

Report on the investigation of the
keel failure and capsizing of
the Comar Comet 45 Sport yacht
Tyger of London

1 nautical mile south of Punta Rasca, Tenerife
on 7 December 2017



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

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

NOTE

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

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GLOSSARY OF ABBREVIATIONS AND ACRONYMS

ABS	- American Bureau of Shipping
CE	- Conformité Européenne
DoC	- Document of Compliance
EPIRB	- Electronic position indicating radio beacon
EU	- European Union
GRP	- Glass reinforced plastic
gt	- Gross tonnes
ISO	- International Organisation for Standardisation
kg	- kilogram
kt	- knot
LSA	- Life-saving appliances
m	- metre
MCA	- Maritime and Coastguard Agency
MGN	- Marine Guidance Note
MLC	- Maritime Labour Convention
N	- Newton
nm	- nautical mile
RCD	- Recreational Craft Directive
RINA	- RINA Services S.p.A
RYA	- Royal Yachting Association
SAR	- Search and rescue
SCV Code	- Maritime and Coastguard Agency's Small Vessels in Commercial Use for Sport or Pleasure, Workboats and Pilot Boats – Alternative Construction Standards (MGN 280(M))
SOLAS	- International Convention for the Safety of Life at Sea 1974, as amended
STCW	- International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended
t	- tonne
UTC	- Universal Co-ordinated Time
VHF	- Very high frequency

TIMES: all times used in this report are local time (UTC)

SYNOPSIS

At 0930 on 7 December 2017, the skippered charter yacht *Tyger of London* departed San Sebastian, La Gomera, bound for Marina San Miguel, Tenerife, with four paying passengers acting as crew on board.

At about 1700, 1 nautical mile south of Punta Rasca, the crew heard a loud bang. *Tyger of London* immediately heeled to starboard, capsized and inverted. The crew released their lifelines, fell from the cockpit into the water and their lifejackets automatically inflated. One crew member was briefly trapped below the yacht but managed to swim clear.

The skipper of another yacht, *St Barbara V*, which was 200m to the west, raised the alarm and rescued the crew from the water. Once landed in Tenerife, they were treated by Spanish emergency services before being released. There were no serious injuries.

The yacht was salvaged by its insurers on 13 December and taken to Tenerife, where it was declared a total loss on 12 February 2018. The MAIB investigation commenced on 19 February 2018.

The investigation found that the failure of the keel structure caused the loss of the keel and led to the yacht capsizing. Technical inspection of the keel plate, recovered with the hull, revealed that the keel had not been manufactured in accordance with the designer's drawings. Furthermore, the unusual keel design meant that the condition of the weakest part of the keel structure could not be monitored or inspected as it was hidden within the external lead casting.

The investigation also found that the crew of *Tyger of London* were well prepared for emergency situations such as capsize; they were wearing lifejackets and the yacht was equipped with a liferaft and electronic position indicating radio beacon (EPIRB). However, the EPIRB and liferaft were not rigged to float-free and the crew did not have time to release and operate them before the yacht capsized.

The MAIB has issued a safety bulletin advising owners of yachts fitted with similar keels, of the potential risks of this design, specifically: to note, due to its design, the condition and tightness of the keel bolts do not indicate the true condition of the keel; to arrange for an out of water inspection by a suitably qualified surveyor if damaged, grounded or if in any doubt as to the condition of the keel; and, that technical advice could be sought from Gesti Nautica srl, a shipyard in Fiumicino, Italy, which has experience of repairing Comar yachts.

A number of actions have been taken by the Maritime and Coastguard Agency and British Marine in response to this report, to improve guidance on keel inspection and the stowage of lifesaving appliances. A recommendation has been made to British Marine to propose changes to the International Standards Organisation, to require, rather than recommend, that manufacturers provide guidance on the inspection and maintenance of keels fitted to their craft.



Tyger of London

SECTION 1 - FACTUAL INFORMATION

1.1 PARTICULARS OF *TYGER OF LONDON* AND ACCIDENT

SHIP PARTICULARS	
Vessel's name	<i>Tyger of London</i>
Flag	United Kingdom
Certifying Authority	Royal Yachting Association
Hull ID number	IT-CMR450451707
Type	Commercial yacht
Registered owner	Privately owned
Manager	Swiss Sailing Connection
Year of build	2007
Construction	Glass reinforced plastic
Length overall	13.77m
Registered length	13.77m
Gross tonnage	18.28 tonnes
Minimum safe manning	Not applicable
Authorised cargo	Not applicable

VOYAGE PARTICULARS	
Port of departure	San Sebastian, La Gomera
Port of arrival	Marina San Miguel, Tenerife
Type of voyage	Coastal
Cargo information	Not applicable
Manning	5

MARINE CASUALTY INFORMATION	
Date and time	7 December 2017, 1700
Type of marine casualty or incident	Very Serious Marine Casualty
Location of incident	1nm south of Punta Rasca, Tenerife
Place on board	Unspecified
Injuries/fatalities	None
Damage/environmental impact	Capsize leading to total constructive loss of the vessel
Ship operation	Commercial voyage
Voyage segment	Mid-water
External & internal environment	Daylight; wind easterly 30kts; wave height 1-2m
Persons on board	5

1.2 NARRATIVE

1.2.1 Activity prior to the accident

At 1700 on 1 December 2017, *Tyger of London* commenced a 7-day charter. The four crew met the German skipper at the Marina San Miguel, Tenerife, and proceeded to the yacht. After a short safety brief and discussion about the plan for the week, the crew went ashore to buy provisions before spending the night on board.

The following morning the charter skipper gave the crew a more detailed safety brief. This covered the use of the navigation and communications equipment, and the yacht's lifesaving appliances, including lifejackets, liferaft and grab bag. On completion the yacht sailed from the marina, and as there was almost no wind, motored to San Sebastian, La Gomera.

Over the next 4 days the wind increased in strength, and the yacht's programme followed a pattern, with *Tyger of London* sailing during the day and remaining in harbour overnight. The yacht visited various ports in La Palma and La Gomera before returning to the port of San Sebastian on the evening of 6 December (**Figure 1**).

1.2.2 The accident

At approximately 0930 on 7 December, the penultimate day of the charter period, the yacht left the harbour and headed east towards Tenerife into a fresh south-easterly force 5 breeze. Aware that it would be a rough passage, the crew wore lifejackets and secured their safety lines to the yacht. Noting that the navigational track to Marina San Miguel was into wind, the skipper chose a passage plan that took the yacht almost due east to the coast of Tenerife before tacking south, in the lee of the island, towards Punta Rasca (**Figure 2**).

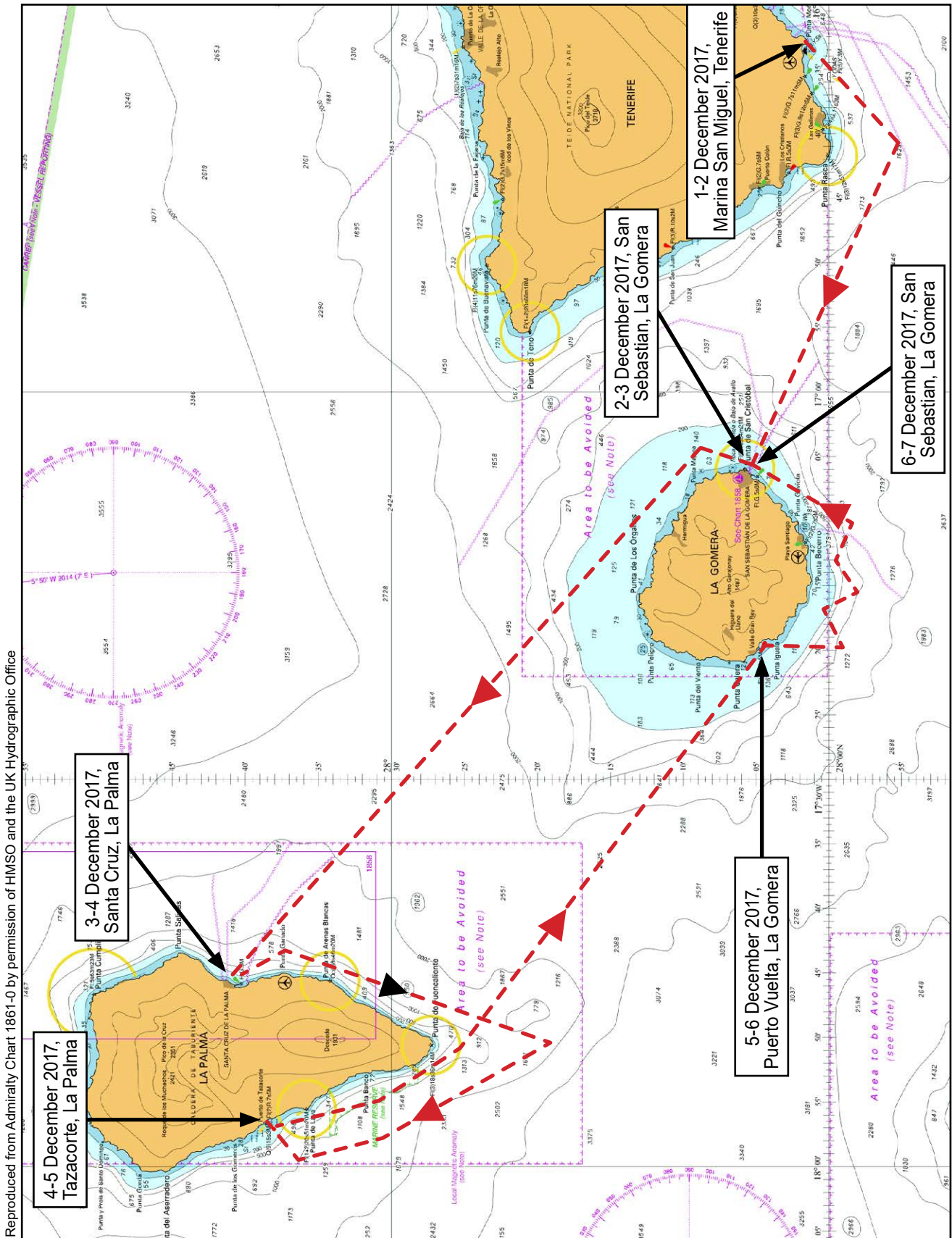
At 0945 *Tyger of London* cleared the harbour and the crew hoisted and set the sails with a single reef in the main sail. Shortly afterwards, as the wind strength increased and the yacht began to pitch in the 1-2m sea state, the skipper ordered a second reef be put into the main sail. During the passage the crew noted that water had seeped into the cabin through the forecabin hatch and cabin windows. With the yacht heeling to approximately 20° the electric bilge pump, positioned on the centreline, was unable to pump the water out, so the skipper bailed it out by hand.

At about 1600, *Tyger of London's* skipper and crew sighted another yacht, *St Barbara V*, approximately 1 mile ahead. As the wind had reduced to force 6 they decided to remove the second reef from the main sail to pass *St Barbara V*.

As *Tyger of London* cleared Punta Rasca, the wind backed to the east and increased to force 7. The skipper decided to reduce sail and gave the order to put a second reef into the main sail. Once complete, the crew returned to the cockpit and remained clipped on with their safety harnesses. The helmsman then altered course to starboard to fill the sails. *Tyger of London* was approximately 200m to the east of *St Barbara V*.

A few minutes later, at approximately 1700, the crew heard a loud bang. The skipper thought that one of the shrouds had parted; another member of the crew thought that a heavy object had fallen over in the cabin. *Tyger of London* heeled rapidly to starboard, its mast and sails hit the water and then, after a brief pause, the yacht inverted.

As the vessel heeled over, the crew fell from the cockpit. Some of the crew struggled to unclip their lifelines. However, they had all managed to release themselves and, as they entered the water, their lifejackets inflated automatically. Four of the five crew members quickly swam clear of the upturned yacht. One was trapped by the netted guardrails (Figure 3), but after 30-40 seconds managed to swim clear.



Reproduced from Admiralty Chart. 1861-0 by permission of HMSO and the UK Hydrographic Office

Figure 1: Tyger of London's navigation track 1-6 December 2017

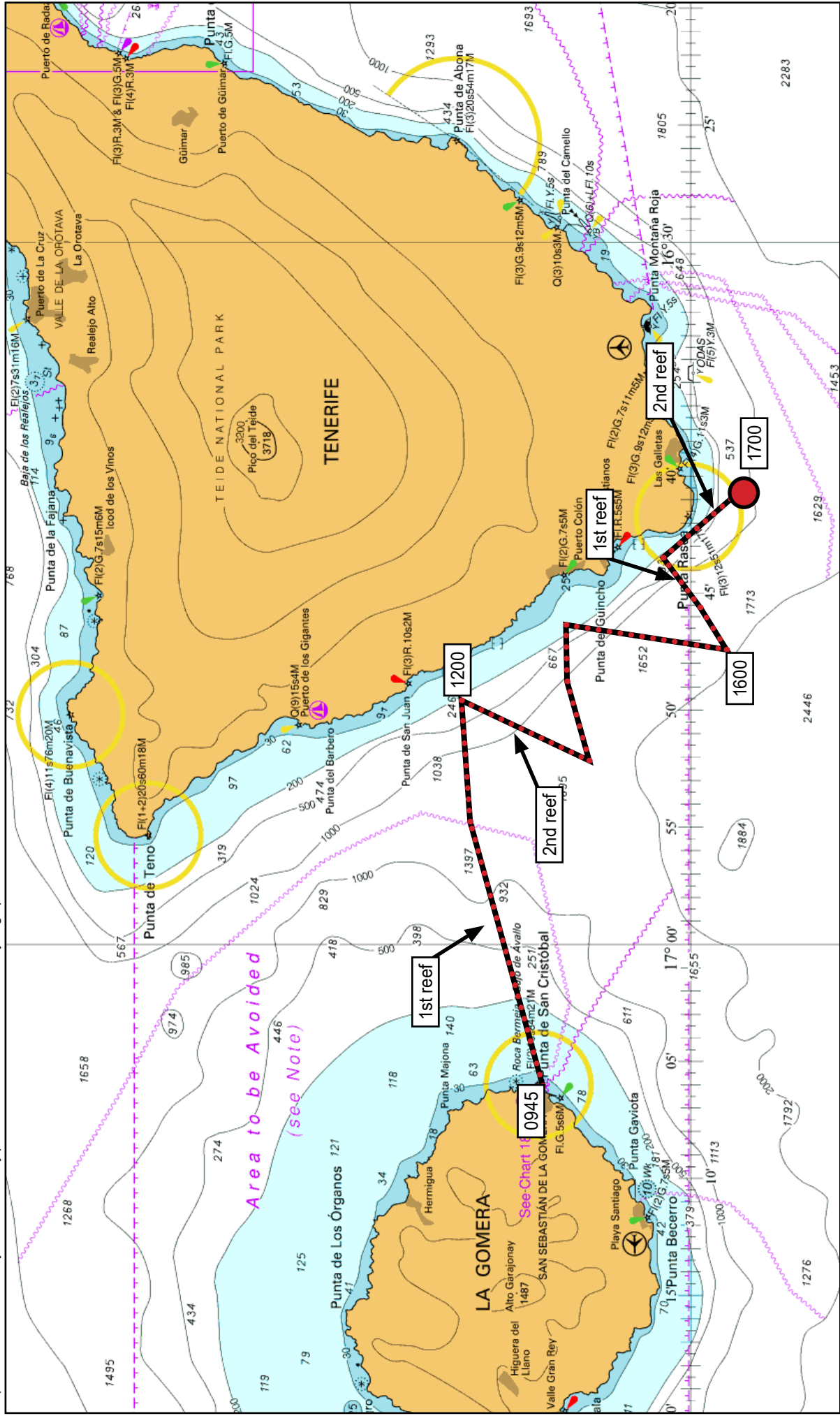


Figure 2: Tyger of London's navigation track 7 December 2017



Figure 3: *Tyger of London* berthed at Marina San Miguel, Tenerife, showing guardrail netting

1.2.3 The rescue and salvage

The skipper of *St Barbara V*, 200m to the west, saw *Tyger of London* capsize. He immediately instructed his crew to start the engine and drop the genoa while he made a “Mayday” call on VHF radio. As *St Barbara V* passed the upturned hull, he called to those in the water and established there had been five personnel on board. *St Barbara V*'s crew then quickly counted the fluorescent lifejackets and confirmed that they had all five in sight (**Figure 4**).

St Barbara V's crew then prepared to recover the personnel from the water. The skipper manoeuvred the yacht (**Figure 5**) while the crew rigged the boarding ladder on the transom to allow the casualties to climb on board. They also streamed a buoyant rubber fender on the end of a mooring



Figure 4: Lifejacket worn by *Tyger of London*'s crew

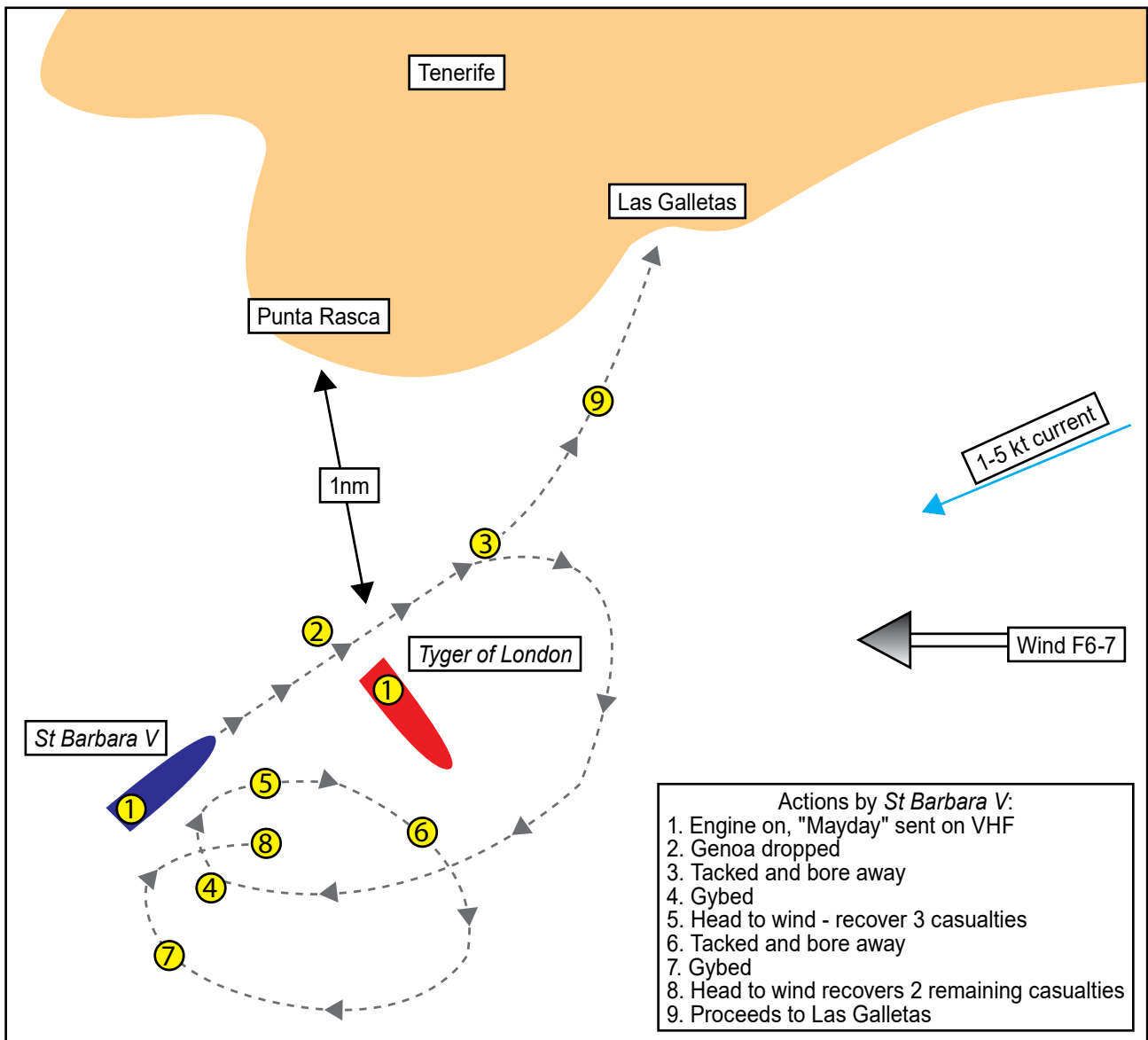


Figure 5: Rescue of *Tyger of London's* crew by *St Barbara V*

line behind the yacht to act as a hand-hold for those in the water waiting their turn to climb the ladder. First-aid was administered in the yacht's cabin, where the rescued crew were provided with dry clothing and a warm drink.

Tyger of London's crew were shaken but unhurt. All five required assistance from *St Barbara V's* crew to climb the boarding ladder. One of those rescued was found to be wearing their lifejacket under their outer clothing.

During the rescue, a Spanish search and rescue (SAR) helicopter arrived, but after being informed by *St Barbara V's* skipper that *Tyger of London's* crew had been recovered unhurt, it left the scene and returned to base.

At 1730, *Tyger of London's* EPIRB was detected by the UK coastguard. At 1740, the UK National Maritime Operations Centre called the yacht's owner, who confirmed that *Tyger of London* was at sea.

At about 1800, *St Barbara V* arrived at Las Galletas and landed *Tyger of London's* crew, where they were met by the local police and emergency services. One crew member was treated for shock but was discharged shortly afterwards. The survivors were accommodated overnight by fellow yachtsmen and women within the marina prior to flying home the following day.

Tyger of London's upturned hull was sighted on 10 December 2017 drifting approximately 10nm north of the capsized position. The mast, sails and sail drive were cut away by divers and the hull was salvaged by the insurer on 13 December and taken to Tenerife.

The Royal Yachting Association (RYA), the Certifying Authority for *Tyger of London*, became aware of the accident via a third party and suspended its small commercial vessel (SCV) certification on 13 December 2017.

The MAIB became aware of the accident on 27 December 2017. On 19 February 2018, a safety investigation was commenced once the yacht had been declared a constructive total loss.

1.3 ENVIRONMENTAL CONDITIONS

At the time of the accident the wind was easterly force 6 to 7. It was daylight, with good visibility and approximately 4/8th cloud cover. There was a 1-2m swell and the current was setting to the south-west at 1.5kts. The air and sea temperature were 20°C.

1.4 TYGER OF LONDON

1.4.1 Background

The Comar Comet 45 Sport yacht *Tyger of London* was built by Comar Yachts srl, Fiumicino, Italy in November 2007. From delivery until 2013, the vessel was based in Majorca and sailed locally by its owner and his friends at weekends, occasionally completing longer voyages in the Mediterranean during the summer.

In 2013, *Tyger of London's* British owner employed a German manager to operate, maintain and market the yacht as a skippered, commercially coded vessel. The manager held an RYA Yachtmaster offshore certificate of competency, a commercial endorsement and an RYA cruising instructor's qualification.

The manager set up the website 'Swiss Sailing Connection'¹ to market skippered voyages to Swiss and German customers who needed to gain sea experience in order to obtain yachting qualifications.

In the summer of 2013, the manager moved on board the yacht with his partner and took control of the boat. They sailed *Tyger of London* from Palma to Barcelona, Spain, to complete the SCV Code certification process. The first charter took place in October 2013, with the manager acting as skipper.

¹ <https://sites.google.com/a/swissailingconnection.com/swiss-sailing-connection/>

1.4.2 Operating pattern

For the next 2 years, *Tyger of London* was operated as a skippered charter vessel spending the summer (April-October) in the Mediterranean and the winter (November-March) in the Canaries. However, from December 2015, this operating pattern changed, and the yacht was operated throughout the year from the Canaries. The manager remained the primary skipper for the yacht and employed two local yachtsmen to act as charter skippers when required.

It was estimated that prior to the capsizing, *Tyger of London* had completed approximately 29,000nm; 6,000nm accumulated while based at Palma and a further 23,000nm as a commercial charter yacht.

1.4.3 Skipper and crew

At the time of the accident, *Tyger of London's* skipper was a locally employed 69-year-old German national. An experienced local yachtsman and former deck officer in the merchant navy, he held a range of German sailing qualifications, the paperwork for which was lost during the accident. He did not hold a commercial endorsement but had sailed on *Tyger of London* with the manager and had skippered the yacht on several previous occasions.

The four crew members were Swiss nationals. They had paid the manager for a voyage in the Canaries to gain sea experience. Two of the charterers were experienced sailors and two were new to the sport.

1.5 COMAR COMET 45S DESIGN AND MANUFACTURE

Derived from the Comar Comet 51, the Comet 45S was designed to appeal to owners who wanted to cruise or race their yachts. Between 2004 and 2010, 57 Comet 45S yachts were manufactured by the yard. The Comar shipyard went into liquidation and ceased trading in 2011.

The designer, Vallicelli & C – AVC srl. provided the shipyard with drawings for the Comar Comet 45S. The contractual arrangement between Comar Yachts and the designer stated that the shipyard was responsible for the production of detailed 'shop drawings', the quality control of the production of the yacht, and for gaining European Union (EU) Recreational Craft Directive (RCD) certification for the yacht's design.

1.5.1 Keel design

In common with several other Comar vessels, the Comar Comet 45S design provided a choice of two keels, each of which could be fitted to a recess on the bottom of the yacht's hull. These were:

- A 3200kg deep draught keel, comprising a cast iron fin with a lead bulb fixed to its base (**Figure 6**). This keel extended approximately 2.24m below the hull.
- A 3774kg shallow draught keel, comprising a stainless steel keel plate and frame onto which the lead fin was cast to form the keel (**Figure 7**). This keel, which extended 1.8m below the hull, was aimed at owners who were more interested in cruising or whose home port could not accommodate the deep draught keel.

Tyger of London was fitted with the shallow draught keel.



Figure 6: Comar Comet 45S, deep draught racing keel (not fitted to *Tyger of London*)



Figure 7: Comar Comet 45S, shallow draught, lead, cruising keel fitted to *Tyger of London*

1.5.2 Keel design and manufacture

The keel drawings (**Figures 8 and 9**) for *Tyger of London's* cruising keel showed:

- A lead keel fin, which was cast around,
- A stainless steel keel frame, made up of: a rectangular top plate into which 12 x 30mm diameter rods were threaded and welded; 150mm interconnecting, transverse and longitudinal stiffener plates welded to the rods, but not to the top plate; and two deep web centre line plates that stiffened the rear of the keel.

The shipyard subcontracted the manufacture of the shallow draught keel to two companies. The first, Bruno Tornani Lavorzione Ferro, fabricated the welded stainless steel keel frame. The second, SAT Fondeira Meccanica srl, placed the frame in a mould and cast the lead fin around the stainless steel structure. Both subcontractors were based in Rimini, Italy. The completed keel was then transported to the Comar shipyard in Fiumicino.

After attempting to manufacture the stainless steel frames on one or two occasions as designed, the fabricator proposed some changes to the shipyard. These included changes to the manner in which the 30mm diameter threaded rods were welded to the underside of the stainless steel top plate. Specifically, rather than weld the full circumference of each rod as it passed through the underside of the plate, the fabricator proposed to weld only the outside of each rod, but to extend the weld on to the interconnecting plates (**Figure 9**). It was also agreed that the sump for the bilge pump, shown in the designer's drawings, was not required.

These discussions took place by phone and fax. No records of the exchanges were retained by the parties involved, and no 'shop drawings' were created by the shipyard to capture these changes to the keel design. *Tyger of London's* keel was manufactured using this modified approach. The yacht's designer was not consulted on these changes to the shallow draught keel's design.

Staff from Comar Yachts conducted periodic visits to the subcontractors to observe and quality control the keel manufacturing process.

When delivered to the shipyard, the completed shallow draught keel was bolted, via the top plate, to the bottom of the yacht's hull using 16 stainless steel bolts. The gaps between the keel plate and the hull were then filled and faired prior to antifouling.

Between 50 and 100 Comar vessels have been fitted with shallow draught keels manufactured in a similar way. These vessel types include:

- Comar Comet 41, 45, 45S, 50, 51, 52rs, 54, 62ed; and,
- Comar Genesi.

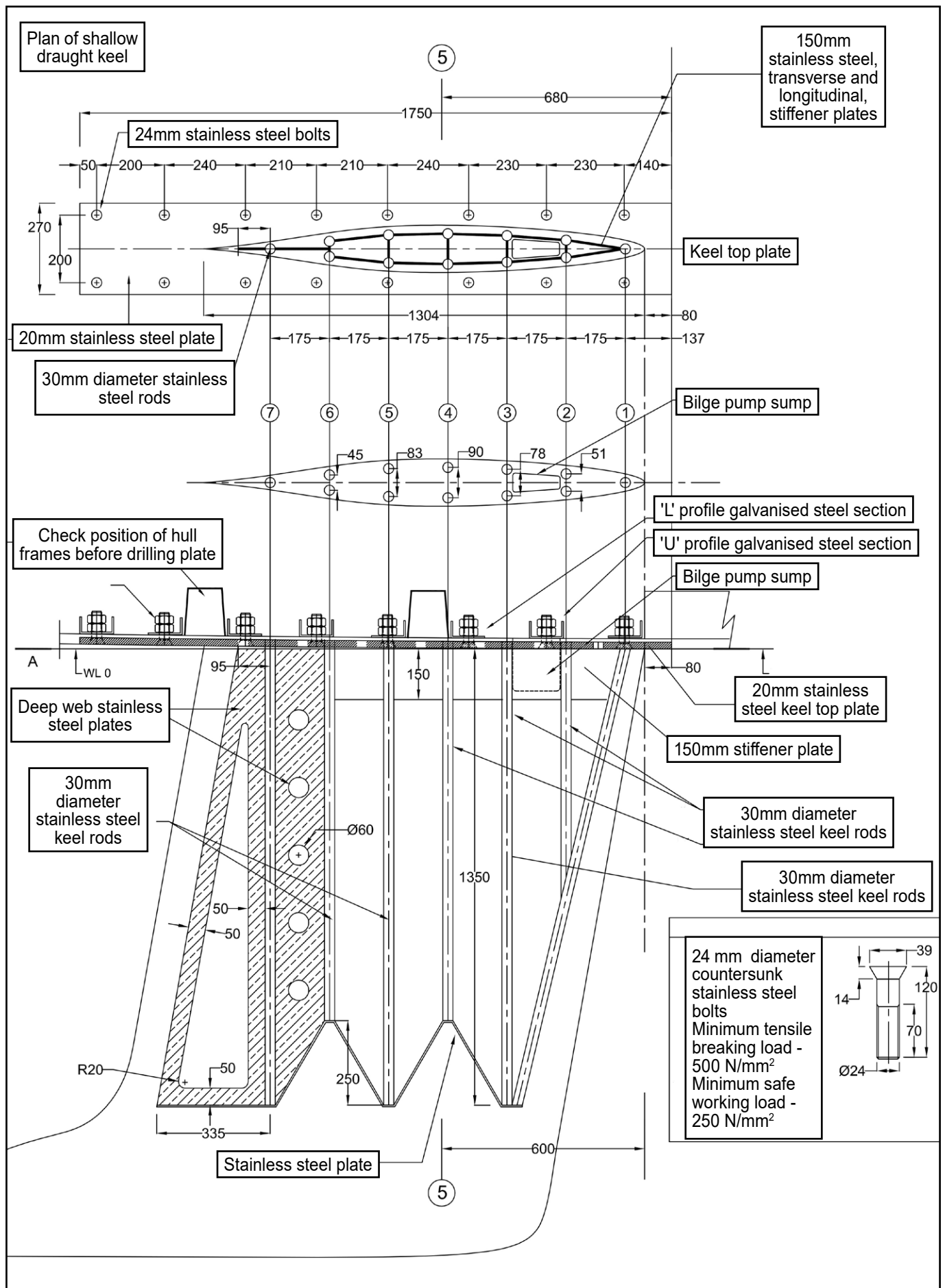


Figure 8: Drawing of Comar Comet 45S shallow draught, lead, cruising keel

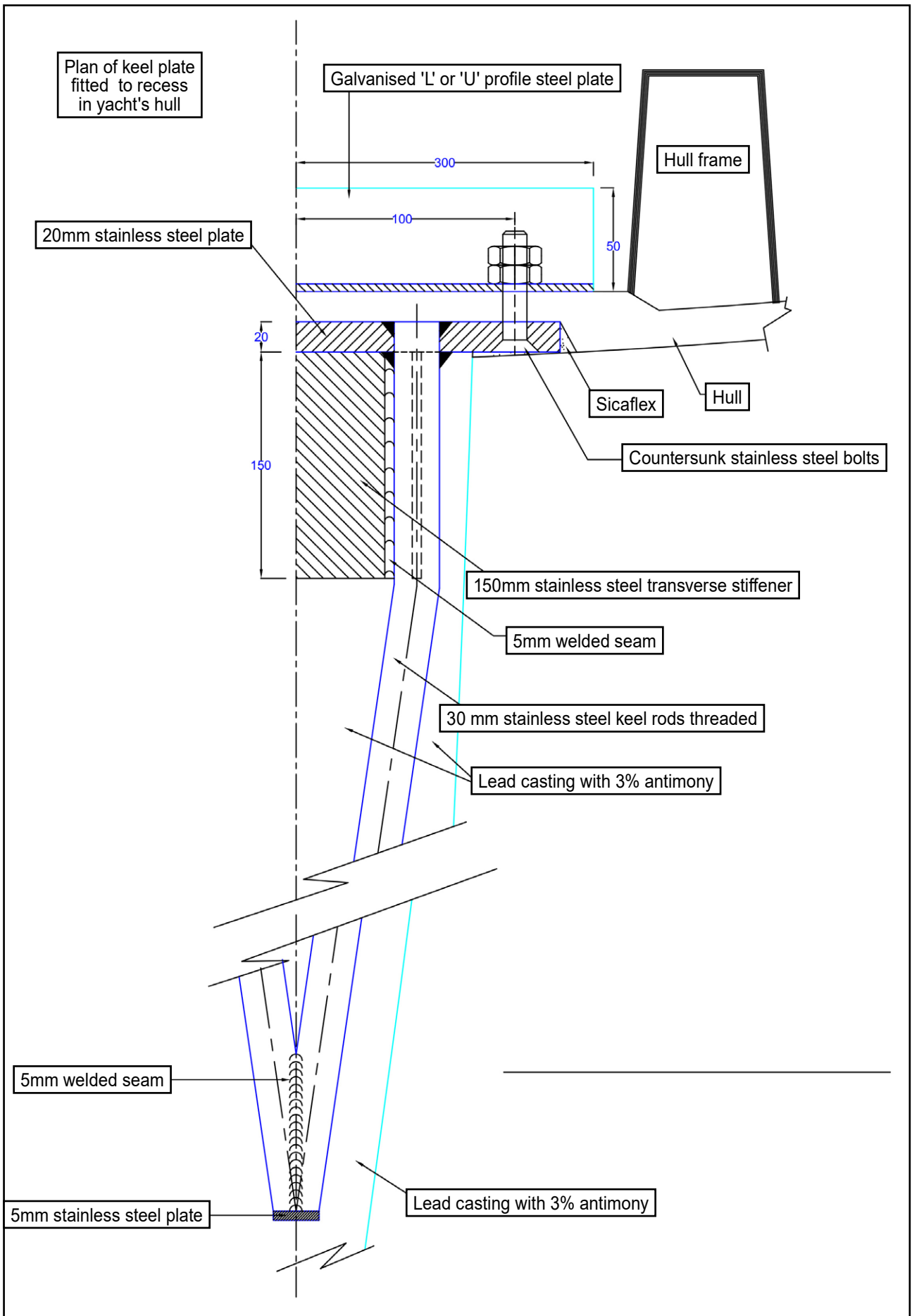


Figure 9: Drawing showing cross-section of Comar Comet 45S shallow draught, lead, cruising keel

1.6 SMALL COMMERCIAL VESSEL CODE

As a UK registered vessel *Tyger of London* was certified for commercial operation under the MCA's SCV Code of Practice, detailed in MGN 280(M). Under the Code, the MCA delegated survey and certification of small commercial vessels to several Certifying Authorities. The Certifying Authority for *Tyger of London* was the RYA.

The SCV Code divided vessels into seven categories of operation with respect to intact stability performance (**Table 1**):

Permitted Area of Operation	MCA Code Category	ISO 12217 Design Category
Unrestricted	0	A
Up to 150 miles from a safe haven	1	A
Up to 60 miles from a safe haven	2	B
Up to 20 miles from a safe haven	3	B
Up to 20 miles from a safe haven in favourable weather and daylight	4	C
Up to 20 miles from a nominated departure point in favourable weather and daylight	5	C
Up to 3 miles from a nominated departure point in favourable weather and daylight	6	C

Table 1: Small Commercial Vessel permitted areas of operation

Tyger of London was certified by the RYA for Category 2 operations as the yacht had an ISO 12217 design category at B or above. This allowed the yacht to operate up to 60 nautical miles from a safe haven.

1.6.1 Examinations

As *Tyger of London*'s Certifying Authority, the RYA was required to examine the yacht to enable the issue of a Certificate of Compliance under the Code. This required the yacht to complete an out of water inspection every 5 years with an intermediate, in-water inspection, during year 3. These formal examinations, by RYA approved surveyors, were interspersed with annual statements of compliance by the owner/manager.

Tyger of London's inspections by the RYA and the manager are summarised below:

- In August 2013, the initial SCV Code compliance examination of *Tyger of London* was conducted at Barcelona by an RYA appointed surveyor. The surveyor recorded that the joint between the keel and hull was satisfactory, with no sign of significant deterioration. The surveyor also noted four defects where remedial

action was recommended: to monitor the propeller as there was slight play in the sail drive; to align the starboard mast spreader; to service all seacocks; and, to re-laminate the secondary bonding under the forward berth.

Once the manager reported that these defects had been addressed, the RYA issued *Tyger of London* with an SCV certificate valid for 5 years.

- In March 2014, the yacht was lifted ashore for maintenance by its manager in Tenerife. There was some minor cracking along the joint between the keel and hull (**Figure 10**). This area was ground out and filled prior to the hull being painted.



Figure 10: *Tyger of London's* keel, March 2014

- In December 2014, the manager submitted his annual inspection declaration to the RYA, reporting no defects.
- In August 2015, the manager submitted his annual inspection declaration to the RYA, reporting no defects.
- In February 2016, in Tenerife, the yacht was lifted ashore at the Marina San Miguel. Maintenance was conducted on the hull, sea cocks, engine and keel. Keel

maintenance included removal of all paint and filler from the top of the keel, exposing the joint between hull and keel top plate and top plate and keel fin. The manager reported that there were no gaps in either joint (**Figure 11**). Furthermore, to ensure that the keel was secure, the boat was hoisted and the keel pushed by three or four people; no movement within the keel structure was observed. On completion, the joints between both the hull and the top plate, and the top plate and the keel fin, were resealed and faired with filler before being repainted.



Figure 11: *Tyger of London's* keel, February 2016

- In October 2016, while *Tyger of London* was alongside in Marina San Miguel, Tenerife, an RYA appointed surveyor conducted the mid-term, in-water, SCV Code survey. The surveyor noted four areas where remedial action was required. These included: purchase of two additional lifejackets; replacement of a fire extinguisher; labelling the fuel cut-off; and replacing the cooker. The manager reported that these remedial actions were complete in November 2016.
- In October 2017, the manager submitted his annual inspection declaration to the RYA, reporting no defects.

Tyger of London was due its next out of water compliance examination in August 2018.

1.7 LIFE-SAVING APPLIANCES

In accordance with MCA Code as a Category 2 vessel *Tyger of London* was fitted with the following life-saving appliances (LSA):

- An 8-person liferaft (without SOLAS pack); post-accident, the yacht's valise liferaft was found in its stowage locker below the cockpit floor (**Figure 12**).



Figure 12: *Tyger of London's* valise liferaft, post-accident, in its cockpit locker

- Grab bag stowed under a seat in the cabin. The grab bag contained: 1 x MCA approved spare sea anchor & line; 1 x SOLAS approved CAT-C first-aid kit; 1 x SOLAS approved inflatable radar reflector; 1 x SOLAS No 2 table of lifesaving signals; 1 x heliograph (signal mirror); 1 x SOLAS approved thermal protective aid per person. Post-accident, the remains of the grab bag were found in the yacht's cabin.
- Lifebuoys with lights, drogues and buoyant lines; post-accident these were found attached to the yacht.
- Flares (four parachute; six red hand-held; three buoyant smoke); post-accident, the flares were found stowed within the yacht's cabin.
- A portable VHF radio; this was not found post-accident, but was reported to be within the grab bag.

Although not required to carry an EPIRB, *Tyger of London's* beacon was found inside the cabin post-accident.

1.8 PREVIOUS GROUNDINGS

Tyger of London was reported as having grounded on the following occasions:

- 2007-2013 The yacht grounded on several occasions at slow speed (less than 1kt) while anchoring/manoeuvring.
- 2014 The yacht grounded on two occasions at slow speed (less than 1kt) while approaching marina berths.
- 2015 The yacht grounded at slow speed (less than 1kt) in mud. It took between 3 and 5 minutes to free the vessel using the engine.
- 2016-2017 No reported groundings.

1.9 POST-ACCIDENT INSPECTION

In February 2018, the MAIB inspected *Tyger of London's* salvaged hull in Tenerife. Examination of the keel area identified that the keel top plate was securely attached to the bottom of the hull. The keel bolts had been removed by the insurance surveyor.

The internal structure of the hull and the keel matrix was found to be in good condition (**Figure 13**). There was no sign of cracking or damage around any of the internal beams. Externally there were no signs of damage to the hull. The keel plate was removed by the MAIB and shipped to the UK for technical examination.



Figure 13: The keel matrix (bolts removed by surveyor prior to keel plate removal)

1.10 TECHNICAL ANALYSIS OF KEEL CONSTRUCTION

The MAIB commissioned Southampton University's Wolfson Unit² to conduct a technical analysis of the keel plans and the recovered keel top plate. The purpose of this was to:

- Assess the keel design against the international standard (ISO 12215-9:2012(E) - Small Craft-Hull Construction and Scantlings – Part 9: Sailing craft appendages).³
- Examine the manufacture of the keel against the designer's drawings.
- Establish the possible sequence of failure.

A copy of the report is at **Annex A**.

The Wolfson Unit report noted that *Tyger of London's* usage "correspond[ed] to about 25-30 years of moderate-to-high ... recreational sailing or about five years of very extensive ocean racing". The report concluded that:

- The keel design met the static load cases of ISO 12215 part 9. However, the report noted that the interface between the keel rods and the top plate was weaker than that between the top plate and the hull.
- The yacht's keel had not been manufactured by the fabricator, Bruno Tornani Lavorzone Ferro, in accordance with the designer's drawings. Specifically:
 - The 12 stainless steel keel rods that made up the keel frame were partially - rather than fully - welded to the top plate.
 - A different configuration of interconnecting stiffener plates was used at the rear of the keel. There was no evidence to indicate that one of the two deep web centre line plates had been fitted.
 - The sump for the bilge pump had not been incorporated into the top plate.

The report concluded that the most likely sequence of failure was that threads on rods 6 and 7, under the heaviest load, began to strip (**Figure 14**). Thereafter, cyclic loading gradually increased the lateral movement between the keel and its top plate. Once these two rods shed their load, the remaining rods steadily failed until the keel fin detached from the keel plate.

1.11 RECREATIONAL CRAFT DIRECTIVE

EU Directive 94/25/EC⁴, known as the RCD, harmonised the EU Member States' differing national standards for recreational craft. These craft are defined as "*boats intended for sports and leisure purposes of a hull length between 2.5 and 24 metres*". *Tyger of London* was built in accordance with the requirements set out in the 1994 RCD.

² The Wolfson Institute is part of Southampton University and provides independent marine consultancy.

³ ISO 12215-9:2012(E) - Small Craft-Hull Construction and Scantlings – Part 9: Sailing Craft appendages was not in force when the *Comet 45S* was designed.

⁴ EU Directive 94/25/EC, in force at the time of *Tyger of London's* manufacture, was subsequently replaced by EU Directive 2013/53/EU on 18 January 2016.

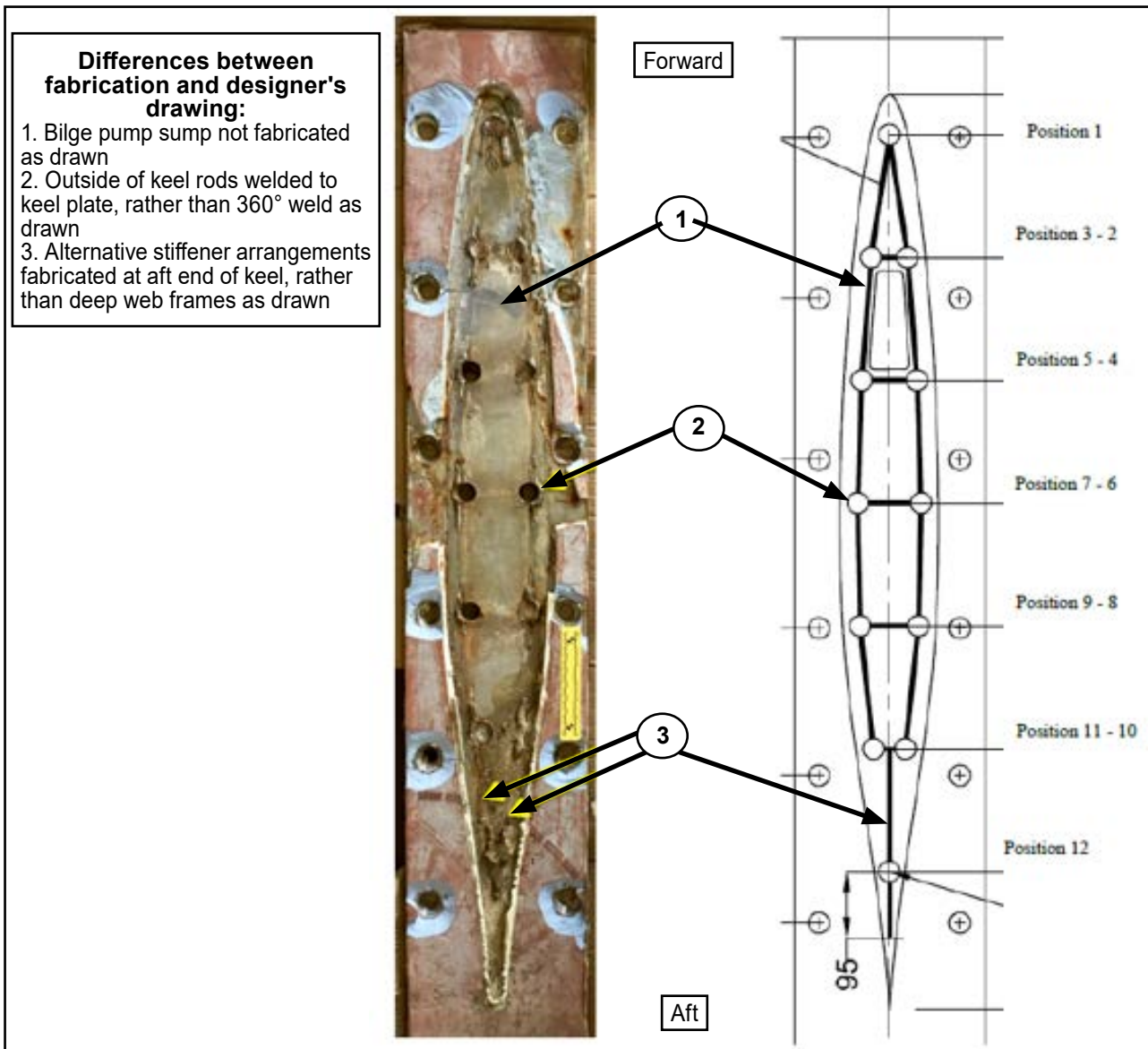


Figure 14: *Tyger of London's* keel plate noting differences between recovered keel plate and designer's drawing

The key purpose of the RCD was to create a common technical standard for recreational craft within the EU and promote internal trade. The RCD is accompanied by a further publication entitled 'Recreational Craft Directive and Comments on the Directive Combined', referred to as the RCD Guidelines.

The RCD provides four vessel design categories (**Table 2**).

Design category	Wind force (Beaufort scale)	Significant wave height (H 1/3, metres)
A- Ocean	Exceeding 8	Exceeding 4
B- Offshore	Up to, and including, 8	Up to, and including, 4
C- Inshore	Up to, and including, 6	Up to, and including, 2
D- Sheltered waters	Up to, and including, 4	Up to, and including, 0,5

Table 2: RCD design categories and weather limits

Tyger of London was certified as an RCD design Category A 'Ocean' vessel:

“Designed for extended voyages where conditions may exceed wind force 8 (Beaufort scale) and significant wave heights of 4m and above, and vessels largely self-sufficient.”⁵

1.11.1 Approval process

The RCD required that craft of between 12 and 24m underwent an approval process to ensure they conformed to the Directive. The RCD detailed a modular framework for manufacturers/importers to achieve this, based on the design category of the vessel. The modules ranged from: a relatively low level of assurance for sheltered water and inshore craft using Module A, which relied on self-assurance by the manufacturer, to the high level of assurance provided by Module H, which required full quality assurance of each craft produced.

In the case of the Comar Comet 45S, a design Category A ocean-going vessel, the shipyard chose the RCD Module B + C approval process, described below:

- **RCD Module B (type examination).** Required the shipyard to appoint an approved Notified Body⁶, in this case RINA Services S.p.A (RINA), to conduct a type examination of the Comar Comet 45S.

To achieve this, the RINA design centre in Genoa reviewed and approved the drawings for the Comar Comet 45S provided by the shipyard. A RINA appointed surveyor then visited the shipyard in Fiumicino to observe the manufacturing process of at least one of the early Comar Comet 45S yachts, to confirm that the yacht was being built in accordance with the drawings.

RINA completed the Module B approval process for the Comet 45S in November 2003.

During the approval process, the RINA surveyor did not visit the keel fabricator or foundry in Rimini. RINA records also showed that the shipyard provided the drawings for only the deep draught and not the shallow draught keel. The design of the shallow draught keel, fitted to *Tyger of London*, had therefore not been assessed or inspected as part of the RCD Module B approval process.

- **RCD Module C (conformity to type).** Once the Module B approval was complete, under Module C, the manufacturer then self-certified RCD compliance and issued a Document of Compliance (DoC) for each vessel. A copy of the DoC for *Tyger of London* could not be found.

⁵ RCD Annex I.

⁶ Notified Body - a professional body that an EU member state appoints as being suitable to assess RCD conformity requirements.

1.11.2 Owner's manual

The RCD required the manufacturer to provide an owner's manual with the vessel in accordance with ISO 10240 (Small Craft Owner's manual). This manual drew the owner's attention to the risks of fire and flooding, and contained information on:

- The design category.
- The maximum number of persons/loading that could be carried by the vessel.
- Details of the openings in the hull, deck and superstructure.
- Handling characteristics of the vessel.

ISO 10240 did not specifically require any reference to keel construction or its inspection.

The RCD also required manufacturers to compile and retain technical documentation that:

*'shall enable understanding of the design, manufacture and operation of the product, and shall enable assessment of conformity with the requirement of the directive.'*⁷

The RCD did not state how these records should be retained if the manufacturer ceased trading.

1.12 HISTORIC KEEL CONSTRUCTION STANDARDS

In 2003, when the keel was designed and manufactured, there was no formal international standard for yacht keel design. Instead, the designer, like many others, used the American Bureau of Shipping (ABS) 1994 'Guide for Building and Classing Offshore Racing Yachts'. This guide provided formulae for calculating the strength of keel bolts, chain plates and other fastenings used to secure the keel to the yacht's hull. It did not detail how to evaluate the construction of the keel itself.

1.13 MARITIME LABOUR CONVENTION

The Maritime Labour Convention (MLC) was ratified by the UK government in August 2013 and came into force on 7 August 2014. Its application to small vessels of less than 200gt engaged in commercial activity is described in MGN 600 (M)⁸ and MGN 601 (M)⁹.

The MLC applies to all seafarers who work on UK vessels 'ordinarily engaged in commercial activities', and specifically that 'operate on a voyage from a state other than the UK'. It specifies the standards required for the protection and welfare of seafarers, such as: accommodation standards, training and certification, medical standards and areas such as health and safety and hours of rest.

⁷ RCD Annex XIII.

⁸ MGN 600(M) Amendment 1 – Maritime Labour Convention: Inspection of Coded Vessels.

⁹ MGN 601 (M) – Maritime Labour Convention: Crew accommodation for small vessels of less than 200GT that are ordinarily engaged in commercial activities.

As a skippered charter vessel, *Tyger of London* had been operating on voyages from states other than the UK since October 2013. It should therefore have complied with MLC regulations. To do so, the yacht would have had to complete an MLC survey by the Certifying Authority.

In the case of *Tyger of London*, only the declaration and administrative audit would have applied. Therefore, although concessions might have been required for the standard of accommodation available to the crew (most existing yachts struggle to comply, due to lack of space), the survey would have required the yacht's skipper to hold:

- a valid commercial STCW certificate; or,
- an RYA Yachtmaster offshore certificate, with commercial endorsement; and,
- be in date for a seafarer's medical.

The RYA's assumption was that the yacht was operated as a bareboat charter vessel (without a skipper). *Tyger of London* had therefore not completed the MLC survey. The owner and manager were unaware of the need to comply with MLC regulation, although both the RYA and the MCA had issued letters to all UK coded vessels on the subject in 2013.

1.14 PREVIOUS/SIMILAR ACCIDENTS

The MAIB has investigated the following two previous accidents involving keel failure:

Hooligan V

On 3 February 2007, while on passage from Plymouth to Southampton, the keel of the Max Fun 35 sailing yacht, *Hooligan V*, became detached and the yacht capsized. One life was lost. The investigation found that the keel had not been constructed in accordance with the designer's drawings and, in addition, had been subsequently modified by the owner such that the keel structure was unable to withstand the bending stresses to which it was exposed ([MAIB 19/2007](#)).

Cheeki Rafiki

On 16 May 2014, the UK registered yacht *Cheeki Rafiki* capsized in the North Atlantic with the loss of four lives. The investigation found that the yacht capsized due to the detachment of its keel. The cause of the keel loss was probably the combined effects of previous groundings and subsequent repairs to the keel and the hull's internal structure, along with the possible deterioration of one or more keel bolts ([MAIB 8/2015](#)).

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 OVERVIEW

Tyger of London's passage from La Gomera to Tenerife on 7 December 2018 had been fast and exhilarating for the crew. At the time of the accident the yacht was heeling approximately 15-20° to starboard and behaving as expected.

Tyger of London was a 10-year-old Comar Comet 45S that had been used extensively, completing more than 29,000nm underway. However, while the yacht had been 'worked hard', it had been designed and manufactured as an ocean-going vessel, had undergone regular inspections and its structural condition was not in doubt. It was therefore reasonable to have expected its keel to have remained intact. Instead, *Tyger of London's* keel failed and the yacht capsized.

To analyse the causes of this accident and make appropriate recommendations this section will focus on six areas: keel failure mode, keel design, keel construction, keel inspection, emergency response and the role of the Certifying Authority.

2.3 KEEL FAILURE MODE

The technical analysis carried out by the Wolfson Unit (**Annex A**) confirmed that *Tyger of London's* keel failed unexpectedly because although its design met the static load case of the international standard ISO 12215 part 9, it had not been manufactured to meet the designer's drawings. However, it is also necessary to consider how the operation of the yacht possibly contributed to the keel failure.

2.3.1 Contact with an underwater object

Contact between yachts and submerged debris or marine life are rare but not uncommon. At the time of the keel failure, *Tyger of London* was sailing at between 6 and 7kts and no impact was felt by the crew prior to capsize. The yacht's hull showed no scuffing or cracking of the gel coat to indicate contact with an underwater object.

There was, therefore, no indication to suggest such an event was a direct contributory factor in this accident.

2.3.2 Groundings

Grounding is a hazard for all yachts that operate near the coast. It is a risk that is recognised by yacht designers, who factor in the additional loads involved into the design of the keel.

It was reported that the yacht had grounded on several occasions. However, each time this occurred it was at slow speed and on sand or mud; the type of minor impact allowed for in the keel design.

These reported grounding events all preceded the last out of water inspection of the yacht's keel by the manager in February 2016. This inspection was thorough and included the removal of all paint and filler from the keel top plate and the upper part of the keel fin. It allowed an external inspection of the join between the keel fin and keel plate, but it was not possible to examine the condition of the internal keel rods that subsequently failed. The inspection also included the yacht being lifted and the keel fin physically pushed to see if there was any movement of the keel structure; none was observed.

A grounding that directly led to the keel failing is therefore considered unlikely. However, the cumulative effect of reported - and perhaps unreported - groundings over time might have contributed to weakening of the keel's internal structure through its life.

2.4 KEEL DESIGN

2.4.1 Overview

The design of the Comar Comet 45S's shallow draught keel was very different to that of a traditional lead keel.

A traditional lead keel is cast around steel 'J' or 'L' shaped keel bolts, the ends of which are then bolted through a yacht's hull structure (**Figure 15**). The benefit of this simple design is that the condition of the hull-to-keel connection can be assessed by observing the keel bolts and ensuring that they are tightly secured with no signs of corrosion. Equally, the keel can be removed to make a more detailed examination of the keel-to-hull connection if required.

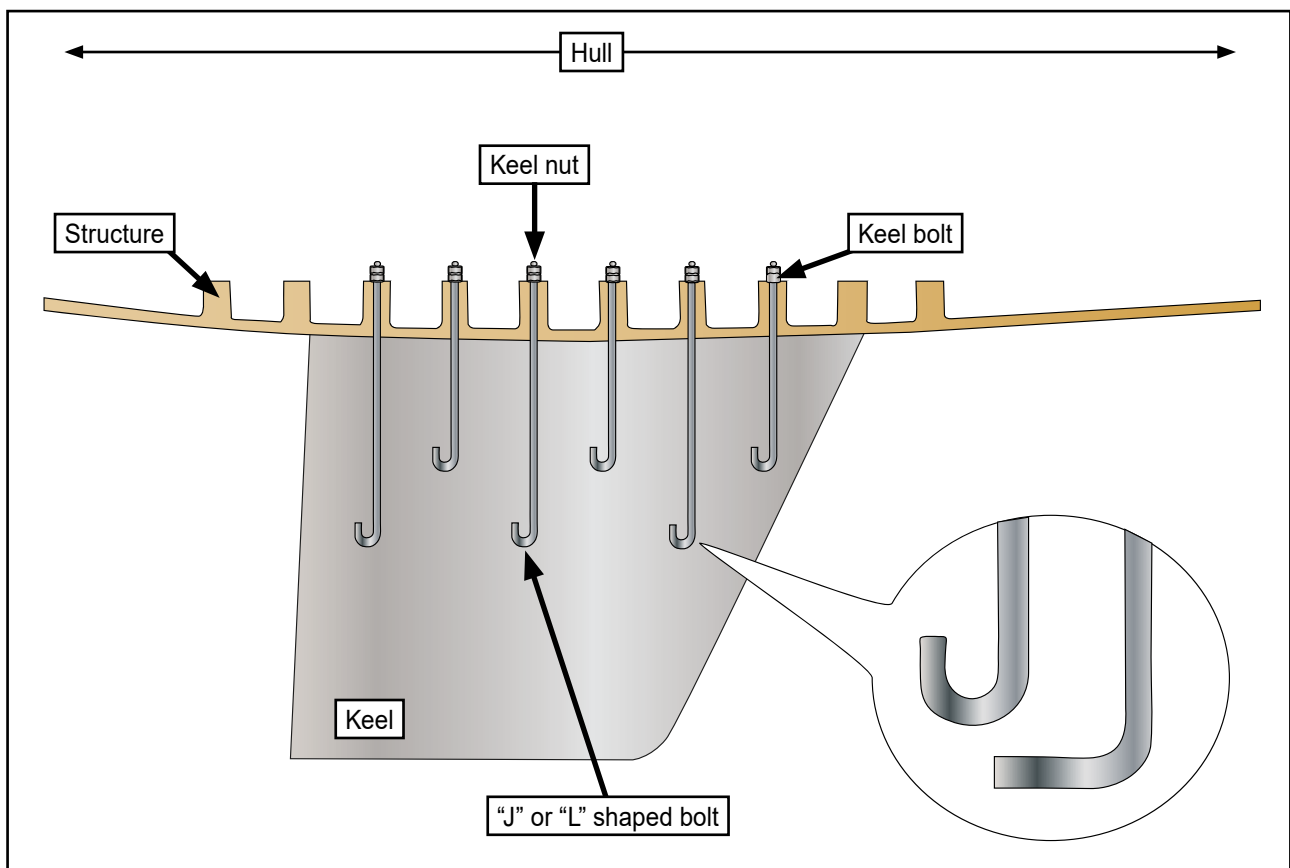


Figure 15: Traditional lead keel

In contrast, the unusual design of the Comar Comet 45S shallow draught keel was more complex. Its construction relied on a top plate attached to the yacht using 16 bolts. However, the majority of the 3.7t mass of the keel was hung from 12 rods, threaded and welded to the top plate and hidden within the lead casting.

2.4.2 Compliance with international standards

There was no formal international standard for keel design when *Tyger of London* was built. The ABS standards focused on the strength of the bolts that attached the keel to the hull, rather than the ability of the keel's structure to withstand the forces exerted on it in a seaway.

When the Wolfson Unit assessed the keel design against the 2012 ISO standard (ISO 12215 part 9), it revealed that, while the keel bolts achieved a factor of compliance of 1.67, the keel rods achieved a factor of compliance of only 1.12. As a result, the join between the keel plate to the keel rods was 33% weaker than the join between the keel plate and the yacht's hull.

The Wolfson Unit concluded that, given the keel's unusual design, their assessment - that it met the current ISO standard - should be used with caution.

2.4.3 Designer's drawings

The Wolfson report also highlighted several ambiguities in the keel drawings. In particular, the drawings lacked detail in describing the join of the keel plate to the keel rods.

The design drawings required the keel rods to be threaded into the keel plate. For threaded joints to be effective the thread must be kept under tension; yet the design did not detail how this was to be achieved. Guidance as to whether the keel rods were bent prior to, or post threaded insertion was not provided. If the rods were bent post-insertion, it is unlikely that the thread would have been under the required tension.

A further element missing from the keel drawings was detailed guidance on the welds fixing the keel rods and keel plate. Typically, the designer would provide standard notation (ISO 4063-Welding and applied processes-nomenclature of process and reference numbers), which would detail the weld throat size and leg length for this critical element of this keel's construction (**Figure 16**). The Wolfson Report also noted that the design did not take into consideration the access required by the fabricator to achieve an adequate weld with each keel rod in place; a practicality that led the fabricator and shipyard to modify the design.

Without detailed shop drawings from the boat builder, it was unlikely that the critical join between the keel plate and the keel rods would be correctly welded.

2.4.4 Keel design approval and European Conformity

The designer's drawings for the shallow draught, lead cruising keel were not forwarded to RINA as part of the RCD Module B approval and CE process. However, given that the regulations in force at the time focused on the stability of the yacht and the strength of the keel bolts, it is unlikely that the vulnerability of the internal keel structure would have been identified.

However, as the drawings for the Comar Comet 45S shallow draught keel were not included as part of the RCD Module B type examination process, *Tyger of London* was sold by the shipyard without a valid certificate of European Conformity (EC).

Image courtesy of Wolfson Unit, Southampton

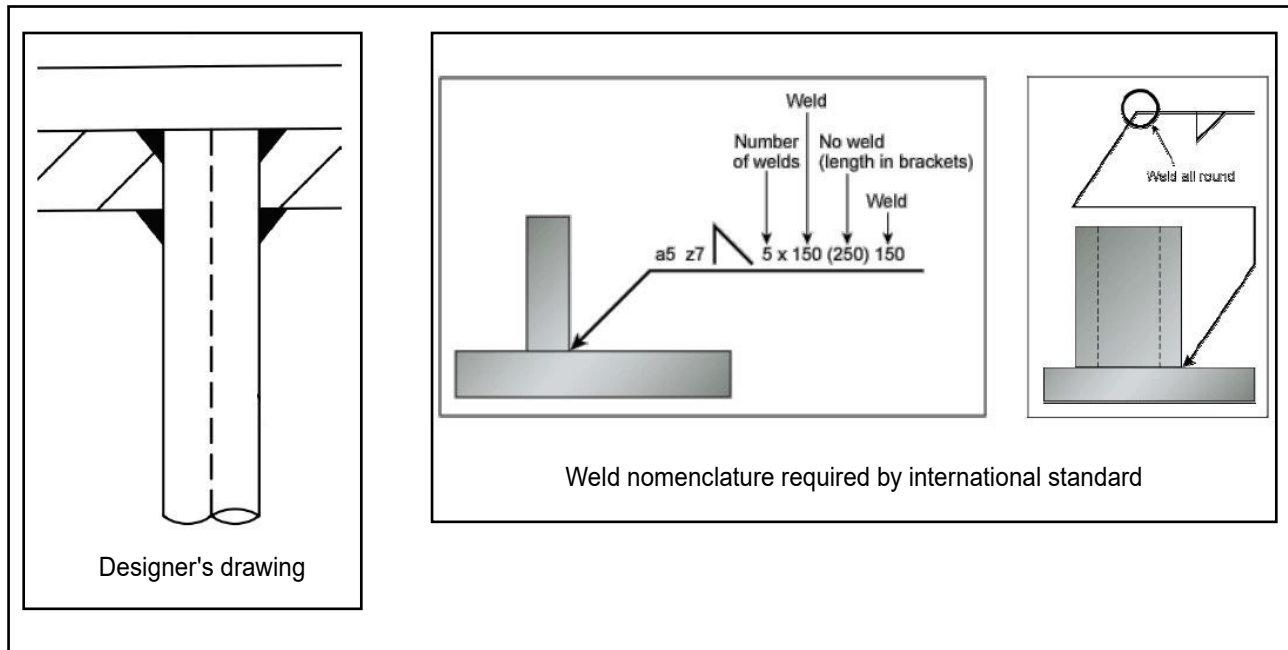


Figure 16: Comparison between designer's drawing and weld nomenclature required by international standard

2.5 KEEL CONSTRUCTION

The examination of the keel top plate revealed that the stainless steel frame of *Tyger of London's* keel had not been constructed in accordance with the designer's drawings. Most critically, the complex design made it difficult for the fabricator to manufacture the keel frame in accordance with the designer's drawings. As a result, the manner in which the keel rods were welded to the underside of the keel plate was changed. This undocumented change, albeit made in discussion with the shipyard, resulted in less than 50% of the keel rods' circumference being welded as they passed through the underside of the top plate. However, the shipyard did not consult the yacht designer over these changes. Additionally, when the quality of the welds was examined it revealed that a number had fillet leg lengths of 4-7mm when the minimum should have been at least 8mm.

The fabricator's adaptation of the design weakened the join between the keel fin and top plate. As a result, over time the tensile lateral loading on the keel broke the welds and began to strip the threads on the two midship rods through tensile-tensile cyclic loading. As the Wolfson Unit report concluded:

"Therefore, under local tensile-tensile loading there was relative movement between the rods ... and the top plate, which led to thread flank wear which increased the freedom of movement. Once the load was no longer supported by the central rods, load shedding and cyclic deflections failed the remaining rods."

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¹⁰ Wolfson Report Unit No 2701 dated 4 June 2018.

Several measures could have prevented this and ensured that the keel was produced in accordance with the designer's intent.

1. Improved quality control of the keel manufacturing process. This could have been achieved during the RCD Module B approval process where an observation by the Notified Body surveyor could have resulted in these inconsistencies being observed and changes to the keel design being formally approved.
2. Consulting the yacht designer over the proposed changes to his keel design. This, too, could have prevented the structural flaw in *Tyger of London's* keel.
3. More detailed technical drawings of the keel, which would have provided a better understanding of the design intent. The Wolfson Unit noted that the keel drawings represented these welds as simple black triangles rather than full weld notation, including details such as throat size and leg length, as required by international standard.

The practical nature of manufacture often requires change or adaptation of the original design. However, it is essential that these changes do not undermine the designer's intent. If there is any doubt, shipyards should formally refer the proposed changes back to the designer for approval. Informal discussion by fax and telephone can, as in this case, lead to misunderstanding and compromise the original design. Instead, these changes should have been documented in either the designer's drawings or shop drawings produced by the shipyard to capture and standardise them.

2.6 KEEL INSPECTION

A further challenge for all those examining Comar Comet yachts is that of inspecting the structure of the keel, post-manufacture.

The design of the Comar Comet 45S shallow draught, lead, cruising keel presented several challenges. The securing bolts within the bilge of the yacht, for the shallow draught lead keel, connected the top plate to the hull. However, the condition and tightness of these keel securing bolts did not indicate the condition of the keel's internal structure. Furthermore, the use of traditional non-destructive methods of inspection, such as ultrasound and x-ray, would not have been able to penetrate the lead casting to deliver an accurate result. Removing the keel to examine it would also not have helped. Even following the manager of *Tyger of London's* example, and applying a lateral force to the keel while the yacht was out of the water, was unlikely to provide an accurate indication of the condition of the keel's internal structure.

The unusual design of *Tyger of London's* keel meant that there was no means of inspecting or monitoring the condition of the join between the keel top plate and the keel rods. It is important for yacht manufactures to include advice to owners on the construction of the craft's keel and the occasions for, and methods of, inspection to ensure such difficulties are highlighted. This requirement could be included in ISO 10240, which specifies the details that must be included in small craft owners' manuals.

2.7 EMERGENCY RESPONSE

2.7.1 Use of lifejackets

Tyger of London carried eight 150N self-inflating lifejackets fitted with lights and whistles. The skipper of the yacht made the decision that the crew would each wear their lifejacket and safety harness during the passage from La Gomera to Tenerife. Therefore, when the yacht capsized unexpectedly, and the crew fell into the water, their lifejackets self-inflated. Four of the crew swam clear, unhindered; one became trapped under the cockpit by the netted guardrails. Although the inflated lifejacket delayed this crew member's escape, ultimately they were able to free themselves.

An auto-inflation lifejacket has the major benefit of requiring no initiation by the wearer when entering the water. Therefore, if the wearer is unconscious the lifejacket will still inflate and prevent the wearer from drowning. However, there are occasions where an auto-inflation lifejacket may hinder escape, as occurred during this accident. This should not detract from the benefit that auto-inflation lifejackets provide, and manual inflation lifejackets should be used only after careful consideration of the risks.

The decision as to which lifejacket to carry is a matter of personal choice. Nevertheless, the fact that all five of the crew were wearing lifejackets when they entered the water directly contributed to their survival by keeping them afloat and allowing *St Barbara V* to quickly locate them. However, crew must never wear an inflatable lifejacket beneath clothing, as one crew member on board *Tyger of London* did, as this can result in the lifejacket either not activating, or not inflating properly. In particular, it could prevent the wearer from being able to manually operate the lifejacket, top it up using the mouth piece, or access the whistle. Furthermore, it could obscure the light and high visibility reflective strips. Skippers and more experienced crew members should ensure that less experienced crew do not make this mistake.

None of the lifejackets carried were fitted with a spray hood or personal locator beacon. Had the capsize occurred at night, or in a more remote location where rescue might have been delayed, both devices would have increased the crew's chances of survival. Although not required under the SCV Code, lifejackets fitted with spray hoods and personal locator beacons would be sensible enhancements for an ocean-going yacht certified to operate commercially up to 60nm offshore.

2.7.2 Electronic position indicating radio beacon

The carriage of a float-free EPIRB is not mandated for an SCV Category 2 vessel under the Code. However, the owner and manager had decided to carry one on board *Tyger of London*, albeit that it was not float-free and was carried within the cabin.

Had *St Barbara V* not triggered the SAR response, the EPIRB would have raised the alarm.

Though not mandated, the carriage of the EPIRB was a useful addition to the yacht's outfit of lifesaving appliances. However, to be fully effective the EPIRB should have been fitted in a position to enable it to float free, or at least be easily accessible in an emergency. On this occasion the crew were fortunate that the beacon activated from within the upturned cabin.

2.7.3 Liferaft, grab bag and flares

The successful deployment of a liferaft will significantly enhance a crew's chances of survival following the loss of a yacht. This is especially true in cold conditions where there is a risk of hypothermia.

Tyger of London's 8-person valise liferaft was carried in a locker below the cockpit deck, as required by the regulations. Although *St Barbara V's* proximity meant that on this occasion there was no requirement to gain access to it, had circumstances been different, it would have been very difficult for the crew to do so. The positioning of liferafts on yachts is particularly challenging as stowing them securely on the open deck can lead to them being washed overboard. Stowing a liferaft in a locker will protect it from the elements but will also present difficulties if it has to be retrieved. It is important to consider positioning the liferaft so that it remains readily accessible and capable of being deployed in the event of a yacht capsizing and inverting.

The safety equipment in *Tyger of London's* liferaft was augmented by an emergency grab bag. This bag, containing additional lifesaving equipment along with the yacht's outfit of flares, was stowed below a bench seat in the cabin. As neither the liferaft nor the grab bag could be accessed when the yacht capsized, the equipment they contained was not available to the crew. Ideally, all emergency equipment should be stowed where it can be retrieved following capsize.

2.7.4 The rescue

On seeing *Tyger of London* capsize, *St Barbara V's* skipper immediately responded by raising the alarm and preparing his yacht to rescue the survivors.

The skipper's team responded in an exemplary fashion. The decision to drop the genoa, start the engine, post a lookout, set up a first-aid station in the cabin, and rig a boarding ladder and guide rope over the transom, were all well-judged and highly effective. As a result, *Tyger of London's* crew were in the water for less than 30 minutes. However, even with a transom ladder that extended a metre below the waterline, the level of assistance required to help those who had been in the water was substantial. By the end of the process *St Barbara V's* crew were extremely tired. In part, those climbing out of the water were obstructed by the bulk of their inflated lifejackets, but it is also probable that shock played a part. There is little doubt that the swift, well-judged actions of *St Barbara V's* crew helped save the lives of the five crew in the water.

2.8 THE ROLE OF THE CERTIFYING AUTHORITY

2.8.1 Manning

The MLC came into force at a similar time to *Tyger of London's* conversion from leisure to commercial vessel. Given that the plan was for the yacht to be operated "from a state other than the UK", the convention applied.

Despite communications from the RYA and MCA in 2013, *Tyger of London's* owner and manager were unaware of the need to comply with the MLC or the implication of operating the yacht as a skippered vessel, rather than bareboat charter. Initially, the manager, who lived on board and acted as the yacht's skipper, was partially compliant in that he held the RYA Yachtmaster's certificate with commercial

endorsement. However, he had continued to skipper the yacht after his commercial endorsement had expired on 17 September 2017. Additionally, there is no record of him complying with the other MLC requirement of holding a valid medical certificate. Furthermore, while the skipper in command at the time of the accident held German sailing qualifications, his commercial qualifications were out of date, so he was not qualified for the role for which he was being employed.

While it is the responsibility of the owner and operators of commercial yachts to ensure their skippers hold the required qualifications, certifying authorities could bring to the attention of owners and managers the implications of the MLC during the SCV Code inspection process.

2.8.2 Reporting the accident

The SCV Code requires the owner/managing agent to notify both the certifying authority and the MAIB if the vessel suffers major damage.

In this case, although the owner and manager of *Tyger of London* were both aware of the accident on the day it occurred, they did not report it to the certifying authority or to the MAIB.

However, there is much that certifying authorities could do to emphasise this important point when their surveyors conduct compliance inspections. Simple measures, such as including the requirement for owners/managing agents to report accidents as part of the SCV certifying process, and re-emphasising the issue during the annual owner's declarations, would do much to make this requirement more obvious.

SECTION 3 - CONCLUSIONS

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

1. *Tyger of London* capsized without warning because its keel failed. [2.3]
2. The keel failed because it had not been manufactured in accordance with the yacht's design intent, and the quality of the welding during the manufacturing process did not meet recognised best practice. [2.4]
3. Without detailed shop drawings from the boat builder, it was unlikely that the critical joint between the keel plate and the keel rods would be correctly welded. [2.4.3]
4. The design of the keel was complex and difficult to fabricate. As a result, the shipyard and fabricator made undocumented changes to the design to ease the manufacture of the stainless steel keel frame, unaware that these changes had weakened the joint between the keel plate and internal keel rods. [2.5]
5. Once the keel had been cast, the weakest point of the yacht's keel could not be inspected, and in service the integrity of the keel could not be assessed. [2.6]

3.2 OTHER SAFETY ISSUES NOT DIRECTLY CONTRIBUTING TO THE ACCIDENT

1. The design of the shallow draught keel fitted to *Tyger of London* had not received EU Recreational Craft Directive approval, and the yacht did not have a valid certificate of European Conformity when it was sold to the owner in 2013. [2.4.4]
2. *Tyger of London's* crew were all wearing lifejackets, and these contributed to their survival. [2.7.1]
3. The location of the liferaft, grab bag and the electronic position indicating radio beacon, meant that these lifesaving appliances could not be accessed once the yacht had capsized. [2.7.2 and 2.7.3]
4. While in this instance the search and rescue response was triggered by a nearby vessel, had this not been the case, *Tyger of London's* electronic position indicating radio beacon would have raised the alarm. [2.7.2]
5. The swift response of the skipper and crew of *St Barbara V* ensured *Tyger of London's* crew were rescued unharmed. [2.7.4]
6. The owner and manager of *Tyger of London* were unaware of the need to comply with the Maritime Labour Convention when offering the yacht as a skippered, rather than bare boat charter, or of the certification required by the skipper to operate under the UK Small Commercial Vessel Code. [2.8.1]
7. The owner and manager of *Tyger of London* were unaware of the requirement to report the accident to the MAIB. [2.8.2]

SECTION 4 - ACTION TAKEN

4.1 MAIB ACTIONS

The **MAIB** has:

- Contacted the owners of UK registered Comar yachts that potentially had a similar keel design to *Tyger of London*.
- Issued a Safety Bulletin (**Annex B**) making owners aware that the shallow draught lead keel fitted to a range of Comar yachts might not have been fabricated in accordance with the designer's drawings.
- Conscious of the international review of ISO 10240 taking place in June 2018, the Chief Inspector of Marine Accidents wrote to British Marine recommending:

2018/119 Propose to the International Organisation for Standardisation that the requirement for 'information connected with the risk of flooding and stability', detailed in ISO 12215-9 (Small craft-Hull construction and scantlings – Part 9: Sailing craft appendages), be enhanced, at paragraph F2.4.2, to require, rather than recommend, manufacturers to provide clear guidance on the inspection method and procedure for keels in the owner's manual.

4.2 ACTIONS TAKEN BY OTHER ORGANISATIONS

British Marine has:

- In response to MAIB recommendation 2018/119, British Marine made the proposal at the ISO 10240 working group in June 2018. However, the consensus at the meeting was that, in light of British Marine's and several other proposals, the international standard should instead be amended to require small craft owner's manuals to:

"Provide information, applicable to the craft type, for actions to be taken following a grounding of the craft."

The **Maritime and Coastguard Agency** has:

Following this and the *Cheeki Rafiki* report, the Maritime and Coastguard Agency has:

- Drafted a series of MGNs to provide improved guidance on keel inspection and the stowage of lifesaving appliances.

The **Royal Yachting Association** has:

- Amended its annual letter to SCV owners and managers reminding them of the importance of reporting accidents to both themselves and the MAIB.

SECTION 5 - RECOMMENDATIONS

In view of the actions already taken, no further recommendations have been made.

