Part 3 – Leisure Craft

Life is full of risks, both at home and at work. Those of us working in the marine environment will face our fair share, but they will be different to those encountered by our land-based counterparts.

Risks are an integral part of everyday life, and to some extent they make life exciting and challenging. Some can be mitigated by making an assessment in advance, but very often we are faced with completely unexpected risks or ones which we have never encountered before. These are the ones that creep up unexpectedly and trigger a chain of events which take us completely by surprise. So often at sea, a minor problem can escalate very quickly into a catastrophe.

Many of us have made errors of judgment at sea. We might have embarked on a rough passage which, in hindsight, should have been delayed to the following day until the weather conditions improved, or perhaps we have not worn the appropriate safety gear for the task in hand. You look at the risk, make the assessment and nearly always hope for the best. Lone sailors may find this type of approach satisfactory. But if you are in charge of a crew, whose safety is of primary concern, you must be more cautious.

Today the internet provides us with vast amounts of information about numerous incidents which have taken place, and the lessons learned by the investigating authorities. Never before have we had such instant access to a huge library of such information. Somebody somewhere has possibly faced the same situation and the same risks as you; by reading about what went wrong, you can learn very quickly the correct procedures.

The reports which appear in this publication are produced on a regular basis by the MAIB, and are one of the greatest tools available to us as marine surveyors and naval architects. Any seagoing person – whether in a pleasure or professional capacity – is urged to read as many of these reports as possible to increase their own working knowledge of their hobby, their work or their life's experiences. They contain good factual reporting and do not attribute blame; instead they present the facts about what went wrong and explain how the situation could have been avoided.

In life, we all learn from our mistakes. However, the Safety Digest provides us with a unique opportunity to learn from other people's mistakes. I still find it interesting to read other people's opinions, and often from publications such as this one I pick up a real gem of information, which I can store away and hopefully use in the future. I urge you to do the same.

James W F McIlraith

Jim McIlraith is principal surveyor of Survey One Limited, which specializes primarily in small craft under 24 metres for survey and design work. Jim has a lifetime's experience in small vessels, and is an active member of many of the associations. His work was recently recognized by RINA and IESIS, by being awarded fellowships. He is also one of a rare breed of professionals who enjoy the water for pleasure purposes, being a keen sailor, too. Jim is an honours graduate in naval architecture from Strathclyde University, Glasgow, where he still lectures occasionally.

Keel Failure Leads to Loss of Life

Narrative

Following a very successful 2006 racing season, the owner of a 10 metre yacht put the boat into a boatyard for repairs and maintenance. The boat looked in great shape as the 5-man delivery crew arrived to take it back to its home port. The boat was checked over, the two new crew members were briefed on the safety gear, and the mainsail and genoa were rigged as the boat sailed at 2335. There was an 8 -10 knot north-easterly wind, and the boat was on a port tack and heeling about 15° to starboard when the first reef was put in the mainsail just before midnight.

Everything was normal, the boat felt businesslike – this promised to be an exhilarating trip and the chance for the new crew to gain experience. Unfortunately this expectation was soon to change.

By 0045 the owner, one of the watch leaders, and crew were in the cabin, having put the second reef in the mainsail. By 0245 the wind had increased to 25 knots, gusting 35 knots, and the boat was heeling 25° to starboard. At 0300 the relief crew arrived on deck, and at 0315 the heel increased to 30° and preparations were made to put the third reef in the mainsail, the genoa having already been ⅔ furled.

Before the mainsail could be reefed, the heel rapidly increased, and at about 0320 the boat very quickly inverted, trapping the skipper inside the cabin. Once in the water, three of the crew made their way to the transom and immediately noticed that the keel was missing.

One of the crew was not wearing a lifejacket and found it difficult to keep himself afloat; despite this he set about cutting the liferaft lashings at the transom. One of the others was wearing an auto-inflation lifejacket, which had operated, and the other crew member was wearing a manual inflation lifejacket, which he did not inflate. Despite this rapid change in circumstances, the skipper kept calm in the upturned yacht. He managed to locate and push the flare box and grab bag out of the cabin. These floated to the surface and the flares were set off. At the third attempt the skipper escaped from the cabin, but there was no sign of the fifth crew member.

The skipper, who was not wearing a lifejacket, was slipping in and out of consciousness, and was suffering the effects of hypothermia. Fortunately the crewman wearing the auto-inflated lifejacket was able to support him.

The crew managed to cut the liferaft free and set off the flares held in the liferaft. They were rescued at 0430 by a nearby ship. The body of the missing crew member was recovered by a lifeboat at 0655.

Investigations found that the fabricated steel keel had failed just below the fillet weld connecting the fin to the taper box (see Figure 1). Laboratory metallurgical analysis confirmed that the keel had suffered fatigue failure due to reverse bending stresses. Defects were also found in the keel taper box welds, and two of the three keel bolts had also failed.

It was further discovered that the boat builder had sub-contracted the hollow keel construction to a steel fabricator who had no marine experience. The fabricator changed the original design, and incorporated a fillet weld in a critical area. He did so to ease manufacture and reduce costs, but without the supporting calculations to assess the stresses to which the keel would be subjected. He did not consult with the designer on the changes. In 2005, 160kg of lead was added to the keel bulb for racing optimisation reasons. Once again there were no supporting calculations, nor were there detailed checks made against the "original" or "as built" designs to ensure that the modification was safe.

It was found that none of the designs achieved the required Safety Factor of 2. The addition of

Figure 1

Figure 2

the extra bulb weight exacerbated the problem and the keel was unable to withstand the "in service" bending stresses, and this led to the conditions of failure.

When the boat was taken out of the water at the end of the 2006 racing season, considerable detachment of the keel's epoxy filler and anti-fouling was found (see Figure 2). There was also evidence of the likelihood of fine cracking in the steel adjacent to the fillet weld, but this went undetected by the repairer, so the last chance to prevent the accident was missed.

The Lessons

1. **Yacht designers should ensure component designs satisfy the appropriate standard safety factor requirements. In this case, the keel steel's full ultimate tensile strength was used in the calculations instead of yield strength, and thus an artificially high safety factor was achieved.**

2. **Changes to critical parts such as hollow, highly stressed keels, should be properly worked through and supported with calculations to ensure their suitability. Owners should seek expert professional advice, and wherever possible, reference should be made to design drawings, and the designer/builder consulted to check construction details and suitability of the modification.**

3. **Do not dismiss the importance of keel coating detachment, or evidence of cracking of the coatings at the keel to hull interface; this may indicate more deep seated keel structural problems. Seek expert advice – you may need to use non-destructive procedures to check that the keel structure is sound. Also, regularly check the tightness of keel bolts and thoroughly investigate the cause of any failures. *Remember*, action at this stage could save your life.**

4. **The RNLI recommends that liferafts are secured on deck and that nothing is stowed on top of them. Hydrostatic Release Units (HRU) can be fitted to automatically release liferafts in a sinking or capsize situation. Where it is not practicable to fit an HRU, skippers and owners should consider securing liferafts with quick release knots to expedite release.**

5. **It is always good practice to wear your lifejacket while on deck. It significantly improves the chances of survival, and in cold waters, in the middle of the night, it will prove to be your very best friend. Look after it, know how to use it and maintain it correctly.**

Wayfarer Sailors Have Narrow Escape

Narrative

Two Wayfarer class sailing dinghies were crossing the Solent, close-hauled in a fresh breeze and good visibility. The boats were sailing abeam of each other about 150m apart on a parallel course.

The crew of the windward Wayfarer saw a powerboat cross close in front of their leeward companion before continuing towards them and hitting them amidships with great force. The dinghy was almost cut in two and dismasted. The helmsman sustained head injuries from the impact and was thrown into the water. The crew, who was sitting further forward, passed underneath the powerboat and fortunately was missed by the propellers. He then had to disentangle himself from rigging and wreckage to reach the surface, from where he and his helmsman were recovered by the powerboat.

The semi-submerged dinghy was taken in tow by the powerboat and they started to make slow progress towards a harbour. However, the dinghy helmsman began to go into shock, and medical assistance was sought. He was transferred to an ambulance via a RIB, and was taken to hospital where he received treatment for concussion and shock.

Photograph courtesy of Steve O'Toole

Vessel being recovered

The Lessons

1. In the busy waters of the Solent, close-quarters situations between small craft are not uncommon, but catastrophic collisions are thankfully rare. The importance of keeping a proper lookout is obvious, but particularly so when navigating a large powerboat at high speed.

2. The powerboat was being operated single-handedly and was being steered from the interior steering position. The boat was of a semi-displacement design which tends to be fairly 'bow-up' when travelling at speed. Forward visibility can therefore be restricted by the boat's attitude. Such an accident is inevitable if no-one can see clearly ahead.

3. Although not the give-way vessel, had the crew of the Wayfarer been aware of the approaching powerboat, they could have made an emergency alteration to avoid/minimize the collision. The fact that the powerboat might have been obscured by the other Wayfarer, meant that the dinghy that was hit had very little time to take avoiding action. Additionally, vision to leeward would inevitably have been restricted by the sails, so the importance of frequently glancing under the boom is clear.

Great Fun Until it all Goes Wrong

Narrative

A new model of a 7m long, stepped deep V hull powerboat had been acquired by a leisure craft sales office. The outboard engine had a maximum power rating of 225kW (300hp), and had been supplied with a mid-range 21.5" pitch propeller. Meanwhile, the manufacturer of the powerboat had decided that an 18.5" propeller would give better performance, so had dispatched one to the sales office.

On receiving the replacement propeller, the manager tasked his contractor, an experienced powerboat driver, to fit the new propeller and to take the powerboat for a sea trial and find out how it performed at maximum speed. After fitting the new propeller, the contractor cast off and, while leaving the marina, pumped the bilges using the electric pump. The contractor took along with him a friend, as a passenger, having been granted the manager's permission to do so. There were two lifejackets in the forward cabin, but the contractor and his friend did not put them on, and they did not carry a VHF radio.

The contractor, who had the engine kill cord attached to him, made several straight runs at high speed with the engine trimmed out. At the end of the runs, he made wide turns at reduced speed and with the engine trimmed in. Before heading back to the marina, on the approach to the last turn, the contractor reduced speed by 25% and trimmed the engine in. He then made an "aggressive" turn to starboard, but the powerboat unexpectedly rolled to port and capsized.

The contractor and his friend were unhurt and managed to cling onto the upturned hull and wave to attract attention. Onlookers ashore saw them, and called the RNLI lifeboat service and the coastguard. Two passing jet skiers recovered the two men from the water and they were taken back to the marina. The upturned hull was returned to the beach, where it was recovered.

The Lessons

1. **The contractor was an experienced powerboat driver and had made "aggressive" turns before, although not with the same hull and propulsion unit configuration. Stepped hull powerboats have different handling characteristics to those associated with straightforward deep V hulls. The contractor was caught out by the configuration on this occasion; make sure you are not! If the boat configuration is new to you, seek professional advice before taking the boat through its paces.**

2. **Companies engaged in the sale of powerboats have a duty of care to their employees, contractors and customers. They should carry out risk assessments and implement appropriate and robust safety control measures. Particular attention should be paid to recognised driver training, the carriage of a VHF radio and the wearing of lifejackets.**

3. **The manufacturer's *Owner's Manual* gave advice that owners should receive appropriate training and that they should slow down when going into turns. This manual should also provide clear and specific safe handling advice for the particular class of powerboat, highlighting the real danger of capsize if such advice is not followed.**

Safety Briefing Saves the Day

Narrative

A 5-day motor cruiser hire on a calm inland waterway was a real treat for a couple and their 2 boys, especially so as one of the boys was disabled. It was going to be a great break, a chance to do a little fishing and, well, just to take it easy. However, a very unpleasant surprise was just around the corner.

The father was very safety conscious and made sure that the group paid attention to the safety briefing given by the hire company. They also paid close attention to the accompanying video, which provided advice on conning the vessel, its safety features and emergency actions. Not content with this introduction, the father insisted on being shown each of the cruiser's safety features.

Now fully prepared, the group left the berth to start their holiday. All went well for the first 2 days, and the experience certainly met the group's expectations. On the third day, the cruiser was brought alongside so that the group could buy provisions. A couple of hours later, at about 1815, the cruiser once again left the berth and headed out to the open water at about 5 knots.

A short time later, the disabled boy went to the bathroom which was located off the lounge, on the main deck, where the engine access hatch was also positioned. The other three members of the group were on the flying bridge. It was at this time that the father heard an extinguisher discharging. He looked through the glass access from the bridge to the lounge and saw the lounge rapidly filling with thick black smoke which was emanating from the engine compartment hatch. He tried to stop the engine from the bridge, but was unsuccessful.

The father, conscious that the disabled boy was in the bathroom, immediately went down into the lounge and found the engine emergency stop. He knew where it was located because he had been shown it during the safety briefing. He pulled it and stopped the engine because he wanted to prevent the chance of diesel fuel supplying the fire, which was clearly in the engine compartment.

The father then managed to take the disabled boy to the bridge so that he could be in fresh air. He instructed the family to go to the stern, to put them as far from the fire as possible. The father then went back to the lounge, where the smoke levels had reduced slightly.

He gathered a foam extinguisher, carefully lifted the engine hatch and discharged the extinguisher into the compartment. Having done as much as he could to fight the fire, the father alerted the emergency services. He then went to the stern of the cruiser to join the rest of his family, and instructed them to put on as much clothing as possible and to don their lifejackets. He checked that they were fitted correctly and instructed them that the group should stay together if they had to abandon the vessel.

While waiting for the emergency services to arrive, the father heard the lounge deck cracking and assumed that the fire had re-ignited. The engine then restarted, and the cruiser slowly headed towards the bank. After about 5 minutes, the engine stopped, by which time the cruiser was close to the bank. Conscious that it may be necessary to abandon the cruiser, the father decided to jump into the water to test the depth and so enable him to make a decision on the best way to take his family to safety. Fortunately, he found that he was able to walk in the water.

The emergency services arrived and took the group off the cruiser. The vessel was then taken under tow to a nearby jetty, where it was met by the local Fire and Rescue Services, who extinguished the fire.

The Lessons

This case illustrates the importance of thorough safety briefings, and the need to pay careful attention to them. The father of the group was especially safety conscious and had prepared himself well for an emergency situation. All too often, those enjoying boating on benign waters do not consider themselves as susceptible to emergencies as those on open waters.

The father thought his way through the situation, and even if it had become necessary to abandon the cruiser, he had a plan which the entire group understood. This ensured the best chance of survival.

The subsequent investigation found that the most likely cause of the accident was an electrical short as the cable exited a metal conduit. The engine re-started when the insulation burnt through on the start electrics, which connected the start circuits. The engine subsequently stopped as the fuel pipes failed.

The following lessons emerged from this accident:

1. **Make sure everyone pays attention to the safety briefing – it could save your life and others.**
2. **Know where the lifejackets are stowed, and where the emergency stops and fire extinguishers are located.**
3. **Keep calm – it helps you to think more clearly, and others around you will have confidence in your actions.**
4. **Take people to a point of safety away from the fire.**
5. **Don lifejackets and be prepared to abandon the vessel.**
6. **Be very careful when opening hatches/doors where there has been a fire; the sudden inrush of oxygen can cause re-ignition, with fatal results.**
7. **Check that electric circuits are in good condition and that fuel pipes are free from chaffing.**
8. **Attend to fuel leaks promptly.**