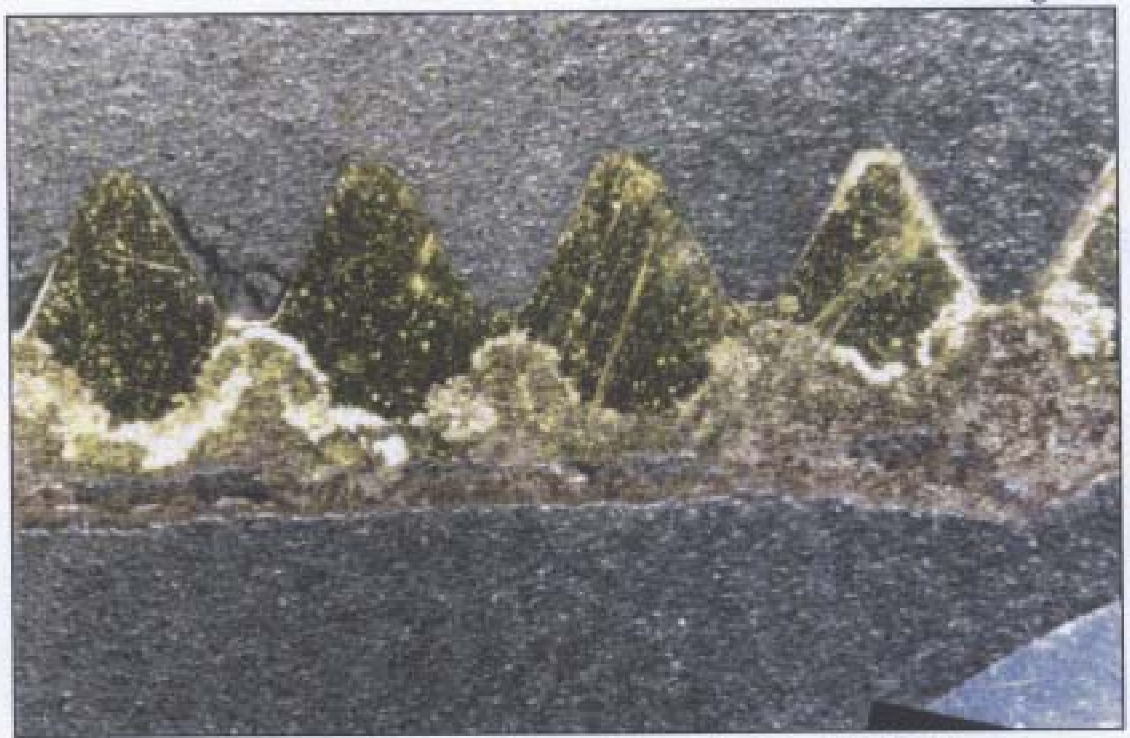
Random Harvest has no watertight bulkheads, and is fitted with a manual bilge pump and an electrical bilge pump. The cooling water inlet piping to the main engine has been arranged to draw water from the bilge instead of the sea in an emergency, substantially increasing the bilge pumping capacity when it is most needed.

It was the owner's usual practice to lift the vessel out of the water once a year for maintenance and the inspection of fittings. However, because the vessel was late being put back into the water in 1998, due to the replacement of the engine, he decided to delay lifting her out until the winter of 1999.

1.4 Metallurgical examination

The MAIB sent both of the original fittings to Southampton University's Engineering Materials Consultancy Service for examination. They were asked to determine the likely cause of the failure and the chemical composition of the skin fittings' material. It was found that the failure had been caused by dezincification which had advanced through the thickness of the metal into the root of the screw thread **(Figure 4)**. The second fitting also showed dezincification. Both had been manufactured from the same material, a 60/40 leaded brass.

Figure 4



A section taken lengthwise through the wall of the failed fitting
(magnification x 14.7)

Initially the owner was unsure from which chandler he had bought the fittings, so the MAIB purchased similar components from the three chandlers in the locality to try and identify the source. The three components were: Aquafax part number 2-70030 made from Tonval ATD; E C Smith & Sons (ECS) part number 49013/PK made from bronze approved material; and Sowester part number 37912 made from gunmetal. These were analysed for their chemical composition. All were found to be made from a 60/40 leaded brass, meeting the composition of alloy CW619N (referring to the ISO material designation). When ECS and Sowester were advised of this problem, both companies immediately acted to correct future catalogue and packaging descriptions.

Later in the investigation the owner remembered where he had purchased the fittings; it was one of the chandlers "sampled" by the MAIB.

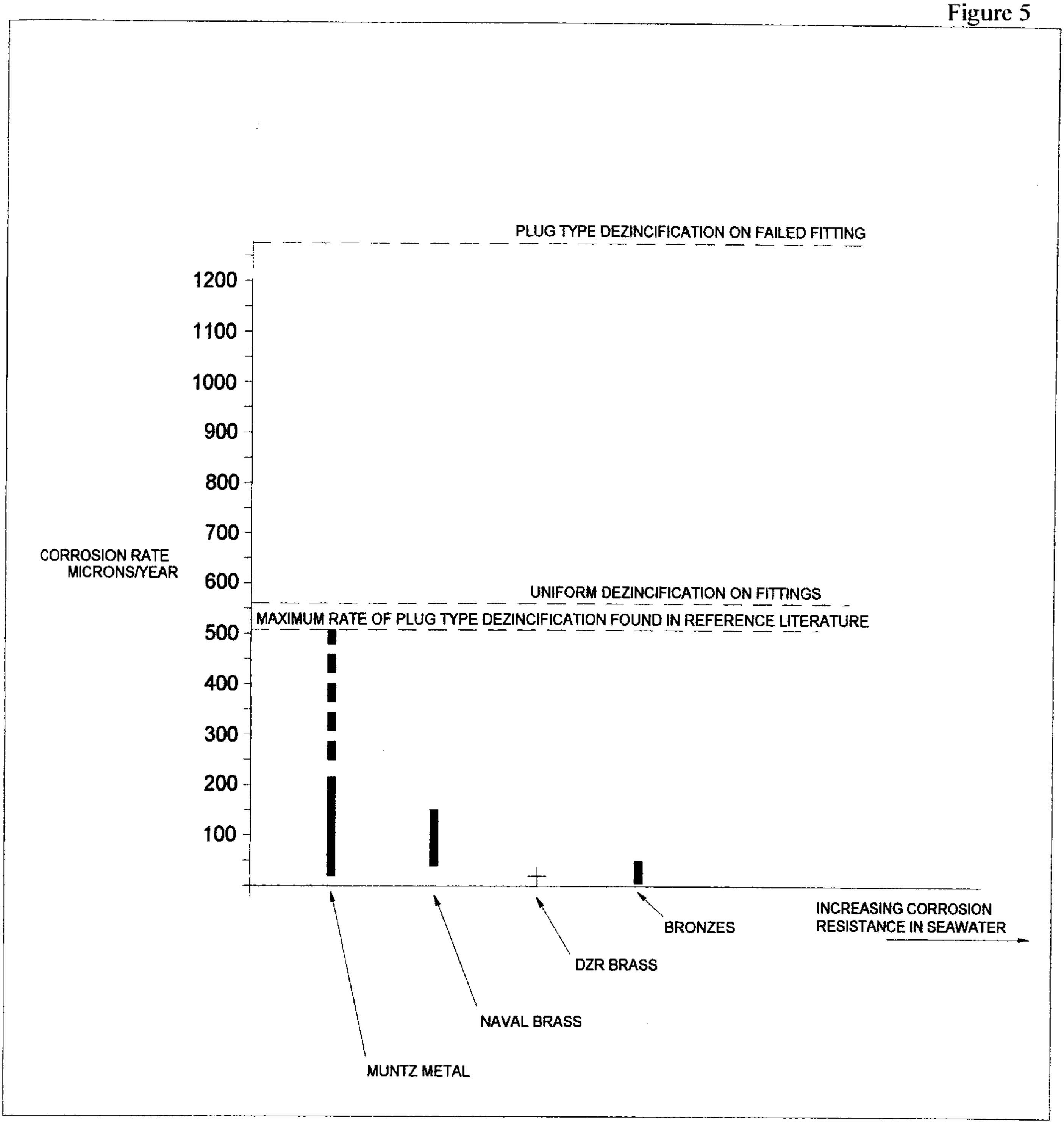
1.5 Corrosion rates

Both of *Random Harvest*'s toilet fittings were installed when they were new. One of them failed 16 months later. The failure was in the root of the thread where the material was about 1.7mm thick, indicating a rate of corrosion of 1.275mm per year. The dezincification was non-uniform, known as 'plug' type corrosion, and peaked under the roots of the thread where the stresses, from tightening the fitting, were greatest **(Figure 4)**.

The second fitting showed uniform dezincification about 0.75mm deep, indicating a rate of corrosion of 0.56mm per year.

Data from the Copper Development Association and other sources **(Figure 5)** provides a rough guide to the rates of corrosion in seawater that can be expected of the copper alloys. It shows that some brasses can corrode at over 0.2mm/yr. There is also a report of plug type dezincification reaching 0.5mm/yr.

Figure 5



Expected corrosion rates of various copper alloys in seawater

SECTION 2 - ANALYSIS

2.1 Damage control

The bilge alarm alerted the crew to the flooding. This early warning was undoubtedly a major factor in the survival of the vessel, and the safety of her passengers and crew. Too often, where bilge alarms have not been fitted, the first indication of flooding on small vessels is the main engine stopping; causing a total power loss to the bilge pumps and the sinking of the vessel.

As *Random Harvest* lacked watertight bulkheads to restrict the spread of flooding, she was wholly dependent on her bilge pumps for survival. The flooding through the small bore of the broken seawater inlet was well within the capacity of the vessel's pumps, and the bilge alarm gave sufficient warning to allow these pumps to be brought into action.

Access to the failed through-hull fitting was inadequate. It was under the wheelhouse deck, and well off to the port side, not directly under the hatch. The source of the leak was not therefore found, and the soft wooden bungs carried on the vessel for just such an emergency could not be used. The owner should move the fittings to a more accessible location.

2.2 Location of batteries

Both the bilge alarm, and the VHF radio, were connected to the bank of batteries sitting in the bilge. Once submerged, these batteries lost power even before the crew could lift the hatch in the wheelhouse deck to investigate. The brief sounding of the bilge alarm confirmed this.

The owner should move the batteries to a more protected location to preserve power supply to the VHF radio for as long as possible during an emergency.

The *Code of Practice for the Safety of Small Commercial Motor Vessels* does not specifically require that batteries be positioned to protect them against flooding. However, surveyors should be aware of this hazard, and see that owners take reasonable precautions to safeguard the electric supply to the VHF radio.

2.3 Factors influencing the rate of corrosion

The rate of corrosion on the failed fitting was about twice the maximum rate for plug type dezincification found in reference literature **(Figure 5)**. High stresses under the thread roots appear to be an important factor, causing corrosion rates in these regions to be double the underlying uniform rate.

As the uniform corrosion rate itself is double the worse that could have been expected **(Figure 5)**, there are probably other factors involved.

One possibility is galvanic corrosion due to the proximity of the fittings to the copper ground plate for the vessel's electronic equipment, to which they would probably have been connected. But, given the closeness of brass and copper in the galvanic series of metals **(Figure 6)**, and the relatively small difference in exposed area between the fittings and the ground plate, this was unlikely to be important.

The other factor is electrolytic corrosion due to stray electric currents entering the seawater via the through-hull fittings. This is considered a strong probability for the following reasons:

1) The wiring was not insulated return but with a common ground at the engine feet, increasing the possibility that electrical currents found a less resistant path to the negative pole of the battery (stray currents);

2) Some wiring was very low in the hull, increasing the possibility of stray currents in the damp conditions if there were breaks in the wires' insulation;

3) The positive poles of the batteries were not isolated when the vessel was left at its marina berth, so a constant driving force was always available to 'power' any stray currents.

The owner should have the wiring installation inspected and upgraded as necessary by a competent technician to reduce the likelihood of stray currents. He should also ensure that when the vessel is left at its berth in the marina, the positive pole of the battery is isolated.

Since corrosion of the fittings was possibly exacerbated by stray currents, the owner should remove for inspection all metallic, underwater through-hull fittings on the vessel.

The chemical composition of the alloy used for the through-hull fitting was also important. Because dezincification removes only the zinc content of the brass, it penetrates more deeply than a corrosion process which removes uniformly the same weight of material from the exposed surface. So if the fitting had been made from a superior quality metal, one not susceptible to de-alloying, the corrosion would have been uniform, penetrating about 40% of the depth of the dezincification and probably with a less serious consequence. The fitting would have been badly corroded by the stray currents, which were probably present, and would have required replacement; but the life of the fitting would have been extended.

It cannot be determined by how long the fitting's life would have been extended because this depends on the size of the stray current, which is unknown. The current may have been small and active over the full 16 months. In this case a superior quality fitting could probably have lasted beyond 40 months, increasing the likelihood that the developing weakness would have been detected and the fitting replaced before it failed. On the other hand, the stray current may have been large, and started only during the last few weeks of the fitting's life because of a new fault in the vessel's wiring. In this case even a top quality fitting would have had only a few weeks extra life. The former situation is considered the more likely, with the conditions for the stray current established by the disruption to the vessel's wiring when the main engine was replaced and the seacocks renewed.

2.4 The suitability of brass for underwater through-hull fittings

Brass is not accepted for use in underwater through-hull fittings either by classification societies or the MCA, because of its susceptibility to dezincification in seawater and the ready availability of superior alternatives.

The international standard for metallic seacocks and through-hull fittings on small craft, ISO 9093-1:1994, states: "The materials used shall be corrosion-resistant........" and defines corrosion-resistant as: "*a material used for a fitting which, within a service time of five years, does not display any defect that will impair tightness, strength or function*.". The brass through-hull fittings removed from *Random Harvest* could not meet this requirement. Taking 0.15mm/yr **(Figure 5)** as an estimate for the corrosion rate of brass in seawater, which is not an extreme rate, then five years corrosion would penetrate to 0.75mm, or 44% of the wall thickness of the fitting - a substantial reduction in the component's strength, and unacceptable under ISO 9093-1:1994. Vessels constructed to the Recreational Craft Directive would also have to comply with ISO 9093-1:1994.

There is also evidence that the rate of corrosion can be substantially greater in areas of high stress **(Figure 4)** which is undesirable in a component which has to be screwed tight against the hull to prevent leaking. As only one of the fittings showed this stress-related corrosion, it had probably been over tightened.

DZR brass would have been resistant to the form of corrosion exhibited by the fittings from *Random Harvest.* The failed fitting was not made of DZR brass.

Brass is a relatively cheap and strong material, so it could appear an attractive alternative to more durable alloys. The item which failed cost about £6. One made from dezincification brass (DZR brass), silicon bronze, or gunmetal, might cost two or three times as much, but even that cost is still only a minute fraction of the value of the vessel. Using brass for underwater through-hull fittings is a false economy.

DZR brass is more expensive because after machining it has to be heat-treated to remove the chemical micro-structure vulnerable to dezincification.

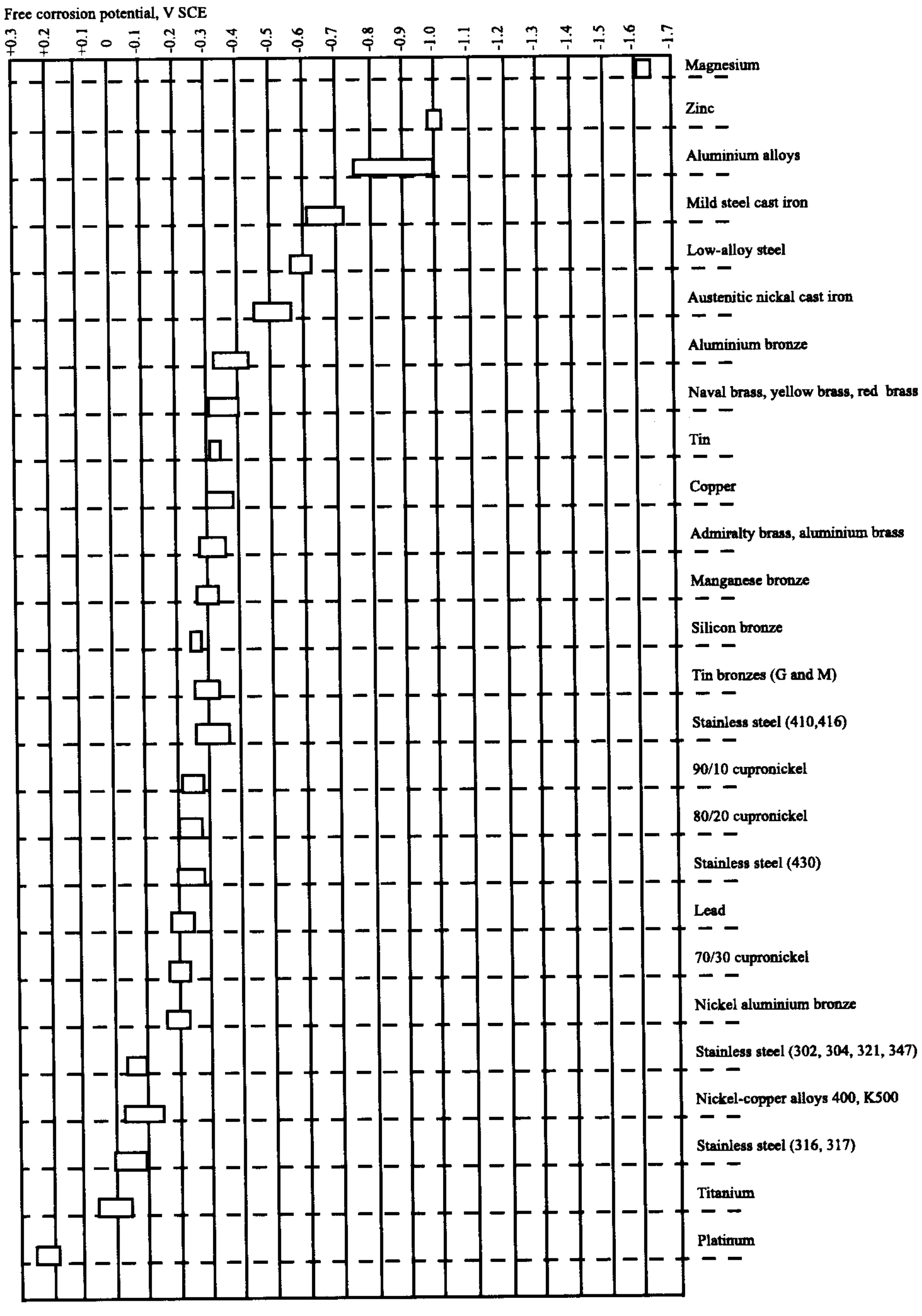
However, discussions with UK wholesalers indicate that brass has been in common use for underwater fittings both within the UK, and on continental Europe, since about 1983. Many hundreds of thousands of items have been sold, and the wholesalers are unaware of any serious dezincification failures.

MAIB has maintained a database of reported marine accidents; about 2000 per annum, since 1991. This is the first accident which has been positively attributed to the failure of a through-hull fitting by dezincification. However, the database contains many cases of small vessels flooding and sinking, where the cause of the flooding was unknown. It contains very few cases involving yachts; the type of vessel on which the fittings are predominantly used. This is because accidents to private pleasure vessels do not have to be reported to the MAIB, so our database probably doesn't accurately reflect the true situation.

The MAIB considers that brass is not a suitable material for use in through-hull fittings immersed in seawater because it can suffer rapid corrosion through dezincification which is probably exacerbated by overtightening. Although the prevalence of such failures appears very small, the consequences can be very serious. The use of brass underwater through-hull fittings creates an unacceptable and unnecessary risk which can be avoided at a very low additional cost. The British Marine Industries Federation (BMIF) should advise its members of the findings and recommendations of this report.

Figure 6

Dissimilar metal corrosion



The galvanic series for metals immersed in seawater

2.5 Cathodic protection

Expert opinion is that a hull mounted sacrificial anode is not as effective in protecting those areas of exposed metal "out of sight", such as the inside of a through-hull fitting (where the failure occurred on *Random Harvest*), as it is in protecting exposed metal "in sight" of the anode.

The general opinion of experts in the field of cathodic protection, is not to bond through-hull fittings and seacocks to the cathodic protection system. Similarly, ISO 9093-1:1994 states, "Materials that have no adequate corrosion resistance in the environment they are used in, or that will act galvanically with others used in the system, may be used if they are isolated", ie not electrically connected to other metallic fittings. The reason being, while cathodic protection systems offer minimal protection for through-hull fittings and seacocks, electrical bonding of these fittings could set up galvanic cells or even, if carried out incorrectly, lead to electrolytic corrosion. *Random Harvest*'s owner, therefore, should consider disconnecting all through-hull fittings from the vessel's cathodic protection system. (Note: ISO 9093-1:1994 only permits the use of a material with no adequate corrosion resistance if it is sheathed in or coated with a corrosion resistant material.)

To conclude, the cathodic protection system on *Random Harvest* probably would have provided minimal protection against the type of failure which occurred, and may possibly have contributed to it.

2.6 Human factors

The guidance offered on the selection of corrosion-resistant material in ISO 9093-1:1994, *Small craft - Seacocks and through-hull fittings*, is vague and of little practical help. While it specifies the desired outcome, a five-year resistance to the effects of corrosion, it does not specify a procedure for testing compliance. The MCA should make representations to the European Committee for Standardization to improve the utility of this standard.

In many cases it is impossible to differentiate between fittings made of brass, and those made of bronze without a chemical analysis - colour and surface texture can be very similar. So most buyers, probably all boat owners, have to rely entirely on the supplier's quality assurance procedures to ensure that their purchase meets their notional specification. These procedures proved inadequate for two of the fittings tested. Both ECS and Sowester had mistakenly, described the materials for their through-hull fittings as bronze, probably because they in turn had purchased the items as manufactured from "Tonval", leading to some confusion as to the true chemical composition.

The trade name Tonval, in the UK, conceals rather than conveys the nature of the material used for the through-hull fittings. To ensure that buyers of these products are fully aware of the nature of the material, such fittings should be clearly described as made of a "brass (not inhibited against dezincification)".

The integrity of through-hull fittings and seacocks should be checked annually with the vessel out of the water. Dezincification is difficult to spot, but it does betray itself by turning the affected areas of the yellow coloured brass to pink or red. This is best seen in the bore of the fitting or on its flange. At the first indication of "pinking" the fitting should be replaced. If no "pinking" is visible the component's strength should be tested with a hammer or given a firm pull. Had the vessel been lifted out of the water after 12 months, as was the usual practice, a 'hammer' test would probably have revealed the fitting's weakness.

SECTION 3 - CONCLUSIONS

3.1 Findings

1. The source of the flooding was the failure of the 25mm diameter through-hull fitting to the toilet seawater inlet. [1.1]

2. The failure was due to dezincification, which had advanced through the thickness of the metal into the root of the screw thread. [1.4]

3. Electrolytic corrosion, due to the poor standard of wiring on *Random Harvest*, probably contributed to the very high rate of corrosion of the failed fitting; and may have affected other through-hull fittings on the vessel. [2.3]

4. The brass through-hull fittings removed from *Random Harvest* did not meet the requirements of the international standard for metallic seacocks and through-hull fittings on small craft, ISO 9093-1:1994. [2.4]

5. The durability of the fitting would have been enhanced if it had been made from a superior quality metal, one not susceptible to de-alloying. [2.3]

6. The guidance offered on the selection of corrosion-resistant material in ISO 9093-1:1994, *Small craft - Seacocks and through-hull fittings*, is vague and of little practical help. [2.6]

7. It is doubtful whether the cathodic protection system on *Random Harvest* provided any protection against the type of failure which occurred and may possibly have contributed to it. [2.5]

8. Access to the failed through-hull fitting was inadequate. [2.1]

9. The bilge alarm's early warning was undoubtedly a major factor in the survival of the vessel and the safety of her passengers and crew. [2.1]

10. The poor location of the battery supplying the VHF radio meant that electrical power was lost to this item very early in the flooding. [2.2]

11. Both ECS and Sowester had mistakenly described the materials for their through-hull fittings as bronze. [2.6]

12. The use of trade names such as "Tonval" conceals rather than conveys the nature of the material used for the through-hull fittings. [2.6]

13. Had the vessel been lifted out of the water after 12 months, as was the usual practice, a 'hammer' test would probably have revealed the fitting's weakness. [2.6]

3.2 Causes

Immediate cause

Random Harvest flooded because of the failure of a through-hull fitting, installed 16 months before.

Contributory factors

1. The leak could not be stopped because the fitting was inaccessible.

2. The poor standard of wiring on the vessel probably allowed electrolytic corrosion of the fitting through stray electric currents.

3. The material used for the fitting was unsuitable because of its susceptibility to dezincification.

4. The vessel was not lifted from the water for her annual inspection.

SECTION 4 - RECOMMENDATIONS

The owner of the vessel, Mr K Meredith, is recommended to:

1. Improve the safety of *Random Harvest* by:

   - Replacing the toilet through-hull fittings with ones made from a material approved by the classification societies;
   - Inspecting all through-hull fittings on the vessel for possible electrolytic corrosion;
   - Disconnecting all through-hull fittings from the vessel's cathodic protection system;
   - Improving access to the toilet through-hull fittings;
   - Raising the battery well above the bilge to protect it from flooding;
   - Fitting a battery isolation switch connected to the positive poles of the batteries and isolate the batteries whenever the vessel is left at her marina berth;
   - Having the wiring installation on the vessel inspected and upgraded as necessary by a competent marine electrician to reduce the likelihood of stray currents.

The Maritime and Coastguard Agency is recommended to:

2. Make representations to the European Committee for Standardization to improve the utility of the standard ISO 9093-1:1994, *Small craft - Seacocks and through-hull fittings*, by including a procedure for demonstrating compliance with the requirement for corrosion resistance.

3. To produce a guidance note for approved surveyors of Small Commercial Motor Vessels advising them of the findings of this investigation, particularly with regard to the location of the batteries.

ECS and Sowester respectively are recommended to:

4. Revise their catalogue entries and packaging for through-hull fittings to remove the incorrect descriptor 'bronze' and replace with 'brass (not inhibited against dezincification)'.

5. Advise chandlers and boatbuilders, to whom they have supplied through-hull fittings incorrectly described as bronze, of the actual nature of the material.

Note: Both ECS and Sowester have notified the MAIB that they are acting upon the recommendations.

Aquafax is recommended to:

6. Ensure that 'Tonval' is clearly and unambiguously identified as 'brass (not inhibited against dezincification)' in their sales literature.

Note: Aquafax has notified the MAIB that it is acting upon the recommendation.

The British Marine Industries Federation (BMIF) is recommended to :

7. Advise its members of the findings of this investigation.

Note: BMIF has notified the MAIB that it is acting upon the recommendation.

Marine Accident Investigation Branch
August 2000