MAIB
MARINE ACCIDENT INVESTIGATION BRANCH

ACCIDENT REPORT

SERIOUS MARINE CASUALTY | REPORT NO 6/2018 | APRIL 2018

Collision between two Formula 4 powerboats resulting in serious injury to one driver at Stewartby Lake on 2 July 2017

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SUMMARY

On 2 July 2017, two Formula 4 (F4) powerboats (*Boat 22* and *Boat 43*) **(Figure 1)** collided at full speed while rounding a marker buoy during a world championship race at Stewartby Lake, Bedfordshire. *Boat 43* flipped over and its driver, unable to free himself from its flooded cockpit, lost consciousness and stopped breathing. The driver was released from the cockpit within about 5 minutes and was revived by the medical team on board one of the race circuit's safety boats. He was taken to hospital for treatment and subsequently made a full recovery. *Boat 22* suffered hull damage and started to flood, but its driver was rescued unhurt.

The collision occurred because *Boat 22* veered suddenly and without warning into the path of *Boat 43* and the drivers had no time to react. The drag caused by the loss of a panel from *Boat 22*'s port hull was identified as the most likely cause of the powerboat's unexpected change of direction. *Boat 43*'s driver almost drowned because he was unable to free himself, or be extracted from the cockpit, before his emergency air supply ran out.

During the early stages of the investigation, the Chief Inspector of Marine Accidents wrote to the Royal Yachting Association (RYA) and issued a recommendation aimed at improving driver safety. In response, the RYA submitted a number of proposed rule changes to the Union Internationale Motonautique (UIM), which were accepted.

A recommendation has been made to the RYA to review the escape protocols taught by its approved driver immersion test centres in light of the safety lessons identified in this report.

Photographs courtesy of Union Internale Motonautigue (UIM)

Figure 1: F4 Powerboats – *Boat 22* and *Boat 43*

FACTUAL INFORMATION

Background

The accident occurred during the final F4 race of a 2-day international powerboat race meeting organised by the Nottingham Powerboat Racing Club at Stewartby Lake. The event was controlled by an RYA approved officer of the day (OOD) and overseen by a UIM commissioner. The RYA was the national authority for powerboat racing in the UK and the UIM was the international governing body for all classes of the sport.

The race rules, boat design criteria and safety requirements for international F4 powerboat circuit racing events were set out in the UIM's 394-page *Circuit Rules 2017* book. The UIM also provided a rule book for offshore powerboat racing.

The 2-day race meeting started on the morning of 1 July 2017 with a series of practice sessions. The first F4 World Championship race took place during the afternoon.

On the afternoon of 2 July, the environmental conditions were within the limits set for F4 racing; there was a gentle north-westerly breeze and the lake was calm with small ripples on the surface. The F4 powerboat course followed a 1.43km route around five sets of marker buoys **(Figure 2)**.

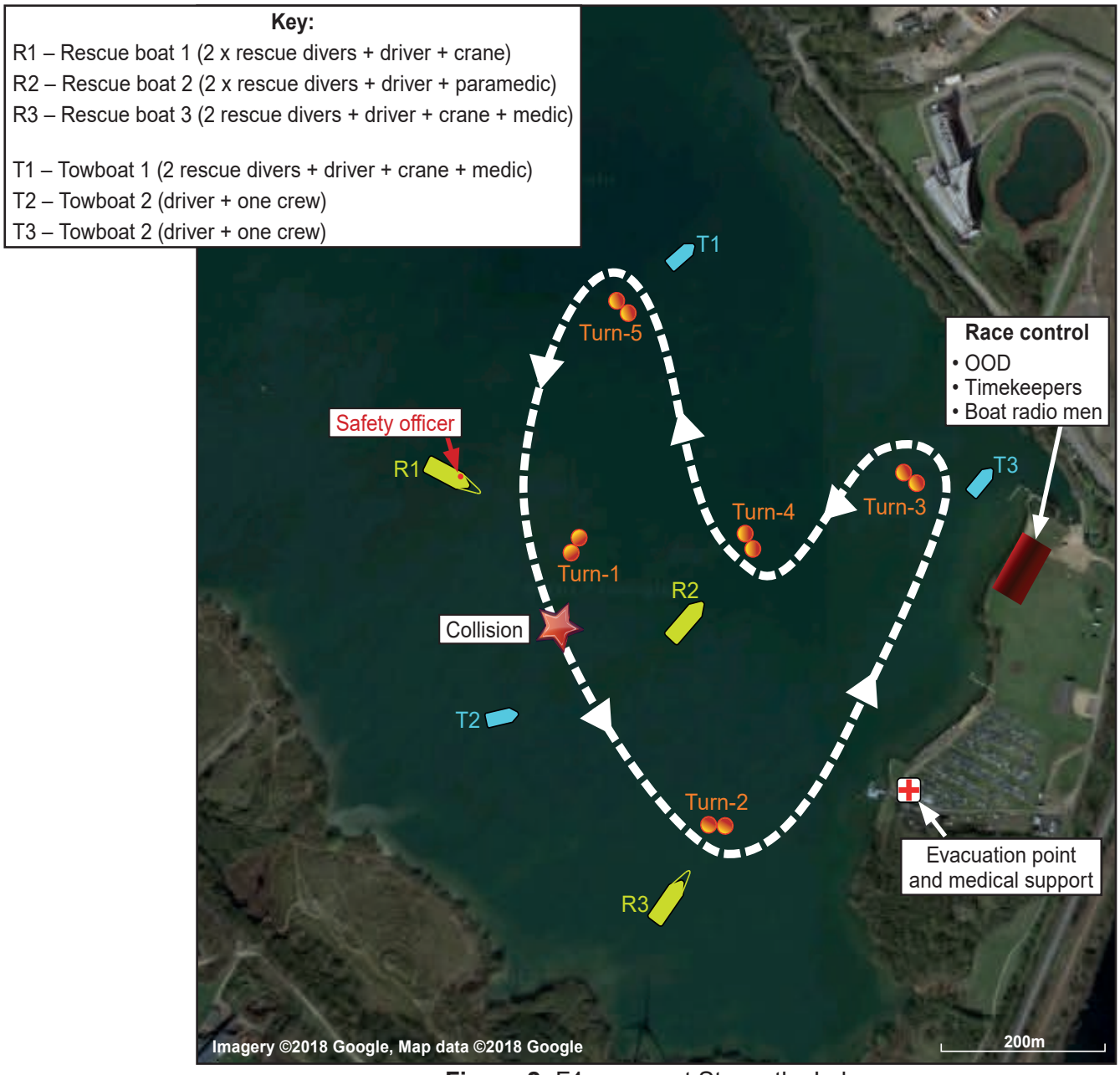

Figure 2: F4 course at Stewartby Lake

Narrative

At 1658[1] on 2 July 2017, after two restarts for minor rule infringements, 15 powerboats commenced the second and final F4 race of the weekend. Mid-way through the race, one of the powerboats hit a circuit marker buoy and the OOD raised a yellow flag[2]. The drivers slowed down and ceased racing while the incident was investigated and dealt with. Once the course was reported clear, the OOD raised a green flag and drivers recommenced racing.

Shortly after the restart, at about 1709, *Boat 22* rounded Turn-1 on the outside and just ahead of *Boat 43* **(Figure 3)**. As *Boat 22* began to straighten and head toward Turn-2 it suddenly veered violently to port and into the path of *Boat 43*. Travelling at a speed of 100km/h (62mph), *Boat 43* collided head-on with *Boat 22*'s port hull **(Figure 4)**. The force of the impact caused *Boat 43* to flip into the air, roll to starboard and capsize. *Boat 22* remained upright but its port hull was holed and it began to sink. The OOD saw that an incident had occurred, raised a yellow flag and despatched the safety boats to the scene.

Figure 3: Picture from *Boat 43* onboard camera having just rounded Turn-5 with Turn-1 buoys visible

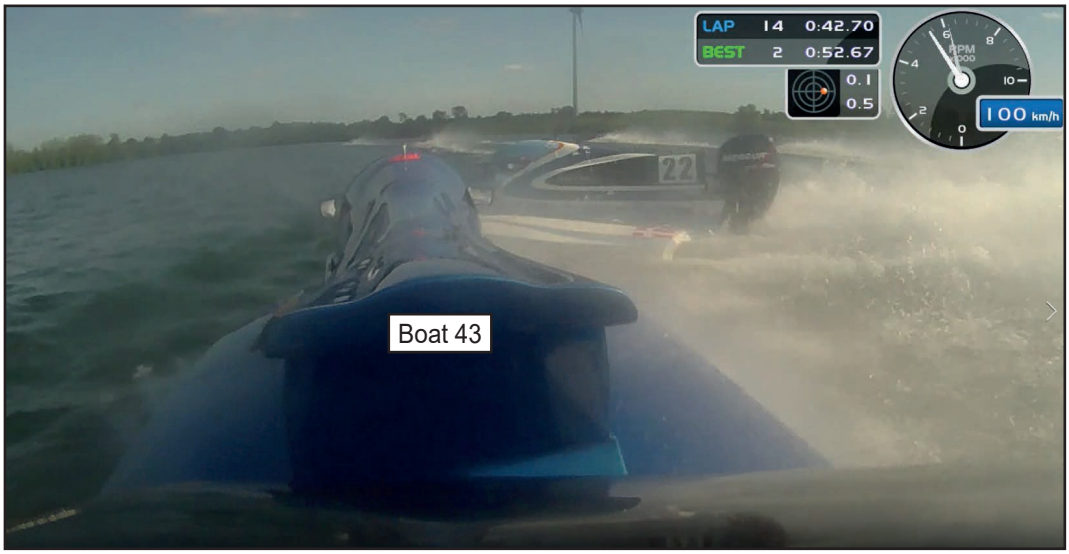

Figure 4: Picture of *Boat 43* and *Boat 22* immediately prior to collision

[1] British standard time (UTC+1)

[2] Red flag – race terminated; boats to return to holding area and await instructions: Yellow flag – danger on circuit, slow down and no overtaking: Green flag – race commenced/recommenced.

Boat 43's cockpit flooded almost immediately and its driver, who was upside-down and in considerable pain, held his breath and tried to release his seat harness. He located the harness buckle, but was unable to release it. Unable to hold his breath any longer, he grabbed the mouthpiece attached to his emergency air supply cylinder and started to breathe from it. He then attempted to cut himself free from his harness.

Within 40 seconds of the collision, two safety boats were at the scene and rescue divers were in the water **(Figure 5)**. When the rescue divers looked through *Boat 43*'s canopy they saw its driver strapped in his seat and breathing from his emergency air supply. One of the rescue divers, positioned close to the bow, tried unsuccessfully to open the canopy using its main release handle. He then attempted to jettison the canopy but could not pull out its emergency release hinge pin.

Image courtesy of Brian Scott

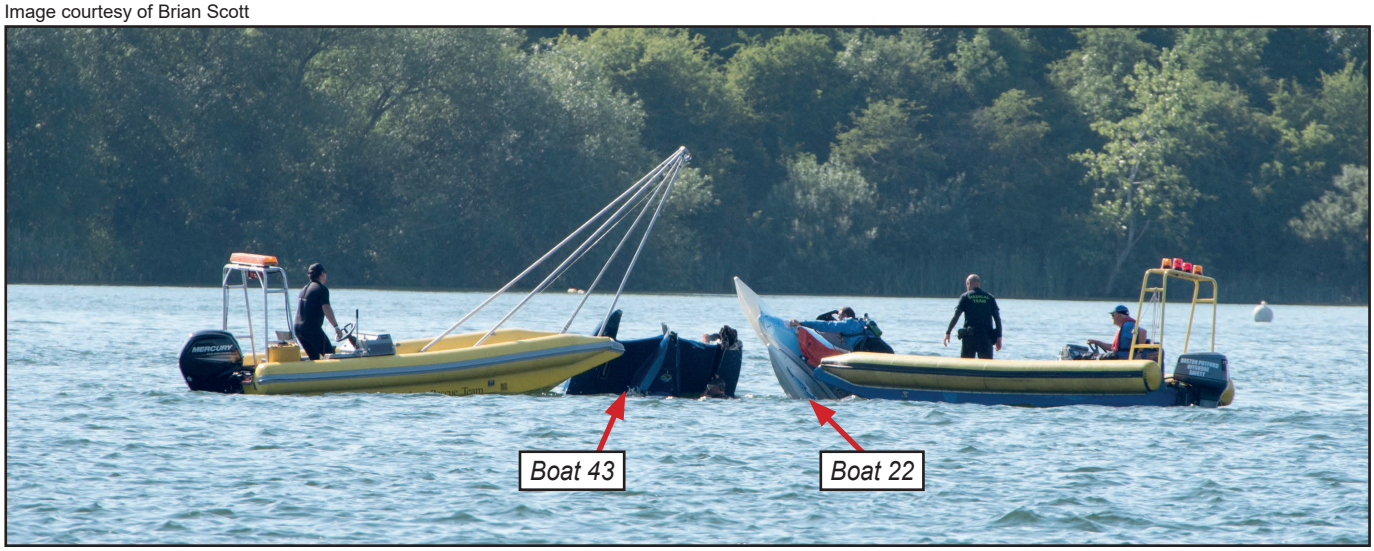

Figure 5: Rescue boats arrive at the scene of the accident

As the first rescue diver continued to struggle with the canopy emergency release hinge pin, a second diver, positioned towards the stern of the boat, managed to open the canopy using the main handle. Once the canopy was open the driver indicated that there was a problem with his seat harness release buckle. The second rescue diver then reached into the cockpit and attempted to remove the steering wheel and release the driver's harness buckle. Unable to do either, the rescue divers started to cut through the driver's harness straps. While this was taking place, the driver ran out of air and lost consciousness.

On the surface, *Boat 22*'s driver was helped from his cockpit without incident or delay by one of the rescue boat crew. The crew of another rescue boat connected the crane hook to one of *Boat 43*'s bow lifting points and started to hoist its cockpit clear of the water. The OOD, realising that the rescue effort was ongoing, shortened the course to divert the other competitors away from the scene of the accident.

Once *Boat 43* was vertical, with its cockpit clear of the water, the rescue divers located and released the driver's seat harness buckle. About 5 minutes after the collision, the rescue boat crew pulled the unconscious driver into their boat **(Figure 6)**; he was not breathing and his airway was full of water.

The rescue boat coxswain reported a potential cardiac arrest situation on his radio and headed at speed towards the emergency evacuation point. On board, the rescue team paramedic and another team member commenced CPR[3]. Once the first set of chest compressions was complete, they rolled the driver on to his side and cleared his airway. As they did so, the driver started to breathe unassisted and was put on oxygen. On arrival at the slipway, the injured driver was transferred to an ambulance, where he regained consciousness and was taken to hospital.

[3] CPR – cardio-pulmonary resuscitation.

Image courtesy of Brian Scott

Figure 6: *Boat 43*'s driver being pulled into a rescue boat

The race continued under the yellow flag, at reduced speed. After one lap, the OOD diverted the remaining competitors to proceed directly from Turn-5 to Turn-2 to avoid the scene of the accident. Once the required number of laps had been completed the OOD then finished the race.

Hospital doctors diagnosed that *Boat 43*'s driver had suffered concussion and a cardiac arrest induced by drowning. He was discharged from hospital after 4 days and suffered no apparent long-term effects.

The powerboat drivers

Boat 43's driver was a 47-year-old UK national. He had started racing powerboats in 1980, owned his own race team, and had won many national and international titles in various boat classes. His 17-year-old son raced for his team and was also participating in the F4 world championship races at the Stewartby Lake event. The driver of *Boat 22* was a 26-year-old Danish national. He had been racing powerboats for 2 years at world championship level.

The drivers of *Boat 22* and *Boat 43* both held international powerboat racing licences issued by their national authorities and were in-date for their UIM medicals and immersion escape tests. During the race, they wore race helmets with forward head restraint (FHR) collars, fire retardant overalls, buoyant cell suits[4] and gloves. They also carried knives for cutting through their seat harness straps in an emergency. All drivers were required to sign indemnity forms that stated they accepted responsibility for their own safety[5] and that their boats complied with UIM race rules.

Formula 4 powerboats

The F4 powerboats were highly manoeuvrable, 3.9m long, lightweight, composite fibre, tunnel hulled catamarans. They were powered by factory standard 60hp, 4-stroke, Mercury outboard engines and could achieve speeds of up to 113km/h (70mph). *Boat 43* was manufactured in Italy by Baba Racing Boats and *Boat 22* was manufactured in Denmark by Molgaard Racing.

[4] A cell suit is a flotation overall that can be worn by drivers in lieu of a lifejacket.

[5] According to the indemnity form the drivers accepted responsibility for: *exposing themselves to such inherent risk, including risks to their person, their property, drowning, hypothermia, collision injuries, burns and other physical injuries as well as possible death.*

UIM circuit rules required F4 boats to be built with several safety features designed to protect the driver in the event of an accident **(Figure 7)**. The drivers had to be seated within an enclosed cockpit that was encased within a safety cell built to withstand an impact of 3000N[6]. Deformable hull and nose cones were required at the bow to help absorb the shock of impact without compromising watertight integrity. Additionally, if flooded or capsized, the hull had to remain afloat with its nose up. This was to allow rescue teams to attach either a flotation bag or crane hook to the boat's bow and lift its cockpit and driver clear of the water.

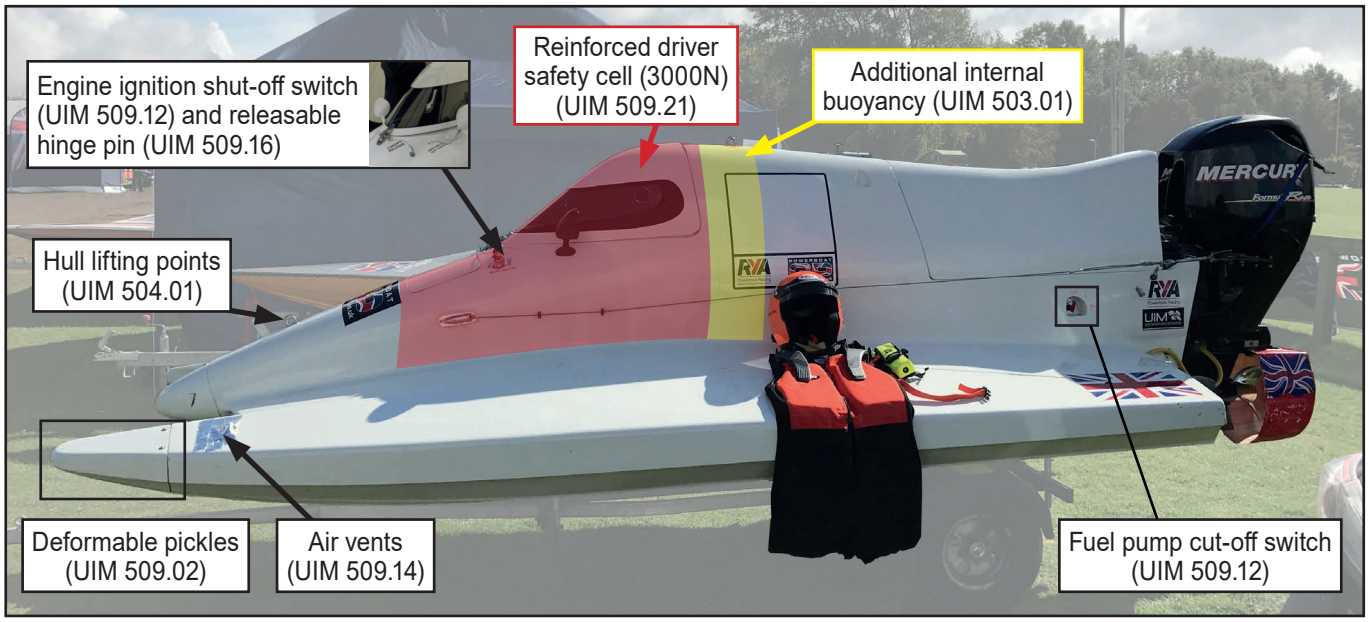

Figure 7: Overview of F4 powerboat safety features

Other safety features required by the UIM circuit rules included:

- Access to the cockpit via a canopy release handle and a removable hinge pin (both of which needed to be operable internally and externally).
- A removable steering wheel.
- A six-point safety harness fitted with a lever operated quick release buckle.
- The provision of an emergency air supply.

Boat 43's cockpit canopy was fitted with a main release handle for opening the canopy, and a removable hinge pin to jettison it in an emergency. Pull wires were attached to the hinge pin **(Figure 8)** to allow it to be withdrawn by rescuers outside the cockpit and by the driver within.

The emergency air supply allowed the driver to breath while escaping from an immersed cockpit. The UIM rules for offshore racing required a minimum air duration of 10 minutes; a minimum duration for circuit racing had not been set. *Boat 43*'s driver had a 0.7 litre portable air cylinder **(Figure 9)** that he had attached to the bottom of his seat. His son's boat was fitted with a 1.5 litre air cylinder that was connected to his racing helmet and released air automatically when the helmet was immersed in water. *Boat 22* was equipped with a portable 1.5 litre air cylinder. All three air cylinders were charged to about 170bar. The design working pressure of *Boat 43*'s air cylinder was 232bar (this was stamped on the neck of the cylinder).

[6] 3000N equated to the force generated by two F4 powerboats colliding head on at approximately 60mph.

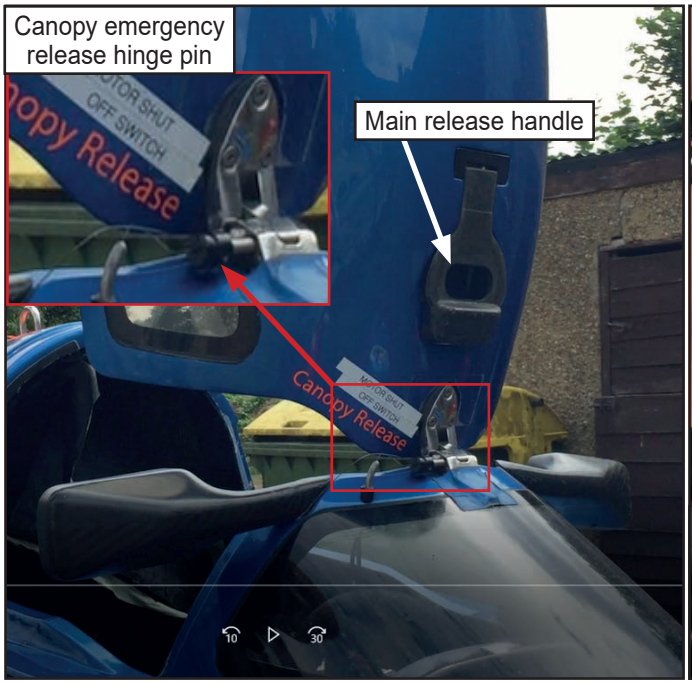

Figure 8: Boat 43's main canopy handle and hinge pin

Figure 9: Boat 43's air cylinder with (inset) close-up of the air bottle gauge

Figure 10: Boat 43 driver's harness with (inset) close-up of harness release and cable tie

Post-accident inspection of *Boat 43* and *Boat 22*

Boat 43 and *Boat 22* were both inspected out of the water at Stewartby Lake after the accident. The hulls of both powerboats were severely damaged and were later returned to their respective manufacturers for repair.

During the inspection of *Boat 43* the following observations were made:

- The driver's six-point harness buckle **(Figure 10)** was undamaged and could be operated normally.
- The driver had attempted to cut through a harness seam where the strap was of double thickness and heavily stitched.

- The canopy could be opened from both inside and outside the cockpit using the main handle.
- The canopy emergency release pin was a tight fit within the hinge and it required force to pull it out.
- The rim of the steering wheel was deformed, but it could still be removed as intended.
- The driver's carbon fibre seat was cracked; but,
- The cockpit safety cell remained intact.

It was noted that a cable tie had been fitted to the harness buckle's release lever **(Figure 10 inset)**. This was a modification made by many drivers to make it easier to locate and pull the lever with a gloved hand.

Further investigation into the cause of the tight-fitting canopy hinge pin revealed that the driver had previously replaced the boat builder's metric-sized hinge with an imperial-sized spare but had retained the original release pin.

Boat 22's safety cell remained intact and its steering system was found to be functioning correctly during post-accident tests. Close inspection of the port hull identified that a small outer panel from the bottom of the boat, adjacent to the impact area, was missing. This panel **(Figure 11)** was later recovered from the water; it showed no sign of lateral impact.

Figure 11: *Boat 22* showing impact damage to port side and detached hull section

Race management and emergency response requirements

The OOD was responsible for the overall management of the race meeting and was supported by a safety officer and team of race scrutineers. The safety officer was responsible for co-ordinating the response to emergency situations on the water, and the race scrutineers were responsible for verifying the F4 powerboats' and drivers' compliance with the UIM circuit racing rules.

The safety officer was embarked in one of the circuit's six rescue boats **(Figure 2)** and had direct radio contact with the OOD, afloat rescue teams and medical teams ashore. Three of the six rescue boats were primarily tasked with rescuing the drivers, and each was crewed by a boat coxswain and two rescue divers, one of whom was an emergency medical technician. In addition, two of the boats were equipped with a lifting crane and one carried a paramedic. The remaining three boats were primarily manned and equipped to tow damaged vessels to shore, but one carried two rescue divers.

The race scrutineers inspected each boat at the start of each racing day and boats identified by the OOD after each race. The scrutineers followed an inspection checklist that included key safety features such as seat harness release, canopy removal, steering wheel release and emergency air supply. The scrutineers typically required the drivers to demonstrate the operation of their boat's safety devices. *Boat 43* was inspected by two experienced RYA approved scrutineers at the start of each race day; no defects were recorded.

To ensure that all drivers received the OOD's instructions (flag signals etc), each boat had its own radio communications equipment and dedicated radioman. Whenever the OOD raised a yellow flag and blew a whistle during a race, the lead boat's radioman would stand next to the OOD and relay his orders to the lead driver to reduce the speed of the competitors. The UIM's circuit racing 'wet driver/man overboard rule', required the race to be stopped whenever a driver entered the water. On this occasion, in the absence of clear information, from the scene of the accident, the OOD allowed the race to continue under a yellow flag on a shortened course.

Driver immersion tests

F4 powerboat drivers were required to pass an annual immersion test at a UIM approved training centre. During the test, the drivers had to demonstrate that they could escape unaided from the immersed cockpit of an upturned boat using an onboard emergency air supply.

Boat 43's driver undertook his annual tests in the powerboat cockpit test rig **(Figure 12)** at Osprey Powerboat Rescue Team Ltd's (Osprey) training centre. Osprey was one of two UK training providers approved by the RYA to conduct the immersion escape tests.

To pass the immersion test, Osprey required each driver to complete three escapes: the first without using the onboard air supply; the second using the air supply; and the third wearing blackout goggles and using air supply. The escape protocol using the onboard air supply taught by Osprey was as follows:

- Strap into test rig cockpit seat.
- Hold breath as the test rig is tipped over.
- Start breathing from the emergency air supply and await the signal from safety diver to escape.
- Release and open the canopy (using the canopy handle).
- Remove the steering wheel.
- Release the FHR.
- Release the seat harness.
- Place hands on sides of canopy and forward roll out of the cockpit and swim to the surface.

The test protocol required the drivers to wear their full racing gear, which *Boat 43*'s driver did. However, online videos show that many who completed the training chose to wear swimming costumes rather than overalls and some did not wear gloves, shoes, their own helmets or FHRs.

Image courtesy of www.ospreyrescue.com

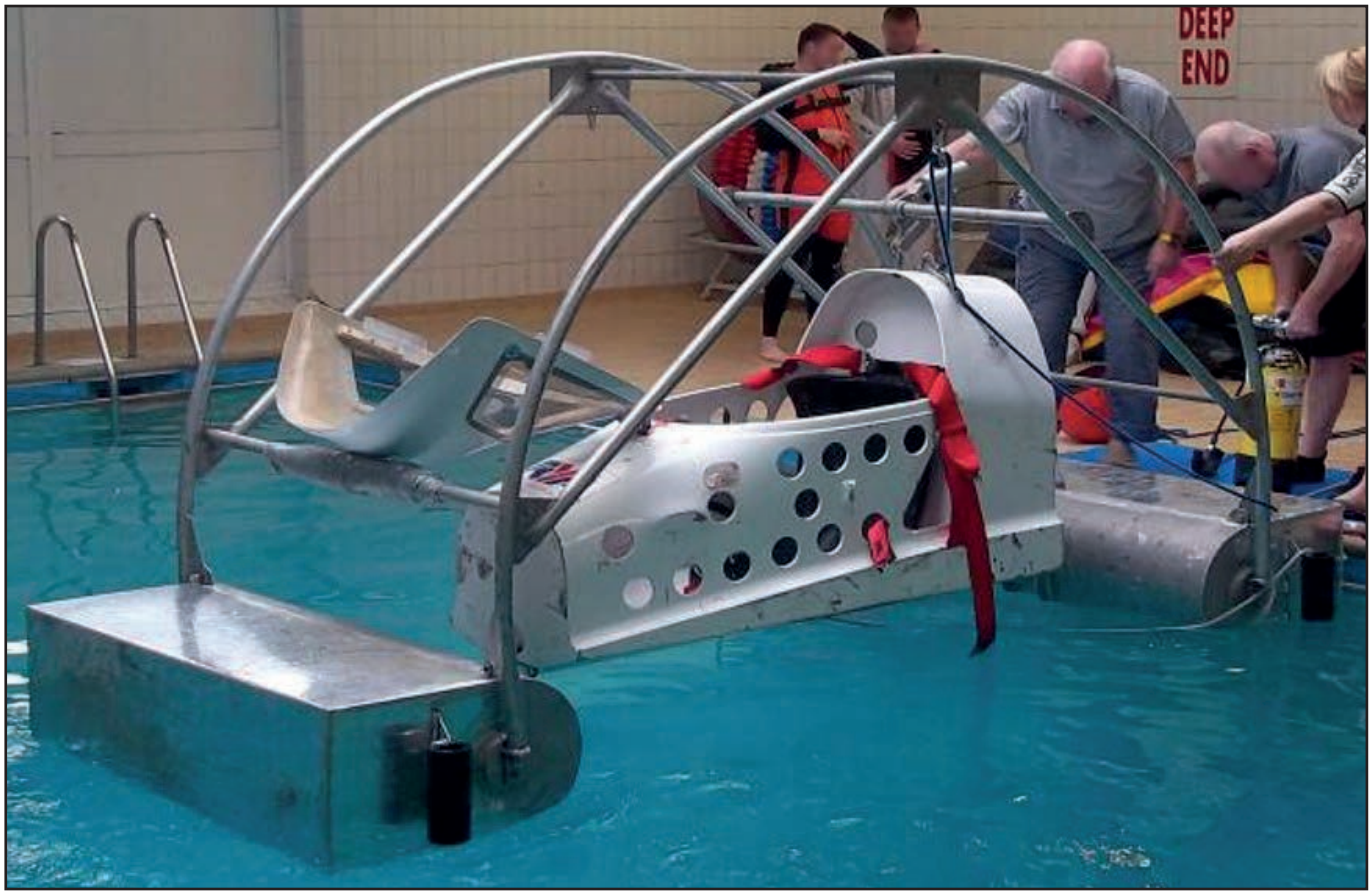

Figure 12: Osprey Powerboat Rescue Team's cockpit test rig for immersion training

Similar accidents

Like most of the competitors in the F4 race, *Boat 43*'s driver had experienced many high-speed collisions and been involved in several racing incidents that had resulted in capsize and the need to escape from an immersed cockpit. Within 4 weeks of being released from the hospital, he was involved in another high-speed collision at a European racing event, where he escaped unharmed.

All powerboat racing incidents and accidents should be reported to and investigated by the host country's National Authority for the sport. Accidents that have serious consequences for the drivers are reported to the MAIB by the RYA. Eight F4 accidents were reported to the RYA during the first 8 months of 2017; seven were collisions, with three resulting in one of the boats capsizing. Powerboat racing accidents investigated by the MAIB over the past 10 years include:

- On 19 June 2005, a 13-year-old boy suffered serious head injuries when the powerboat in which he was co-driver was struck by another during a K-200 class Junior Offshore National Championship race at Portland Harbour. The investigation found that the injured boy's boat had 'hooked' and come to a sudden and unexpected stop directly in the path of the following boat (MAIB report 13/2006[7]).

- On 8 August 2009, a co-driver suffered serious head injuries and died when the race boat he was travelling in hooked and was struck by another race boat during an Offshore Circuit Racing Class A national championships race in Dover Harbour (MAIB report 7/2010[8]).

[7] https://www.gov.uk/maib-reports/collision-between-2-powerboats-during-a-junior-racing-event-at-portland-harbour-england-resulting-in-1-person-injured

[8] https://www.gov.uk/maib-reports/collision-between-offshore-circuit-racing-powerboats-sleepwalker-and-harwich-2011-in-dover-harbour-england-with-loss-of-1-life

ANALYSIS

The collision

The collision occurred because *Boat 22* veered suddenly into the path of *Boat 43* and neither driver had time to react. *Boat 22* was not deliberately steered towards *Boat 43* and its steering control system did not fail. Footage captured by *Boat 43*'s engine-mounted video camera showed that *Boat 22* was crossing the wake of another boat just before it veered to port. The video footage also indicated that the hull panel recovered from the water after the accident came loose at the same time.

It was not possible to determine why the hull panel broke free; the two most likely reasons were contact with debris in the water or structural fatigue failure. Whatever the reason, the drag generated during the detachment was the most likely cause of *Boat 22*'s sudden change of direction. Thereafter, given the speed and proximity of *Boat 43,* the collision between the two powerboats was unavoidable.

Loss of directional control, high-speed collisions and airborne capsizes are far from unusual during powerboat races, and video footage of these types of accidents is often used as promotional material for the sport. Recent powerboat racing rule changes and boat design improvements have significantly increased the level of driver safety and reduced the number of driver and crew injuries and fatalities. However, this accident clearly illustrates the high level of residual danger associated with the sport and, despite the drivers' willingness to sign a disclaimer accepting the risk, this investigation has identified several actions that could be taken to further improve driver safety.

Entrapment of the driver

Boat 43's driver had been trained to, and had experience of, escaping unaided from the immersed cockpit of an upturned powerboat. Despite this, he almost drowned because he was unable to free himself from his seat harness, or be extracted from his cockpit by the rescue divers, before his emergency air supply ran out. The reasons for this include that the driver did not follow the escape protocol practised during annual immersion tests and that he was unable to release his harness buckle.

The driver's initial reaction following the crash was to hold his breath and attempt to release his seat harness. These actions were not in accordance with the recommended protocol of: start breathing from the emergency air supply; open the cockpit canopy; remove the steering wheel; release the FHR and seat harness and roll out of the cockpit. The driver's actions might have been influenced by the level of disorientation caused by the severity of the impact and an instinctive reaction to release himself from his seat. Equally, his judgment might have been influenced by the ease with which he had managed to escape without using his emergency air supply following similar capsizes, and during his annual immersion tests.

The driver's first action should have been to start breathing from his emergency air supply; this would have provided maximum time for him to orientate himself. His next actions should have been to clear his escape route by opening his canopy and removing his steering wheel. The driver was conscious when the rescue divers entered the water, therefore had he opened his canopy from within the cockpit before attempting to release his harness, the divers would have been able to extract him much sooner and possibly before he ran out of air.

Boat design and safety equipment

The main safety features built into the design of the F4 powerboats proved to be effective. *Boat 43*'s deformable nose cones absorbed a significant amount of the energy generated during the collision, the cockpit safety cells of both boats were intact and protected the drivers, and both boats remained afloat. *Boat 43*'s seat harness and its driver's FHR prevented serious impact related injuries and the

emergency air supply provided valuable extra life support. Nevertheless, several shortcomings relating to the operation, maintenance and capability of *Boat 43*'s safety equipment were identified during the investigation.

The reasons why the rescue divers had problems opening the canopy using its main handle and removing the boat's steering wheel are unclear as both functioned correctly during the post-accident inspections. However, when the divers experienced trouble opening the canopy, they should have been able to jettison it completely by simply pulling out its emergency release hinge pin. Unfortunately, this could not be done because the release pin had formed a tight fit within the canopy hinge. This situation arose when the driver replaced his boat's original metric-sized hinge with an imperial-sized spare and retained the original pin. Had the correct pin been used the canopy would have been quickly jettisoned, saving the rescue teams valuable time in gaining access to the injured driver.

The extraction was further delayed because the rescue divers, like the driver, were unable to locate the seat harness release buckle. The release buckle was probably concealed by the abdomen and cell suit of the upside-down driver, and access to it was made more difficult because the rescue divers were unable to remove the boat's steering wheel. The driver had anticipated the difficulty of locating the seat harness release buckle and, to mitigate it, he had fitted a cable tie to the buckle release lever and carried a knife for cutting through the harness straps. On this occasion, the addition of the cable tie did not help the driver or his rescuers locate the harness buckle release lever. Nevertheless, the fitting of a more substantial and visible marker or lanyard to the release lever might have addressed this.

The UIM rules did not require powerboat drivers to carry knives, but most of them did. On this occasion, the driver's attempt to cut himself free was unsuccessful for two reasons: first, he tried to cut through a double thickness, heavily stitched seam, and second, he had run out of air. With more time, the driver would have cut himself free. It would therefore be appropriate to include the carriage of a knife in the race rules. It would also be beneficial to provide instruction during the drivers' annual immersion tests on how to use the knife.

Emergency air supply

The UIM and RYA rules for powerboat circuit racing required each boat to carry an emergency air supply with fully charged gas cylinders but, unlike the rules for offshore racing, did not mandate a minimum duration. The offshore rule was supplemented by a table that charted the volume of air versus pressure and duration, to allow scrutineers to verify compliance.

In the absence of a clear requirement, it was evident that the F4 drivers were equipping their boats to differing standards. Interestingly, *Boat 43*'s driver had provided his 17-year-old son with a hi-tech emergency air supply system that had more than twice the capacity of his own. This demonstrated a high level of confidence, based on experience, in his own ability to self-rescue. This was supported by the fact that he did not charge his air cylinder to its full design pressure. Using an air consumption of 60 litres per minute set by UIM offshore racers, it is likely that *Boat 43*'s driver's air supply of 0.7 litre at 170bar would have lasted no longer than 2 minutes[9]. Had the bottle been fully charged, it would have provided an additional 40 seconds of air.

There is an obvious need for the sport's governing bodies to provide a clear standard and set a minimum duration for the emergency air supplies in their circuit racing rules. Had the offshore racing minimum duration of 10 minutes been applied to the F4 powerboats competing on Stewartby Lake, *Boat 43*'s driver would not have lost consciousness and would have escaped relatively unharmed.

[9] Note that the UIM offshore rules have increased the assumed air consumption from 30 to 60 litres per minute to allow for driver stress during an accident. A 0.7 litre air bottle at 170bar equates to 119 litres of air, providing a duration of 1 minute 59 seconds duration.

Emergency response, race management and the scrutineering process

The emergency response to the collision was swift and effective. Three rescue boats were at the scene of the accident and divers were in the water within 40 seconds, and the well-drilled response of the afloat rescue teams undoubtedly saved the life of *Boat 43*'s driver. However, the rescue divers were unable to extract the driver before he lost consciousness. As discussed previously in this report, this was because valuable time was lost gaining access to the cockpit and locating the driver's seat harness release buckle. The provision of a remote emergency air supply on board the rescue boats, or carried by the rescue divers for entrapped powerboat drivers, could provide vital additional time and should be considered as an additional safety measure in the future.

Following the accident, the OOD allowed the race to continue under a yellow flag. Because of this, several boats passed close to the scene of the accident before being re-routed away from Turn-1. The OOD's decision to continue the race was based on his interpretation of the 'wet driver/man overboard' rule, the information available to him, and the need for the boats to complete more laps to declare a race result. The UIM's 'wet driver/man overboard' rule was primarily put in place to prevent drivers being run down in the water, but stopping the race would also have protected the rescue divers and allowed the race officials and rescue boat crews to focus fully on the emergency response. On this occasion, the decision to continue racing did not adversely affect the rescue effort.

Boat 43 was inspected twice by two experienced race scrutineers prior to the accident, but the tight-fitting canopy hinge pin and the undercharged emergency air supply cylinder were not identified as deficiencies or defects. It is unclear why the hinge pin issue was not identified during the process; either the operation of the release pin was not tested, or the scrutineers and powerboat driver did not fully appreciate the potential consequences of the tight fit. It was more understandable why concerns were not raised about the emergency air supply. The scrutineers had no guidance to follow and the cylinder pressure gauge was difficult to read with no obvious indication of the cylinder's maximum working pressure. The duration of a gas bottle is a function of its volume and pressure. The inclusion of a table, similar to the one in the offshore rules, would have allowed the pre-race verification process to confirm compliance. Such a change would remove the temptation for drivers to compromise their safety by fitting smaller, lighter air bottles.

CONCLUSIONS

- A structural failure to *Boat 22*'s port hull probably caused it to turn into the path of *Boat 43*. Thereafter, the proximity and speed of the boats meant that the collision between them was unavoidable.

- *Boat 43*'s driver almost drowned because he was unable to escape or be extracted from his flooded cockpit before his air supply ran out.

- The injured driver did not follow the correct escape procedure. This might have increased the likelihood of his entrapment.

- An incorrectly sized emergency release hinge pin prevented the canopy from being jettisoned, and cost the rescue divers valuable time gaining access to the injured driver.

- The rescue divers had difficulty locating the seat harness release buckle because it was obscured by the driver's body and cell suit.

- The carriage of a suitable knife for cutting the driver's harness in an emergency is a sensible precaution.

- The F4 powerboats' cockpit safety cells and deformable bow cones, and the driver's safety harness and forward head restraints, provided critical protection to both drivers.

- *Boat 43*'s driver's emergency air supply cylinder was not charged to its full design pressure. Had it been, he might have escaped or been rescued before he lost consciousness. Had the F4 powerboat carried a 10-minute duration air supply, as required for offshore powerboats, the driver would have escaped unharmed.

- The tight-fitting canopy release pin and undercharged emergency air supply should have been identified and action taken during the pre-race scrutineering process.

- The race should have been stopped by the OOD raising a red flag following the collision, but in the absence of information from the scene of the accident, the decision to continue at slow speed, under a yellow flag, did not adversely affect the rescue effort.

- *Boat 43'*s driver survived the accident because of the swift, well-drilled response of the afloat rescue teams.

ACTIONS TAKEN

The **Chief Inspector of Marine Accidents** has:

Written to the **Royal Yachting Association** highlighting the MAIB's early findings and recommending that the association:

> *Submit proposals to the Union Internationale Motonautique and the national governing bodies for powerboat racing aimed at addressing the immediate safety issues identified during the MAIB's initial investigation. In particular, the need to stipulate a minimum duration for emergency air supplies and ensure the effective operation of safety devices is demonstrated during the race scrutineering process.*

The **Royal Yachting Association** has proposed a number of circuit rule changes to the UIM:

- To require the wearing of FHR during immersion training;
- Mandate a minimum onboard air supply of 400 litres, carried in bottles that are at least 2 litre capacity, with sufficient hose to allow the driver to move clear of the hull during the escape.

The UIM has accepted these proposals and they will be included in the Circuit Rules 2018.

Additionally, the **Royal Yachting Association** has:

- Commenced a review of the training and certification of race officials.

RECOMMENDATIONS

The **Royal Yachting Association** is recommended to:

2018/113 Review the escape protocols taught by its approved driver immersion test centres to ensure they are in accordance with UIM guidance and include lessons learnt from this accident, such as the importance of the emergency air supply, access to harness release buckles and the carriage and use of a rescue knife.

SHIP PARTICULARS		
Vessel's name	*Boat 43*	*Boat 22*
Flag	UK	Denmark
IMO number/race numbers	Not applicable	Not applicable
Type	Leisure	Leisure
Year of build	2015	2017
Construction	Composite fibre	Composite fibre
Length overall	3.90m	3.90m
Registered length	3.90m	3.90m
Gross tonnage	350Kg	350Kg
Minimum safe manning	One	One
VOYAGE PARTICULARS		
Port of departure	Stewartby Lake, UK	
Port of arrival	Stewartby Lake, UK	
Manning	One	One
MARINE CASUALTY INFORMATION		
Date and time	2 July 2017 at 1709 (BST)	
Type of marine casualty or incident	Serious Marine Casualty	
Location of incident	Stewartby Lake, UK	
Place on board	Cockpit	
Injuries/fatalities	Serious injury	No injury
Damage or environmental Impact	Vessel incapacitated	
Ship operation	Racing	
External & internal environment	Wind: North-west force 2-3, sea state 1, visibility-good	
Persons onboard	One	One