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Disorientation in Helicopter Ditching and Rigid Inflatable Boat Capsizement: Training is Essential to Save Crews

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Summary

This paper discusses the disorientation problems of escape from a rigid inflatable boat (RIB) that has been capsized. It makes comparisons with executing a ditched helicopter underwater escape and emphasizes the need for realistic training for both RIB and helicopter crafts. Although very poor records are collected on RIB capsizements, each year there is a small but significant loss of life and many close calls. A paper at the Royal Institute of Naval Architects in 1998, reported 13 deaths from an accident involving the Sea Gem in 1965, but gave no further details (Reference 5). The Transportation Safety Board of Canada reported the case of the G.R.1 FRC (Reference 3) launched from the Gordon Reid off British Columbia, which grounded and flung the three occupants over the rocks and back into the water. Miraculously, all three survived. Rigid inflatable boats or fast rescue crafts (FRC) are used by every Navy in the world, as well as many other paramilitary and commercial marine organizations. In 1998, it was reported that the US Coast Guard alone operated over 700 FRCs (Reference 5). To date, no one has examined the problem of escape from such a vessel after it has been capsized, although Oakley has examined the pros and cons of wearing head protection while operating small, fast boats (Reference 2). This paper discusses a recent experiment conducted by Survival Systems to examine the problems of underwater escape from a capsized FRC.

Introduction

The greatest danger faced by crew and passengers in a fast rescue craft (FRC), otherwise known as a rigid inflatable boat (RIB), is capsizing and death from drowning. However, very poor statistics are kept on such incidents. FRCs are used around the world by military and commercial marine operators. There is anecdotal evidence that accidents are occurring, but specific details into the cause or reliable record keeping does not seem to exist. Why this is so is unclear, but it is postulated that FRC operations occupy a somewhat orphan position in marine operations. Unless a death or collision occurs with a marine vessel, or the national Coast Guard is involved, then the incident is not recorded or analyzed as a statistic. It simply is placed in a commercial company or naval safety record after local investigation.

In the event of a sudden capsizement, the crew and passengers are hurled around the FRC. The most likely scenario is that the weather will be cold and miserable, and the crew will be taken by surprise. Thus, no one will have taken a good handhold or may, for instance, be in the process of attempting to drag a victim into the FRC, and therefore have no handhold at all, and the coxswain may be concentrating on a complex maneuver to hold the boat steady, (Reference 1) or a complex geophysical survey (Reference 8). Therefore, people are likely to be physically injured by contact with parts of the FRC and will most certainly be disoriented from inversion and submersion. Sudden immersion in cold water will also produce an

uncontrollable gasp reflex even if a good protective suit is worn. At present, with no training in inversion and immersion, only diving skills, comfort underwater and some luck will prevent someone from drowning.

A classic example of such a tragic accident was the loss of the FRC No. 244 from the CCGS Sir Wilfred Grenfell in October 1989 where all crew perished during the process of attempting to rescue one body surfer at Middle Cove, Newfoundland (Reference 4). Capsize of FRCs is not particularly a rare event in Canada. Records from the Transportation Safety Board of Canada from 1975 to 2000 revealed three additional incidents. In August 1995, a Survival Systems Limited Class 3 FRC capsized in very rough seas at the Halifax Harbour entrance; the five people on board were thrown overboard, rescued, hospitalized, and later released. The coxswain suffered serious injuries to the face, having been hit by the steering wheel and console in the overturn. In March 1998, a Class 2 FRC was involved in whale watching off Vancouver Island; it heeled sharply and spilled four persons into the water, only two people survived this accident. In May 2000, the Class 5 FRC from OSV Hebron Sea capsized off the Sable Island gas field, Nova Scotia; both crewmembers were rescued and med-evacuated to Halifax where they both survived. Finally, a newspaper reported in October 2000, that seven Canadian sailors from HMCS Charlottetown were rescued when their rigid-hulled inflatable boat capsized off Norfolk, Virginia (Reference 6).

To combat this problem, the manufacturers of FRCs have fitted CO₂ inflated self-righting bags activated from the transom. The objective is for the survivors to float up into the air pocket that is theoretically created by the inverted FRC, take a breath, make their way to the stern and activate the self-righting bags. However, the chance of a disoriented survivor making his/her way to the stern and operating the inflation toggle is not as easy in practice as it sounds in theory. Let us review some of the testimonies of people who have survived an FRC capsizement.

Righting systems do not always work!

The rest of the crew (I saw 3) drifted away from the FRC... After that, I banged on the FRC to see if any one might be trapped under the boat to which I got no reply. I then attempted to find and pull the self-righting mechanism. When I found the pull cord and pulled at first nothing happened. After I found the pull cord the second time I jerked it harder than the first time and all that happened was an air release from under the boat, which I presume was the inflation mechanism....Then I waited for the other FRC, which could be seen coming toward me. When the FRC came alongside the upturned FRC, I sent them towards the rest of the crew in the water...

The occupants have been suddenly inverted and submerged in water (which is often cold); they are disoriented and have only a limited breath hold ability.

Now the FRC was starting to flip, the port gunnels went under the water and all members either jumped or were thrown from the vessel.

While under the water I noticed that the FRC was coming over on top of me so I reached up and grabbed onto the rope on the gunnels and pulled myself clear. When I was coming to the surface I saw one of the senior observers going over the top of me and willingly staying with the overturned vessel that was now being towed by the steamer. I immediately looked around and did a quick head count and asked if all individuals were okay, the responses were all positive.

The FRC started to list to port. It was a little slow, then the next thing I knew I was in the water. I don't think I ever got over the seat.

I was face down in the water and under the 'new' port side back corner from about the waist down. I think I was trying to push off the FRC with my feet, and swim/push with my arms. Apparently, the FRC was being pulled port so I wasn't making much progress. I saw someone float by, so I grabbed their feet and twisted out and to the surface.

They are further encumbered by bulky, buoyant survival suits and lifejackets and have no additional underwater guidelines to locate the toggle. Furthermore, if (s)he has never before experienced being rapidly rolled over and submerged two meters underwater, the event may be such a terrifying experience that it causes panic and drowning. When an incident occurs, the coxswain may be standing or sitting. This is probably exactly why one passenger was trapped under FRC Uruao and drowned in March 1996. The craft was in the process of conducting whale watching tours off the Kaikovra Peninsula when there was a catastrophic failure of the buoyancy bags, and it rapidly capsized. Also, why two US Coast Guard officers died in an FRC capsizement on the Niagara River in March 2001. (Reference 1)

Two die as US Coast Guard vessel flips: Rogue wave swamps patrol boat

A US Coast Guard boat patrolling the Niagara River along the US-Canada border capsized and two of the four crewmen died Saturday after floating for hours in the icy waters of Lake Ontario.

"A four-foot (1.2 metre) wave hit the bow of the boat, swamping it and flipping it over," said Adam Wine, chief petty officer at the Coast Guard's Buffalo station.

The 6.5 metre, rigid-hull inflatable was found floating bow up along the lake shore about 1.5 kilometres east of the mouth of the river, and the crewmen were rescued soon after midnight about five kilometers northeast of the river, Wine said.

Petty Officer Scott Chism, 25, a boatswain mate from Lakeside, Calif., and Seaman Chris Ferreby, 23, a native of Morristown, N.J., were both suffering from hypothermia when they were pulled out of the water. They were listed in critical condition through the night but both died Saturday morning. (The Chronicle Herald, Halifax, 25 March 2001)

Therefore, Survival Systems Training Limited's President and prior Training Manager, John Swain, theorized that it might be possible to use the current helicopter underwater escape trainer to:

- (1) Incorporate a FRC Ditching Simulator
- (2) Investigate the human factors involved in an escape from a FRC
- (3) Design a simulator that could be used to train coxswains and crew how to make a successful escape from a capsized FRC.

This scientific report will describe the work undertaken by the staff at Survival Systems to complete this experiment.

Method

Initial problems experienced with the design of the FRC Ditching Simulator.

Over a 12-month period, several prototype FRC hulls and consoles were designed. The parts for the self-righting system were manufactured, but all were subsequently abandoned. The principle problem was that it was not possible to design inflatable self-righting bags that would overcome the buoyancy pods installed on the helicopter underwater escape trainer and produce a surface-righted simulator at the surface.

Solution to initial righting problems experienced with the design of the FRC Ditching Simulator.

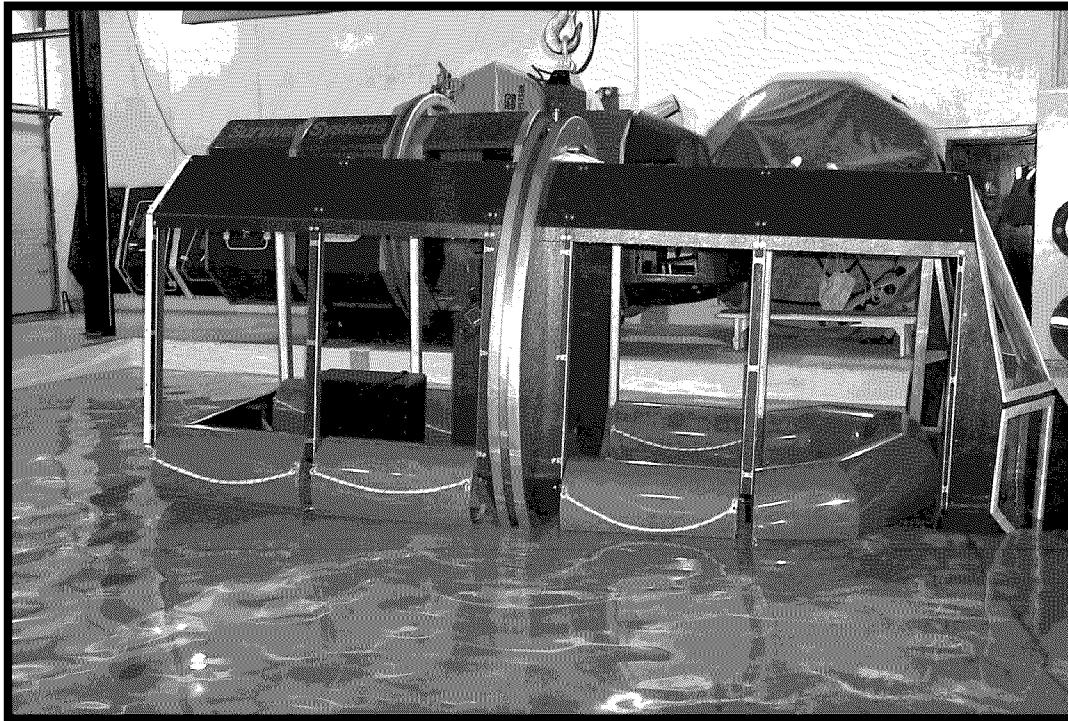
After further experimentation, it became clear that to simulate capsizing and then surface righting, there was no need to install self-righting bags. The simple solution was to sink the helicopter under water escape trainer to a specific depth indicated by the outboard becketed grab lines on the FRC Ditching Simulator. This allowed the downward momentum of the helicopter underwater escape trainer and the upward thrust of the buoyancy pods to invert the simulator replicating an FRC capsizement. Then, after a short period of time, the crew would escape and muster at the stern. The helicopter underwater escape trainer could be then gently raised by the hoist back to the surface of the water, enough for it to rotate back to its original upright

position. Having completed 50 immersions to test that this theory worked in practice, it was then considered safe to proceed to a human factors experiment.

Human Factors Experiment

The helicopter under water escape trainer was adapted to accept the prototype FRC Ditching Simulator (Figures 1 and 2).

Figure 1: Starboard View of the FRC in Survival Systems' helicopter underwater escape trainer.



The helicopter underwater escape trainer was hoisted over the pool, and a series of immersions were conducted with the FRC in an unmanned condition. This was to confirm the correct depth to submerge the becketed grab lines on the FRC, estimate the roll rate; and to establish crane operator and safety diver emergency procedures in the event of a subject becoming trapped.

Physical Positions Prior to Inversion

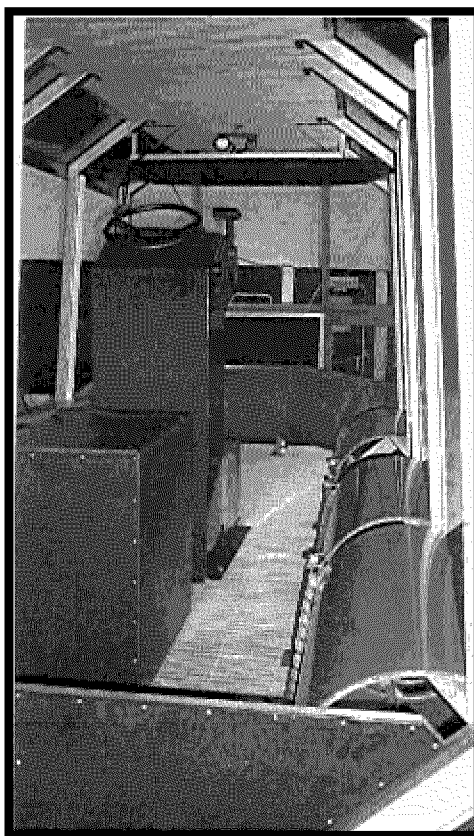
Once this was completed, three instructors from Survival Systems Training and the author each acted in turn to be the coxswain, the port lookout, and the starboard lookout. Following this, each instructor acted in turn as the coxswain while the other two instructors acted as port rescue staff and then starboard rescue staff; i.e., for each of these immersions, two instructors were leaning over the same side of the FRC holding the inboard or outboard becketed grab line depending on how comfortable they were with their natural reach (one subject was short, 157cm, while another subject was tall, 188cm).

When an incident occurs, the coxswain may be standing or sitting. Therefore, for the coxswain position, half of the immersions were done from the standing position and the other half from the sitting position.

Irrespective of whether the coxswain was standing or sitting, s/he was instructed to hold firmly to the steering wheel and secure his/her feet in the canvas stirrups.

For the lookout positions, each instructor knelt down and held firmly onto the port or starboard inboard or outboard grab lines depending on which position they had been allocated.

Figure 2: View looking forward from the transom showing the coxswain's seat and console.



All the rolls are described as referenced from the stern of the FRC looking forwards so that the coxswain and crew are at 0° . If the FRC rolled clockwise, (i.e. to the right) the starboard lookout would enter the water at 90° and finish rolling at 180° , whereas the port lookout would start the roll in air at 270° , enter the water at 90° and finish at 180° .

The direction of rolls were equally distributed between anti-clockwise and clockwise, and each instructor experienced virtually an equal number of immersions directly into the water; i.e., from 90° to 180° as well as rolls over the top beginning from the air; i.e., from 270° to 180° . Because it was unclear whether there would be an air pocket under the FRC in a capsizement, the helicopter underwater escape system was operated to provide: (a) no air gap, (b) a small air gap where there was just enough room to catch a breath of air, and (c) a greater air gap where it was possible to float underneath the capsized system and breath freely.

For all conditions, on the command: "Ditching!" the instructions were to hold firmly onto either a grab line or the steering wheel (depending on the subject's position). When inverted underwater, two separate techniques were developed to escape. First, from the coxswain's position, it was necessary to hold firmly onto the steering wheel until the instructor was confident that s/he could locate and grab the inboard port or starboard grab line (depending on direction of roll). Once the grab line was located, the technique was to take a firm grip on it with one hand, let go of the steering wheel with the other hand, release the feet from the canvas stirrups and pull oneself around the sponson, and, if necessary, grab the outboard grab line to provide extra leverage to escape. For the port and starboard lookout positions, and the port and starboard rescue positions, the technique was to hold firmly onto the inboard or outboard grab line until the roll had been completed, then simply pull hard on the grab line to lever the body from underneath the FRC.

Each condition was videotaped, and after each escape, each subject had to rate the ease or difficulty to escape on a scale of one (1) to five (5) where “1” was very easy and “5” was very difficult. Furthermore, they had to comment on good or bad techniques that they tried when making an escape. These included:

- (a) Technique for ensuring a firm grip on the becketed grab line, and choice of inboard or outboard line.
- (b) Technique for locating the inboard port or starboard becketed grab line from the coxswain’s position.
- (c) Technique for overcoming the buoyancy of the survival suit or using it to one’s advantage.
- (d) Technique for figuring out the best way to overcome disorientation and make a rapid, effective escape.

Results

A) Individual Escapes from the Coxswain’s Position

Individual Escapes from the Coxswain’s Position			
Subject	Condition	Ease or Difficulty	Comments
1	Standing	2	Must hold on tight and difficult to locate grab line.
2	Sitting	3	Must hold on tight and difficult to locate grab line.
3	Standing Floating to Top	3	Must hold on tight, lost handhold, and came out on opposite side than planned.
3	Standing Floating to Top with Bigger Air Gap	3	Must hold on tight and air gap is useless.

The ease or difficulty ranged between a rating of “2” and “3”.

The subjects in the first series of individual escapes reported several problems with escape as follows:

- i) The first universal comment was that it was essential to hold on as tight as possible and not to relax the grip under any circumstance. Unlike the helicopter underwater escape trainer where the students are strapped in with a 2, 4 or 5 point harness, the students in the FRC are not restrained at all. This is difficult enough to prevent being flung around by rotation and inrushing water for the lookout who enters the water directly, i.e. from a 90° position to a 180° position in a clockwise direction, but extremely difficult for a person on the opposite side of the craft who starts at 270° and rotates clockwise around to a position of 180° underwater.
- ii) The second universal comment was that inrushing water contributed to a violent roll-over, and it was essential to hold onto the steering wheel and the grab lines as firmly as possible. In the normal helicopter underwater escape trainer, the in-rushing water is not as violent, because there is the windshield, door, and fuselage panels providing some direct protection. Loss of handhold, as occurred in subject number 3’s first immersion, resulted in the subject only barely being able to escape, because the buoyancy of the suit took charge of the direction of underwater movement, which was in the opposite direction to the intended path of escape. The subject found his way out by good luck rather than by good management.

- iii) The third universal comment was that the buoyancy of the suit made escape much more difficult.
- iv) The fourth comment was that, from the coxswain position, it was very difficult to reach the inboard grab line from either the standing or sitting position (while maintaining a grip on the steering wheel for primary reference). The reason for this was simply that they were placed too far apart for even an extended reach.
- v) The fifth comment was that to allow oneself to “float to the top” to access the air gap was not as easy to do in practice as it was in theory. The disorientation effect and the urgent desire to swim from underneath the FRC module, even if the subject was swimming in the wrong direction, tended to override the alternative action, which was to stay calm and relatively still and allow oneself to float up and find the air gap. The other problem is that the air gap may not exist or be difficult to find. Overcoming the disorientation and making the escape, rather than searching for the pocket of air, appeared to be a more practical objective to aim for in escape.

There were no reports of not being able to get the feet out of the canvas stirrups fitted at the coxswain’s position.

B) Individual Escapes from the Port Lookout Position

Individual Escapes from the Port Lookout Position			
Subject	Condition	Ease or Difficulty	Comments
1	270° - 180° Roll Anti-clockwise	2	Hang on tight and buoyancy of the suit.
2	270° - 180° Roll Anti-clockwise	2	Wedge in between right foot and right hand and buoyancy of the suit.
3	270° - 180° Roll Anti-clockwise	2	Hang on; poor purchase to pull out; and buoyancy of the suit.
1	270° - 180° Roll Clockwise	3	Hang on tight and buoyancy of the suit.
2	270° - 180° Roll Clockwise	3	Hang on tight and buoyancy of the suit.
3	270° - 180° Roll Clockwise	3	Let go inboard painter and hold firmly to out board painter; airbrake cable close; and buoyancy of the suit.

The ease or difficulty ranged between ratings of “2” for the 90 degrees of roll to “3” for the 270 degrees of roll.

The subjects in the second series of individual escapes reported four basic problems as follows:

- i) First, there was the disorientation effect caused by the buoyancy of the suit.
- ii) One subject suggested that, from the kneeling position, the body was less likely to be washed around the FRC if it was wedged between the sponson and the position taken up by the right foot, pressed firmly into the curvature of the sponson and the deck, and the right hand which gripped the inboard grab line.

- iii) One subject cautioned that there was little purchase available to pull oneself out if the grip was maintained on the inboard grab line. He suggested that, at the first indication of capsizing, the victim should grip the outboard grab line.
- iv) One subject cautioned on the closeness of the airbrake cable and airbrake rollers when pulling himself out of the simulator.

All commented on the adverse effect of the additional suit buoyancy, especially if the subject had to do a 270° versus a 90° roll into the water.

C) Three Crew Escape from the Coxswain, Port, and Starboard Lookout Positions

Three Crew Escape from the Coxswain, Port, and Starboard Lookout Positions			
Subject	Condition	Ease or Difficulty	Comments
1	Coxswain	1	* See below
2	Port Lookout 270° - 180° Roll Clockwise	3	* See below
3	Starboard Lookout 90° - 180° Roll Clockwise	2	* See below
1	Port Lookout 90° - 180° Roll Anti-clockwise	1	* See below
2	Starboard Lookout 90° - 180° Roll Anti-clockwise	3	* See below and airbrake cable.
3	Coxswain	1	* See below
1	Starboard Lookout 90° - 180° Roll Anti-clockwise	1	* See below
2	Coxswain	3	* See below and lost grip and came out of the stern of the FRC.
3	Port Lookout 90° - 180° Roll	2	* See below
*All subjects reported that they had to hang on tight; that the buoyancy of the suit affected their planned escape route, and that training for the coxswain position should be done separate from training for the port and starboard lookout positions.			

The ease or difficulty ranged between a rating of “1” and “3”.

In the third condition, where all three crewmembers were in the FRC, the principle observations were reported as follows:

- i) It is essential to hang on tight.
- ii) The buoyancy effect of the suit directed the body in a different direction to that of the intended direction of escape and caused severe disorientation.
- iii) The subjects noted that they were very practiced. Even though two subjects now rated the coxswain's escape as a “1”, it was still the most difficult escape. If the handhold was not meticulously and firmly exchanged from wheel to handhold to grab line, then the chances of disorientation and inability to get out were very likely. As a result, all three subjects recommended that for initial training of the coxswain, only the coxswain should be in the FRC, accompanied by an instructor.
- iv) Closeness of the airbrake cable and airbrake rollers could interfere with a safe escape if not guarded.

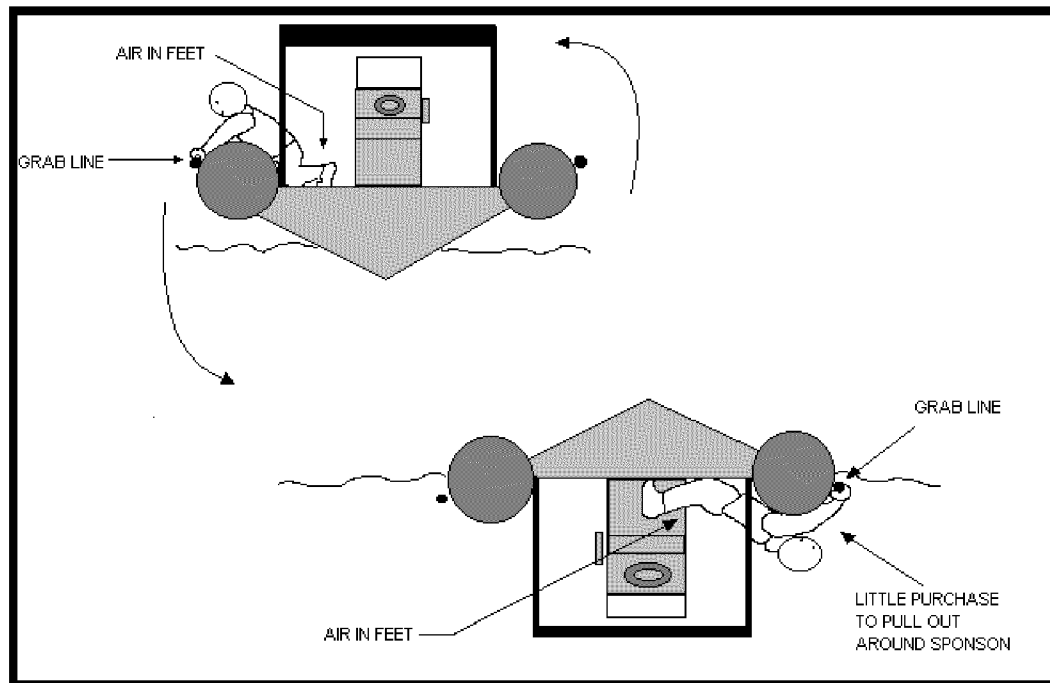
D) Escape from Coxswain and Two Lookouts on the Port or Starboard Sides Undergoing a Recovery

Escape from Coxswain and Two Lookouts on the Port or Starboard Sides Conducting a Recovery			
Subject	Condition	Ease or Difficulty	Comments
1	Coxswain	3	* See below and must keep feet in stirrups.
2	Port – Both on Same Line 270° - 180° Roll Clockwise	3	* See below; line pinched fingers; and airbrake very close.
3	Port – Both on Same Line 270° - 180° Roll Clockwise	3	* See below; line pinched fingers; and airbrake very close.
1	Starboard – Both on Same Line 90° - 180° Roll Anti-clockwise	3	* See below; line pinched fingers; and airbrake very close.
2	Starboard – Both on Same Line 90° - 180° Roll Anti-clockwise	3	* See below; line pinched fingers; and airbrake very close.
3	Coxswain	3	* See below
1	Starboard – On Forward Line 90° - 180° Roll Clockwise	1	* See below
2	Coxswain	3	* See below
3	Starboard – On Aft Line 90° - 180° Roll Clockwise	2	* See below and airbrake very close.
*All subjects reported that they had to hang on tight and that the buoyancy of the suit affected their planned escape route.			

The ease or difficulty ranged between a rating of “1” and “3”.

The three observations made in the previous series of escapes were made again: i.e., the requirement to hang on tight, the buoyancy of the suit, and the proximity of the airbrake hose. There was an additional observation that the fingers were severely pinched when two lookouts were pulling on the same line to exert pressure to pull themselves out over the sponson. They also commented that the air in the feet of the suit was dragging the lower half of the body back into the FRC. A technique to counteract this problem needs to be taught when training students.

Figure 3: A schematic to show how air migrates into the lower part of the suit and feet on inversion. This then holds survivor between the edge of the sponson and the deck.



Conclusion

Twenty-eight experimental subject immersions in the helicopter underwater escape trainer FRC Ditching Simulator have been conducted. In addition, 50 additional pre- and post-experimental subject immersions were conducted to assess rates of roll, techniques to hold onto the becketed grab line, and techniques to assist the coxswain to move from the driving console to access the port or starboard buoyancy sponsons. All four subjects were highly trained and are experienced instructors at Survival Systems Training Limited.

The conclusion from this short study is that there are some very obvious reasons why crews of FRCs die when the vessel capsizes. Worldwide, there is a very small number of deaths of injuries from FRC capsizement. However, poor incident records are kept of such accidents and so it is not at present possible to define the incidence. Overall, the disorientation effect of the FRC capsizement is equally if not more disorientating than that of helicopter ditching and inversion. The principle reasons for this are: (a) the subjects are not restrained, (b) the FRC is open to the intruding water from all directions, rather than having partial protection from a helicopter fuselage, and (c) the excessive buoyancy in the types of survival suits worn by FRC operators renders everyone except for the largest and strongest virtually powerless to control the path of escape.

Whether sitting or standing, the force of the water entry into the FRC, in combination with the rollover, requires that a very firm grip be held onto either the steering wheel or onto one of the handholds on the console. Loss of handgrip causes total disorientation. Then, the buoyancy of the suit exerts forces on the human and drives the person in whichever way the proximity to vertical occurs during the roll. This direction is often contrary to the path intended by the person. This causes further disorientation, because the person is now attempting to swim in a direction opposite to the path of intended escape. In the cumbersome buoyant survival suit, the victim does not have enough dexterity or strength to reverse this direction. Ultimately, and particularly in cold, turbulent water, breath holding time would be reduced, and this would lead to drowning. Loss of foothold in the stirrups for the coxswain only compounds the problem.

For the coxswain to counteract this disorientation, even a firm grip on the wheel or console handles is only a partial solution, because the next step to escape is to bridge the gap between the console and the inboard port or starboard becketed grab line. For most people, this is a long reach even in the upright dry condition of a normal operating FRC. Given the circumstances of being inverted, underwater in poor visual conditions, with cold hands, thick gloves, buoyancy of the suit, and often being driven in the opposite path of intended escape, it is very easy to miss the handhold and again be driven and pinned by the suit buoyancy somewhere against the internal decking of the FRC.

All four subjects agreed that, even under those conditions, the coxswain and the lookouts would be lucky in the disoriented condition to find any air pocket at all. In a rapid inversion, where everyone is in an immersion suit and is taken by surprise, particularly in what will likely be rough sea conditions and cold water, the coxswain in particular has little chance of being able to escape and then move to and muster back aft to right the FRC. Historically, depending on the direction of roll, the look-outs may be flung out clear of the FRC (References 3 and 8). It is, therefore, very important to put a knotted tag line, secured by Velcro, on all FRCs from both sides of the steering console closely following the contours of the FRC to the outboard side of the port and starboard sponsons. Once the coxswain has gripped this line and continues to haul on it, it will improve his/her chance of making an escape. There is also merit in providing FRC crew with helicopter underwater breathing apparatus, particularly if they are working in very dangerous sea states.

For the crewmembers, the problems of escape are related again to:

- (a) Buoyancy of the suit
- (b) The requirement to have a very determined and firm handhold during the immersion
- (c) Being aware that the air that rushes to the feet of the suit will attempt to force the lower part of the body back into the hull.

In the event that the coxswain and crew become disoriented and lost beneath the capsized FRC, the advice to float up and find the air gap is much easier to do in theory than in practice. The skill that must be acquired to stay calm and collected against the psychological terrifying sensation of being trapped underwater with the potential for drowning must be taught. Indeed, the FRC module is a perfect tool for achieving this aim.

From a safety point of view, for training, it is important to put a physical guard in the helicopter underwater escape trainer FRC Ditching Simulator to prevent contact with the helicopter underwater escape trainer air brake system when making the escape. It is also important initially to train students individually to escape from the coxswain's position with one qualified instructor, and until more experience is gained by the instructors about the dynamics of the FRC Ditching Simulator for them to train ab initio crew on a two to one ratio with a safety diver in the pool too. After experience, three students can be trained at a time, providing there is a safety diver in the pool.

Currently, there is no requirement for specific practical training in water capsizement. The US Coast Guard issued a "Manning and Training Guidance for Fast Rescue Boats on US Vessels" instructions in May 2000. This is written in very simple terms and is non-specific.

- A lifeboatman must be competent in the operation of an FRC (i.a.w. 46 CFR 12.10-9)
- Must attend a course (i.a.w. 46 CFR 12.03)
 - Procedures for righting a capsized FRC
 - How to handle an FRC in prevailing and adverse weather and sea conditions

In the author's opinion, it is necessary to insure that in the FRC operator course, the syllabus is revised to include two hours of practical FRC capsizement training in the pool.

Recommendations

- 1) The FRC Ditching Simulator is considered an excellent device to train FRC crews in the problems of underwater escape after capsizement.
- 2) Students will find that the coxswain position is the most difficult one from which to escape. This is due to intrushing water, rotation and disorientation, a buoyant survival suit, difficulty in keeping a good handhold, and the long stretch to reach and grasp the port or starboard inboard becketed grab line from the steering console.
- 3) Therefore, instruction on the coxswain's position should be done on a one-on-one (instructor-to-student) basis with only one student in the FRC Ditching Simulator. A safety diver should also be in the pool during training. See Annex A: Recommended Training Schedule.
- 4) Ab initio port and starboard lookout crew should also be trained on a two-on-one instructor student ratio, providing a safety diver is in the pool. See Annex A: Recommended Training Schedule.
- 5) For all escapes, students must be taught to hold on very tight and be aware of the disorientation effect of the intrushing water and rotation of the FRC. Furthermore, they must be made aware of the suit buoyancy and the fact that it may force them in a opposite direction to the intended escape path, and / or force the lower body back into the hull.
- 6) All students must experience both 90° - 180° rolls and 270° – 180° rolls in a clockwise direction and 270° - 180° and 90°- 180° in a counterclockwise position.
- 7) The technique to find the air gap should be done with only two students at a time and one instructor and one safety diver.
- 8) The FRC operator course should be amended to include two hours of practical FRC capsizement training in the pool.

Annex A: Recommended Training Schedule

No. of Students	Run No. & Type	Instructor	Safety Diver
Coxswain only	1. 90° - 180° Anti-clockwise	1	1
Coxswain only	2. 90° - 180° Clockwise	1	1
Coxswain & Port Look-out	3. 270° - 180° Anti-clockwise	1	1
Coxswain & Port Look-out	4. 270° - 180° Clockwise	1	1
Coxswain & Starboard Look-out	5. 90° - 180° Clockwise	1	1
Coxswain & Starboard Look-out	6. 90° - 180° Anti-Clockwise	1	1
Coxswain & Port Look-out	7. 270° - 180° Clockwise Air Gap Training	1	1
Coxswain & Starboard Look-out	8. 90° - 180° Anti-clockwise Air Gap Training	1	
*Coxswain & Full Crew	9. An anti-clockwise roll	1	1
*Coxswain & Full Crew	10. A clockwise roll	1	1

*Port and starboard look-outs exchange positions for these two runs. (Nos. 9 and 10)

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