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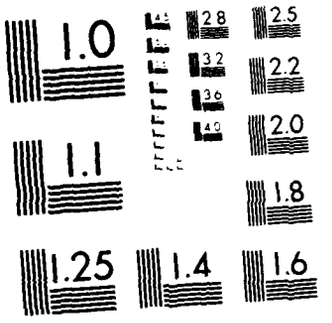

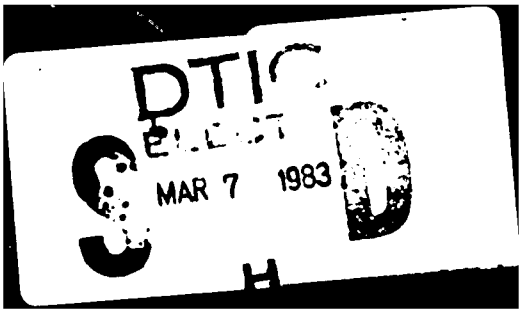
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WATER SURVIVAL - 20 YEARS
CANADIAN FORCES AIRCREW EXPERIENCE

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ABSTRACT

A 20 year review of Canadian Forces (CF) aircrew experience in ejection/ditching, survival/rescue times and injury patterns in salt and fresh water is presented. Five hundred and ninety-five A, B and C category accidents have been reviewed from 1962 to 1982. Thirty-seven of these were water accidents. A total of 116 crew have been involved, of which 38 died (four in fresh water and the remainder in sea water accidents). Twenty-seven accidents (73%) occurred in sea water and ten (27%) in fresh water. Nineteen of the sea water accidents occurred out of Canadian territorial water. All fresh water accidents occurred in Canadian rivers or lakes. The Sea King helicopter is most at risk from sea water immersion (nine cases) followed by the Starfighter (eight cases) and the Tracker (four cases). There have been five single-engine Otter accidents in fresh water. A water immersion can be expected to occur approximately once for every 170,000 hours of total flying time. In 92% of cases (34), the crew had less than one minutes warning that water immersion was imminent and in 78% (29 cases) had no warning at all (less than 15 seconds) in order to make any practical response. There were two clinical cases of hypothermia. One of these required active treatment. Sea King, Tracker, Freedomfighter, Starfighter and Voodoo aircrew should continue to use constant-wear immersion suits when flying over cold water. Aircrew who have received training in water survival, have qualified on the Dilbert Dunker, who are strong swimmers or sports divers, have a better chance of survival in the absence of injuries. Time to rescue in all cases was under three hours and in 16 out of 24 cases (66%) crew members were rescued in under 15 minutes. Of all the fatal cases, more rapid response to the accident site would have made no difference because in each case the accident in its own right was non-survivable. Due to very quick rescue times, desalination tablets have never been used and the question of a fresh water ration has never been a problem, nor has sea sickness posed a threat to survival.

INTRODUCTION

Canada is surrounded by three oceans with a total coastline of 151,489 miles. She possesses a third of the world's fresh water internally in the form of lakes and rivers which cover an area of 221,571 square miles. Therefore, it is not surprising to find that the Canadian Forces go to great lengths to protect aircrew against drowning and hypothermia when there is a requirement to fly over water. As a generalization, all pilots flying ejection seat aircraft are required to wear a lifepreserver as are any other aircrew who fly over large areas of water.

Where the chances of ditching in a cold sea or fresh water has been considered as a high risk, aircrew are also required to wear a constant-wear immersion suit and liner (e.g. Sea King, Tracker, Labrador on search and rescue missions, Freedomfighters crossing the Atlantic to support the northern flank of NATO, Voodoos on intercept missions from east/west coasts and Starfighters operating mainly from Canadian Forces Europe). Passengers may use a constant-wear or quick-donn suit depending on the operational requirements.

Since the Canadian Forces integration in 1967, the number of pilots at the squadron level who flew in the Royal Canadian Navy has diminished; thus, very few people remain in the aviation world who, due to tradition and possibly family ties with the Maritimes or the west coast of British Columbia, have developed a healthy respect for the "perils of the deep". As a result, there has been a considerable number of questions asked as to the real necessity for wearing of the immersion suit. Secondly, many complaints have been voiced about the discomfort of wearing the suit during long coastal patrols. There is no doubt that the pilots have been heat stressed, dehydrated and in difficulty and discomfort with full bladders and with micturition. However it is mandatory to donn the suit when flying missions until the end of the spring and in early fall when the sea water temperature is 13 degrees C or lower, even though the outside air temperature and cockpit air can be as high as 30 degrees C.

The object of this report is to review all the accidents involving the Canadian Forces, the Royal Canadian Air Force, Royal Canadian Navy and Army which involved ditching, ejection or bailing out into the sea or fresh water in the last 20 years in order to identify the incidence of water immersion and the percentage of accidents that occurred in sea or fresh water. These have been analysed to obtain knowledge as to which aircrew are at risk, whether the protection that is provided is adequate or could be improved or, indeed, whether some aircrew are over-protected. Finally, during 20 years of peacetime operation, an analysis will be made as to what the threat is to aircrew from the water temperature and sea state, in conjunction with the analysis of rescue times. Recommendations will be presented as to how our aircrew should be protected to the end of this decade.

With the assistance of the computer at National Defence Headquarters/Directorate of Flight Safety (Ottawa), it was possible to review 595 A, B and C class accidents, from 2 May 1963 to 26 May 1982 whereby:

An "A" Class category accident is one in which the aircraft is destroyed, declared missing, or damaged beyond economical repair;

A "B" Class category accident is one in which the aircraft was shipped, not flown under its own power, to a contractor, depot-level facility, for repair; and

A "C" Class category accident is one in which the aircraft sustained damage to a major component requiring repair beyond field-level resources.

Reference is also made to four other accidents not covered under these categories, which involved either crew falling into the water or aircraft landing in water being able, through pilot skill and good luck, to take off again. Information prior to 1963 is difficult to retrieve, having been scattered or destroyed during the integration of the former Institute of Aviation Medicine with the Defence and Civil Institute of Environmental Medicine (as it is known today), and the transfer of flight safety records to the National Archives from each individual service prior to integration into the Canadian Forces. A fifth accident has been added which occurred in January 1962 prior to computerization of all flight safety information in order to increase the sample size. It is hoped that at a later date the addition of the missing data to 1946 can be added.

BASIC INFORMATION

In 20 years there have been 37 accidents where aircrew have, for various reasons, landed in water. This is presented in Table 1 by aircraft type. There were 13 accidents in which the complete crew perished, and two accidents in which a portion of the crew survived. All survived in the remaining 22 accidents.

Twenty-seven accidents (73%) occurred in sea water (12 accidents resulted in fatalities), while ten accidents occurred in fresh water (3 of these resulted in fatalities). Nineteen of the sea water immersions (70%) occurred outside Canadian territorial water, but all fresh water accidents occurred within Canada. The total number of crew/passengers involved was 116. Thirty-eight lost their lives in sea water accidents (one accident alone, an Argus which was lost off Puerto Rico claimed 16 lives) and four died in fresh water.

There were no fresh water accidents in which the immersion in water per se contributed to fatalities; however, there were three sea water accidents in which immersion contributed to the cause of death (two Sea King helicopters and one Sabre). These cases will be analysed in more detail later. The two Sea King accidents occurred at night, a factor that also contributed to the cause of death; otherwise, there were no common factors in time of day or number of hours in flight which identified a pattern where aircrew may be more vulnerable.

ACCIDENT SITES AND RESCUE TIMES IN FATAL AND NON-FATAL AIRCRAFT ACCIDENTS

Considering Table 2, of the 24 accidents where all or part of the crew survived, the time to rescue was ten minutes or less in 13 cases. This was confirmed by the survivor testimony in seven cases and estimated in six cases. Three further rescues occurred within 15 minutes; two further

rescues occurred in less than 30 minutes, and there was one rescue that occurred at 45 minutes, one at 54 minutes, one at 90 minutes and one at two and three-quarter hours after the accident. (Two Sea King helicopters that water-landed managed to fly out under their own power and therefore did not require rescue.)

Of the 15 fatal accidents, only in the case of one Sea King helicopter (that crashed in darkness when it took a remarkably short 20 minutes before location and rescue of two survivors) could it be argued that an earlier rescue might have saved more of the crew. Although it cannot be proven, it is more likely that those who died were disoriented and drowned on impact and may also have received contributing injuries that retarded their ability to escape in the vital few seconds after the helicopter came to rest. Furthermore, in the second Sea King accident, where the one survivor was rescued in the very short time of 10 minutes (again in darkness), time to rescue was not a factor.

Of the remaining 13 fatal accidents, rescue time was also not important. Specifically, in the unfortunate cases where a crew member fell from the cargo door of a Sea King in flight and that in which the Flight Engineer who disappeared and was presumed to have fallen from the photographic hatch of an Argus into the Bay of Fundy during an anti-submarine warfare exercise, both persons disappeared immediately and were never recovered. One Argus with a full crew on an ASW training mission disappeared with little warning and no trace, as did a Tracker which was witnessed by a German fishing vessel close at hand off the coast of Nova Scotia.

Eight pilots never attempted to eject before impacting water, and in only the case of a Sabre, which will be discussed in more detail later, where the pilot ejected and landed in water 300 yards from a fishing vessel and was seen to enter the water and call for help before drowning, would some form of rescue immediately adjacent to the crew member have possibly prevented his drowning.

The Value of Training, Wet Dinghy Drill and Sea Survival

In nine of the accidents there are very positive comments by the survivors about the part that training had played in their survival, typified by remarks such as: "Wet liferaft drill very useful", "Training was a benefit", "Training considered invaluable in relieving anxiety and giving confidence in procedures and techniques", "Ten years of ejection training paid off". In four cases the fact that some of the survivors had a Ships Diving Course, were sports divers, were strong swimmers, or had previous ejection experience into water (one case only of a Sabre pilot in 1952), may have been important factors in survival.

In the one case in which the pilot of a Tracker was unable to release his overhead escape hatch, which had slammed shut on impact, the cockpit rapidly filled with lake water, and the comments were that "not enough wet liferaft training had been given to the crew". Furthermore one pilot of a Tutor which landed in Old Wives Lake (Saskatchewan) forgot to disconnect his oxygen mask and inflate his lifepreserver prior to water entry. This was attributed to lack of training at that time. As a result, parasailing into sea water was introduced as part of the Sea Survival Course.

METHOD OF RESCUE FOR ALL FATAL AND NON-FATAL AIRCRAFT ACCIDENTS

Reviewing Table 3, in the 22 cases where the total crew survived and the two cases where a portion of the crew survived, the method of rescue for survivors was; helicopter lift (eight cases), boat/submarine (eight cases), walking on ice/swimming ashore (two cases), mixed rescue where two swam ashore, two blown ashore in a liferaft and two assisted ashore by a private boat (one case), towed by canoe (one case), swam/waded ashore (two cases) and flew off the water under their own power (two cases).

Of the 15 accidents which produced fatalities, the bodies were not recovered in nine cases. In four cases the crews were recovered and had suffered massive non-survivable injuries (both Freedomfighters, the Canuck and Starfighter accident off Norway). In the remaining two cases, only two of the four were recovered, those from the Tracker at Sheet Harbour (they suffered non-survivable injuries) and one of the two crew in the Voodoo which crashed in Georgia Straits off Vancouver Island (he had also suffered non-survivable injuries). Thus, in the accidents in which fatalities occurred, time to rescue was not a factor in survival.

Extent of Injuries Received by Survivors

Of the 24 accidents in which there were survivors, the range of injuries extended from minor bruises (four crew), nose bleed (one crew), subconjunctival haemorrhages (two crew), stiff neck (one crew), minor burns from rocket motor (two crew), minor back injury (three crew), burst tympanic membranes due to rapid ascent from 20 feet submerged (one crew), aspiration pneumonia-reactive gastroenteritis (one crew), lacerations/contusions and or abrasions to face (four crew), sprained ankle (one crew), dislocated right shoulder, mild concussion and back pain (one crew), fractures of spine (five crew), and an amputated leg from contact with a ship's propeller (one crew). Long term chronic injury was expected only in the last two cases. There were no injuries due to the direct result of cold water, wind or frostbite.

IMMERSION SUITS

Of the 37 accidents (fatal and non-fatal) there was a total of five accidents (14%), all at sea, in which the crew were wearing immersion suits. Of these, three accidents (all Sea King helicopters) were non-fatal. These occurred 30 miles southeast of Halifax, Nova Scotia, in 2.2 degrees C water temperature when rescue took 10 to 15 minutes. A fourth case took place 45 miles east of Halifax when the aircraft did a water landing and managed to take off and in which the immersion suits were not exposed to water. The fifth accident occurred off the coast of Holland in sea water quoted as high 50's degrees F (estimated by the authors to be between 13 and 15 degrees C) where rescue occurred in five to six minutes. As a result of the first accident, in which the crew were not wearing thermal underwear and socks, these items became standard free issue. All four suits leaked several litres of water. There is no doubt that, in this case, immersion suits contributed to preventing hypothermia and loss of life. In the latter two accidents, the suits appeared to work satisfactorily; however, in the accident off Holland, where the mission was crew training and passenger transfer, the passenger was not issued with a suit. Rescue time was five to six minutes and he did not suffer from exposure in the liferaft.

In the two accidents involving fatalities, the wearing of an immersion suit could not have changed the outcome. The first was the unfortunate case of a crewman who fell from the cargo door of a Sea King in flight into the sea 12 to 18 miles south of Halifax and whose body was never recovered; the second accident was a case of a Starfighter pilot who pitched up at the end of the runway and ejected into the sea off Norway outside the ejection envelope of the seat and received non-survivable injuries.

Immersion Suit Benefit - Fatal or Non-Fatal Accidents

Reviewing the 32 accidents where immersion suits were considered by the Board not to have been worn, the question arises as to whether there were any fatal or non-fatal ones in which the crew would have benefited from the wearing of an anti-exposure suit.

There were 13 fatal accidents which need closer examination; four accidents occurred in which it was impossible to deduce from the Board whether or not suits were worn, in each case the wearing of a suit would not have changed the results: the Tracker which impacted the sea off Sheet Harbour when only two seriously injuried bodies were recovered; secondly, a Starfighter on a radar test flight which flew into the sea off Stranraer, Scotland, with no attempt to eject; thirdly, a Starfighter that crashed into the sea close to the Vliehors range in Holland where no attempt either was made to eject and, finally, the Argus which disappeared into the sea off Puerto Rico. In this last case it is most unlikely that the crew where carrying immersion suits although quick-donn suits would have been available on board.

Of the last nine fatal accidents, there were five cases where pilots did not attempt to eject; a Sabre pilot who was semi-conscious following bailout and was unable to inflate his lifepreserver and drowned; two Sea King helicopters that ditched in warm water where it is postulated that the crew were primarily injured and drowned and, lastly, the case in which a crew member fell from the photographic hatch of an Argus in flight. The wearing of an immersion suit would not have changed the end results in any of these cases.

Of the remaining 19 non-fatal accidents where immersion suits were not worn, only in the case of three Otter mishaps and one Tutor ejection could it be shown that an anti-exposure suit might have benefited the crew. These happened as follows: on two separate occasions an Otter broke through the ice in mid-January (one in Ontario and one in Quebec) and the third one landed inverted in three feet of water in a fast flowing river estuary in the Duke of York Bay, Northwest Territories, in July. There was obviously a considerable amount of luck involved in all three accidents which occurred in daylight and which were witnessed by rescuers ashore. A supply of dry clothing and a warm fire was available in one case. Time to rescue was achieved in under 15 minutes in all incidents.

Following the mid-air collision of two Tutor aircraft flying a student practice formation mission, the crew members of one aircraft ejected into a lake south of the Flying Training School at CFB Moose Jaw, Saskatchewan. They found themselves one mile from the shore in four feet of water; the air and water temperature were both 10.6 degrees C. Quite sensibly they awaited helicopter rescue 54 minutes later rather than trying to

swim/wade ashore. Both were quite cold on rescue and one pilot was noted to have a rectal temperature of 36 degrees C on admission to Base Hospital.

It can be concluded that out of all 37 accidents, the constant-wear immersion suit was of definite benefit in one Sea King helicopter accident, was of marginal benefit in a second Sea King accident and would have been of benefit for the Voodoo crew who ejected into water at 12.5 degrees C in regular flying coveralls. Outfitting of all Otter and Tutor crews with immersion suits would not be practical nor cost-effective in safety or flying performance.

Immersion Suits for Tracker Aircrew

Of the four Tracker accidents, one occurred in warm lake water and the remainder in sea water. Of these three, one was non-survivable (nevertheless in cold Atlantic sea water off Nova Scotia at 2.2 degrees C, one was a planned ditching in warm water and one occurred immediately on take-off from an aircraft carrier). It is still considered necessary for Tracker crews to use constant-wear immersion suits; however, there is merit for review by NDHQ and MAGHQ as to the design of a more comfortable suit. As will be discussed later, the quick-donn suit is not a practical replacement for the constant-wear suit.

WATER TEMPERATURES AND WEATHER CONDITIONS IN ALL FATAL AND NON-FATAL AIRCRAFT ACCIDENTS

Considering Tables 4 and 5, in only 14 cases was the sea water temperature noted; 0 degrees C (one case), 1-5 degrees C (two cases), 5-10 degrees C (no cases), 10-15 degrees C (three cases), 15-20 degrees C (three cases). In this latter category a Starfighter accident is included in which the pilot ejected over the sea (off Denmark) at 16 degrees C and swam for 23 minutes prior to rescue. He was hypothermic and required active re-warming (34.7 degrees C body temperature on shore, 37.5 degrees C 45 minutes later). Finally, five cases were reported for water temperatures between 20 to 30 degrees C.

The following observations are made on the 5 cases of the 27 accidents which happened in water below 15 degrees C; the case of 0 degrees C occurred where the Flight Engineer fell to his death from an Argus over the Bay of Fundy, one of the two cases occurring between 1-5 degrees C was the unsurvivable Tracker accident which occurred off Sheet Harbour, Nova Scotia, in 2.2 degrees C and the other was the Sea King crew who also entered sea water at 2.2 degrees C 30 miles off the Nova Scotia coast suffering from very cold and numbed hands but not being clinically hypothermic. The cases that occurred between 10-15 degrees C included the Voodoo crew who were in their liferaft within five minutes in a sea temperature of 12.5 degrees C, but who were still quite cold when rescued (they found it difficult to operate their flare guns with cold hands) and the last one was the Sea King crew who managed to fly off the sea, not getting wet.

In the 13 accidents where sea water temperatures were not mentioned in the Board, review of such data as time of year, latitude of accident or whether the accident was survivable, leads to the conclusion that sea water temperature was not a factor in these cases. Only in two accidents has the sea water temperature itself been a threat to survival (Starfighter off

Denmark and one Sea King off Nova Scotia).

SEA STATE AND WEATHER CONDITIONS

Generally, sea state and weather conditions for all sea water accidents were reasonably good. In only three cases was the wind reported as high as 21 knots, 25 knots and 18-27 knots. Where other Boards reported such information, the winds were in the range 5-15 knots; three cases were reported with wave height as high as 4-6 feet and one case 3-6 feet. Finally, height of swell was also not severe, the maximum reported being three cases of 5-7 feet, 6 feet and 6-9 feet. In the case of one of the Voodoos which crashed into the Georgia Straits, off Vancouver Island, the wave produced by the crash was in the order of eight to ten feet and there was one comment by the pilot that the liferaft rode this wave well.

If one considers sea water temperature, outside air temperature, wave height, swell height and wind where reported and where not, it can be concluded that sea conditions were generally good and probably contributed to the number of survivors. In the last 20 years of peacetime operation, both the lifepreserver, liferaft and associated equipment have never been subjected to a severe sea state.

FRESH WATER LAKE AND RIVER CONDITIONS

Of the ten fresh water accidents, little detail of lake or river conditions was included in the Boards of Inquiry; however, from analysis of the data, it can be reasonably concluded that in three cases (2 Freedomfighters and a Canuck) where the pilots did not attempt to eject, the lake or river conditions were not a factor in survival. Also, in the Tracker accident in mid-Ontario in September, the lake was warm and the crew waded/swam ashore; therefore, the lake conditions did not pose a threat to the crew.

Mishaps have occurred to five single engine Otters. In four cases, the crew could consider themselves very lucky to have survived. The first case was an Otter that broke through the ice on a lake in Quebec in January. The crew were wearing no lifepreservers, and the wind was reported as 15-20 mph and the outside air temperature as -18 to -20 degrees C. One pilot swam to the ice and scrambled ashore, while the other pilot walked ashore from the wingtip.

The second Otter accident occurred during a familiarization flight and water landing on choppy water with whitecaps noted on the Ottawa River; the wind was 20 mph. Two of the crew were blown ashore in the liferaft, two were taken ashore in a private boat, and two swam ashore. The outside air temperature was reported as 9 degrees C. There was no recording of the river temperature.

The third Otter accident occurred during an ice condition check on a lake in Ontario in January where, on reducing speed, the aircraft broke through the ice. Three crew jumped in the water and swam to the ice, while three walked ashore on the ice. There were no recordings of weather or lake conditions for that day in the Board.

The fourth Otter accident took place during takeoff; the aircraft landed inverted in three feet of estuary river water off the Duke of York

Bay, Southampton Island, Northwest Territories. The outside air temperature was 10 degrees C and the wind was reported as 5-10 mph. The fifth Otter accident occurred on a lake close to Petawawa in June when lake water was warm. Lifepreservers were deployed successfully in this case and reported to have been worn in the second Otter accident only.

Finally included under this heading as previously discussed is the crew of the Tutor which ejected into 10.6 degrees C lake water in Saskatchewan, boarded their one-man liferafts, and awaited rescue 54 minutes later. The air temperature was also 10.6 degrees Centigrade, the lake was calm, and waves were reported as 1-3 feet in height.

HYPOTHERMIA

There have been four cases of hypothermia (three sea water and one fresh water immersion); in two cases, there was a requirement to wear immersion suits but one crew had elected not to do so. There were no cases where hypothermia was the cause of death.

The first case was one of true clinical hypothermia and also the only one where active treatment by rewarming in hot water has been necessary. This occurred in the case of a pilot of a Starfighter who ejected off the coast of Denmark into sea water at 16 degrees C. His temperature (site not identified) was 34.7 degrees C on rescue and after 45 minutes active rewarming, (technique again not identified) was 37.5 degrees C. He was not wearing an immersion suit (not required) and was rescued by helicopter 23 minutes after immersion. Most important to note is that the pilot lost his single man liferaft (which will be discussed later in this report). Being a strong swimmer, he made attempts to swim to shore and as a result lost a considerable amount of body heat. In only the second of these three cases, a Sea King 30 miles southeast of Shearwater were immersion suits worn, (which incidentally all leaked several litres of water - the sea water was 2.2 degrees C). All the crew were very cold and had numb hands. The third case was a Voodoo on a training air intercept mission which pitched up; both pilot and navigator ejected 150 miles southwest of Portland, Oregon, into 12.5 degrees C water. Neither aircrew had elected to wear immersion suits although in this case there was a requirement to do so. Both crew members were rescued from their respective one-man liferaft one and one-half hours later by a Coastguard helicopter. They were cold and noted that the flare gun was not easy to operate with cold slippery wet gloved hands.

The fourth case was one in which the crew members of a Tutor ejected into 10.6 degrees C water south of Moose Jaw, Saskatchewan. Rescue occurred in 54 minutes; both crew were cold and one member was clinically hypothermic with a rectal temperature of 36 degrees C. No active rewarming was considered necessary.

There were four other accidents in which there was mention in the Board of "cold hands", or "feeling cold", "wet and miserable". These could be considered as potential cases of hypothermia if rescue had not been effected so quickly.

The first case involved one survivor of a Sea King at night in 21 degrees C sea water 300 miles southeast of Halifax, following an engine failure during an anti-submarine warfare exercise off a destroyer. (The

cause of the cold physiology reported was more likely his near escape from death and the shock of the loss of the remainder of the crew.) Mainly due to the training that the survivor had received and the fact that he had some diving experience, it was possible for him to make an emergency escape from 20 feet deep water during which he ruptured his ear drums. The remainder of the crew were presumed drowned and may have been injured on impact which reduced their ability to escape in the critical time available. This survivor was rescued within 10 minutes and was reported as cold and understandably shaken.

The second case was an Otter that was doing an ice condition check at the Lake of Bays (Huntsville, Ontario) in January. As the pilot reduced speed, the skis broke through the ice and the aircraft nosed into the water. Three crew walked off the wing on to solid ice and three crew jumped into the water (not wearing lifepreservers) and swam to the ice. They were noted to be cold, but dried their clothing at the fireplace of a nearby cottage.

The third case was yet another Otter which crashed inverted on take-off into the river estuary off the Duke of York Bay, Northwest Territories. All seven crew were immersed in three feet of cold water. All were rescued within 10 minutes and although cold and wet, were dried and provided with warm clothing by military witnesses who were camped close by on the shore.

A fourth case in which no mention of cold was made in the Icard could possibly be considered in this category; this was yet another Otter which was carrying out a "Strange Water Procedure" on Lake Mephremagog, Quebec, in January. The aircraft broke through the ice. One pilot jumped into the water and swam to the ice, while the other pilot walked across the ice from the wingtip. Both were rescued within five to ten minutes. The outside air temperature was reported as -18 to -20 degrees C and there was a 15 to 20 mph wind. Great potential existed for hypothermia if rescue had not been close at hand.

IMPENDING KNOWLEDGE OF WATER IMMERSION FOR AIRCREW
IN ALL FATAL AND NON-FATAL AIRCRAFT ACCIDENTS

Reviewing Table 6, impending knowledge of water immersion could be considered as being of benefit for the potential survivor; therefore, all 37 accidents were reviewed to discover how much warning the crew members had prior to ditching or ejection. In twenty-nine (78%) cases, there was no warning or less than 15 seconds of warning (included here is the case of the Starfighter pilot who had 19 minutes parachute descent following ejection over Sardinia and premature deployment of his parachute). In five (14%) cases, the crew had up to one minute warning. In the case of the Sabre ejection (which has been mentioned previously and which will be discussed more specifically under the heading of lifepreserver performance), the pilot had approximately two minutes warning from entering a spin at 15,000 feet to ejection and 8 minutes parachute descent prior to entry into the sea.

Only in two cases did the crew have any reasonable time to make a practical response to prepare themselves for water entry; the first case involved a Tracker which developed mechanical problems and ditched into a lake with the crew having about 15 minutes warning; however, they were so busy in the cockpit trying to feather engines and sort out a complicated sequence of failures that they would not have been able to donn a quick-donn

immersion suit if required. The second case also involved a Tracker, which, following several missed approaches from HMCS Bonaventure, clipped the wing of a parked aircraft and was unable to land back on the carrier. Following 40 minutes flying to burn off fuel, a planned and successful ditching took place mid-way between Puerto Rico and Jamaica, close to the carrier.

Due to the general discomfort of wearing immersion suits, there has been considerable discussion amongst fixed-wing pilots flying maritime patrols, whether or not a quick-donn suit can be substituted for the constant-wear variety currently in service, the suggestion being that the pilot has enough time prior to ditching to enable him to scramble into the suit. In the two Tracker accidents where this theory could be applied, this would have been possible for the crew who had 40 minutes time to burn off fuel and, most important, who were in control of a reasonably serviceable aircraft even though the accident occurred in darkness; however, in the second case where the crew were struggling desperately to keep the aircraft airborne until a suitable landing site could be found (which turned out to be a lake) it would have been practically impossible.

In the 15 accidents where fatalities occurred, would a longer warning time have changed this number? This question is not easily answered. Eight of the accidents involved aircrew who did not initiate the ejection of their seat or, if they did so, such action was beyond the ejection envelope of the seat. No further comments or conclusions can be made in this paper which addresses water survival primarily; obviously, if these people had received more warning they might have been able to initiate ejection. Of the remaining seven cases, warning for the two unfortunate crew members who fell to their death from an Argus and a Sea King in flight would not have changed events, nor would events have changed for both the Argus and Tracker which crashed into the sea with no warning. In both cases, the injuries sustained would likely have been non-survivable. The cause of death for the Sabre pilot was not due to the fact that he did not have adequate warning but it was due instead to a series of unfortunate events leading up to inability to inflate his lifepreserver; this will be discussed later.

There is no doubt that in the two Sea King accidents, where in the first case one crew member escaped out of four from a depth of 20 feet submerged and in the second case two crew members escape out of four, both occurring at night, some warning of the accident might have increased the number of survivors. However, the requirement for the Sea King to hover over the water both by day and night in its prime role of ASW, and, in a secondary role to act as a hoisting platform for search and rescue in all weather, makes it extremely vulnerable to sudden water immersion in case of engine failure or birdstrike.

SHARKS

In only one case were sharks reported as a possible threat and in that accident, in which an Argus disappeared off the coast of Puerto Rico, the submarine that first arrived at the accident reported aggressive sharks. This was a non-survivable accident and sharks did not play a role in the crew's survival.

LIFEPRESERVERS

Lifepreservers were worn in 28 accidents. They were presumed to be worn in four accidents (although there was no comment available in the board specifically about the performance or the wearing of lifepreservers). All four were non-survivable accidents so the discussion is only of speculative value (Tracker off Sheet Harbour, Starfighter off Deccimomannu, Sardinia, no ejection; Starfighter Stranraer Scotland, no ejection; Starfighter Holland, no ejection). There were two accidents in which it is doubtful that lifepreservers were worn. Both cases were unsurvivable so the answer is again speculative. (16 Argus crew off Puerto Rico during ASW mission and the Flight Engineer who fell from the photo hatch of an Argus on ASW mission in Bay of Fundy.)

Finally, there were three out of the five Otter accidents in which lifepreservers were not worn but which could have been beneficial if worn. Under the circumstances the crew were lucky to survive without them (Lake Mephremagog, Quebec - ice breakthrough, Lake of Bays, Ontario - ice breakthrough and inversion in three feet of water in Duke of York Bay, Northwest Territories).

PERFORMANCE OF THE LIFEPRESERVER

Examination of the 28 accidents where lifepreservers were worn revealed that the lifepreserver inflated either manually or automatically with no problem and provided the necessary floatation in 18 cases (64%). If by personal choice the lifepreserver was not deployed, then it was checked out as serviceable following the accident. In two of these accidents there was a combination of survivors and fatalities; there was one survivor out of four in one case and two survivors out of four in the other case. Their lifepreservers performed satisfactorily. The lifepreserver on the bodies of the crew who perished were never found, so comment about these cannot be made.

Another case warrants special mention; the pilot of a Starfighter who had an abnormally large quantity of publications in his calf pockets was kept afloat by his lifepreserver, and in this case it saved his life until rescue arrived at which point he was exhausted and on the point of drowning. (In his testimony he stated that he had been in the water one and one-half hours whereas in fact he had been in the water ten minutes.) This case is worthy of closer examination - it occurred to the only pilot in this survey who had previously ejected into water (a Sabre in the North Sea in 1952). He ejected at 24,000 feet, omitting to initiate his emergency oxygen. He deployed the parachute too early and as a result received a blow to the head from the parachute drogue plate and, due to a combination of hypoxia and concussion, omitted to punch off the airlock fastener on the seat kit so that 19 minutes later on water entry the maritime lanyard parted and he lost his liferaft and seat kit contents. He was given artificial respiration both in the boat on rescue and ashore; as a result of sea water ingestion, he developed a reactive gastroenteritis and aspiration pneumonia.

Also included in this group of cases was the pilot who inadvertently activated his oral inflation tube on descent and bled off some pressure from the lifepreserver; however, he discovered his mistake and rectified it on immersion. Both crew members of this Voodoo accident, which occurred in

1979, had lifepreservers made in 1976 and 1977 which on post-crash investigation were well worn and not considered able to last the expected five years planned life of the CF lifepreserver.

There were four cases (14%) in which inability or difficulty with pulling the toggle to activate both bladders caused some concern and contributed to death in one case. The first was the Tracker which crashed into the sea on takeoff ahead of the aircraft carrier HMCS Bonaventure, and in which the crew were run over by the ship. One of the crew managed to inflate his lifepreserver after two actions due to difficulty finding the toggle and two of the crew members only managed to inflate one lobe. The pilot who had his leg severed by the propeller was kept afloat by the fact that he had managed to activate both bladders in his lifepreserver and as a result this saved his life.

The second case was a Sabre pilot who was doing a full card air test over the sea off New Brunswick. At 15,000 feet he entered a spin and ejected. He was seen to land in the water with a full parachute, heard by fishermen close by to yell once, and then disappeared. His body was never found although his helmet was recovered; it was concluded that he had probably been hit by the canopy and was mildly concussed, therefore unable to inflate his lifepreserver on descent and drowning on water entry. Further investigation revealed that it took 37 seconds for a mentally-prepared uninjured man in his harness to unbuckle and clear the leg straps and inflate his lifepreserver; undoubtedly in this case an automatic inflation device would have contributed to saving his life.

The third case was one in which the pilot of a Voodoo ejected in the Georgia Straits, B.C. and had difficulty in finding the toggle to inflate his lifepreserver, although finally he did activate it. The fourth case was the pilot of a Starfighter who hit the water off Denmark only five seconds after his parachute had opened. Initially he could not inflate his lifepreserver because he could not find the toggle. He went under the water four or five times and made a concerted effort to release his parachute, boots and spurs; finally by swimming to the surface, he made an extreme effort to find the toggle and inflated his lifepreserver which he claimed to leak at the oral inflation tube (later when tested, it was found to be serviceable). If this pilot had not been an extremely strong swimmer, he would undoubtedly have drowned. In this case where the liferaft was lost, the pilot spent 23 minutes in the water swimming aimlessly and becoming rapidly exhausted; this was the only case in the whole survey in which a crew member suffered from clinical hypothermia that needed active re-warming. Of the remaining six cases (21%), the lifepreservers were either never found (two cases) or no comment was made after the accident about the serviceability or the condition of the lifepreserver (two cases); one of the lifepreservers out of four was unserviceable due to a faulty installation of a CO2 cylinder (one case) and one lifepreserver was severely damaged as a result of the accident itself (one case). Of the lifepreservers that operated correctly, in one of the Voodoo accidents where both crewmen died and only one body was recovered, the lifepreserver inflated and was checked out serviceable. The other body was never found.

In the case of the Starfighter on a bombing mission at the Terschelling Range in Holland, parachute opening and water entry occurred simultaneously. The lifepreserver inflated automatically on immersion; the pilot was

found floating with a dislocated shoulder and mild concussion and was rescued within five minutes. The automatic inflation device on the lifepreserver saved him.

In summary, the lifepreserver has been of very positive benefit in 12 accidents and literally been life saving in four cases. The course of events may have been altered in one case if an automatic inflation valve had been in service at the time.

LIFERAFTS

Liferafts carried in the aircraft involved in water immersion have either been the one-man or the multi-place liferaft. The liferaft was not carried in five accidents (four Otter accidents and the Tracker which ditched into an Ontario lake). In this latter instance, the liferafts had been taken out because it was a ferry flight from the East to the West Coast. Because of this accident, liferafts are now carried on all Tracker flights.

There were ten accidents in which the aircraft and crew were lost in non-survivable accidents and the liferafts were, in most cases, not recovered for examination (in any case the presence or absence of a liferaft did not contribute to survival). In the one Sabre accident nothing was recovered except a helmet; however, it is very doubtful that, even if an inflated liferaft had been available, the pilot would not have been able to grasp hold of it to assist him with floatation while he inflated his lifepreserver and divested his harness.

There were six accidents where the liferafts were not deployed. Into this category comes the case of the Tracker which was overrun by the aircraft carrier Bonaventure following a catapult failure on takeoff. The crew, realizing the immediate danger they faced, elected to squeeze out through the overhead hatches virtually instantaneously without their one-man seat packs which they considered would slow down their escape by vital seconds. Following their passage under the keel of the carrier they were kept afloat by their lifepreservers.

There were eight cases where the one-man liferaft was deployed; in five cases it worked perfectly. In the sixth case it only partially inflated for a Starfighter pilot and, because it became entangled with the parachute and rescue was so close at hand, it was released by the pilot from the barrel connector on the lifepreserver and lost. No reasons were given in the Board for the poor performance. The accident occurred in July in Sardinia so it was not cold temperature that affected the CO2 cylinder. In the seventh case, it was inflated, but the maritime lanyard stitching gave way due to the additional strain put on it, when the Starfighter pilot did not punch off the air lock fastener of the survival kit on water entry. Finally, in the eighth case, the pilot (also of a Starfighter) hit the water only five seconds after parachute opening; in the time allowed and the peril that he faced, he probably did not punch off the air lock fastener either, so the maritime lanyard connecting him to his liferaft and seat contents was severed and he lost everything. In this case his liferaft was discovered later and checked out serviceable.

There were three cases where multi-rafts only were deployed; the first was an Otter accident where the crew had difficulty releasing the liferaft from its stowage, but ultimately two of the crew were blown ashore in the liferaft; in the second accident the crew had great difficulty clearing the raft from the cargo hatch of a Sea King and it was recommended that it should be stowed nearer to the cargo door; and finally, the third case was a planned Tracker ditching in which it worked perfectly.

There have been three Sea King accidents where there has been a combination of both single man and multi-place liferafts deployed. Each case was not simple and should be discussed separately. In one accident the crew had difficulty boarding the six-man liferaft with all their aircrew equipment on and the two one-man liferafts were also successfully inflated. Not all of the liferafts were fitted with radios and one man vomited. (This was the only reference that the authors could find to motion sickness.)

In the second Sea King accident, three one-man liferafts were inflated with no problem, while the fourth required some assistance. The six-man liferaft had to be abandoned when the aircraft rolled on top of it and it could not be launched. Although not very clear in the Board, it must be assumed that because there were six crew and only four one-man liferafts deployed, two survivors spent between 15 to 20 minutes in the water.

The last case was the helicopter which submerged six to seven feet before coming to rest. Three one-man liferafts were deployed, while through personal choice, the observer did not inflate his due to the fact that he went back aft to deploy the six-man liferaft. When he found it impossible to release it, he made an emergency exit through the cargo door window without his survival pack and thus his liferaft. He remained in the water close by the liferafts until rescue ten to fifteen minutes later.

Finally there were two cases of the crewmen who fell to their death where the inflation of the liferaft would not have changed the course of events.

OTHER LIFE SUPPORT EQUIPMENT

Due to the very short time that survivors have spent in their liferafts or in a survival situation, very little practical data is available. The only comments that could be found are as follows:

- one crew member could not make the sun mirror work after the ejection into Old Wives Lake (Saskatchewan), however the flares worked well;

- that the Mark VI flares were very easy to see in the night Tracker accident off Puerto Rico;

- the pencil flares worked well in the night Sea King accident off Bermuda, although the day-night flares only lasted ten seconds;

- the flare gun was not easy to operate with a cold wet gloved hand in the Voodoo accident off the coast of Oregon; in this same accident, the PRQ501 rescue beacon performed poorly, the zipper on the survival contents kit jammed and the way that it was packed was

considered unhelpful for the survivor, i.e. the beacon, the first essential piece of equipment, was packed at the bottom with the socks and mitts at the top;

- in the Sea King accident off Holland, three lifepreservers did not have signal flares, pencil flares or strobe lights fitted and the six-man liferaft did not have paddles;

and finally,

- in the Sea King accident off Bermuda, not all the liferafts were fitted with radios.

There were two cases reported where both the pilot and navigator of a Voodoo had difficulty operating the quick-release box on the parachute harness and in one accident, the navigator had difficulty in deploying his seat pack. One crew member of a Tutor had some difficulty deploying his seat pack prior to descent into Old Wives Lake (Saskatchewan). It was finally released prior to water entry by releasing one of the air lock fasteners. Desalination tablets have never been used and the lack of water has not been a threat in any of the sea immersions.

CONCLUSIONS

1. Five Hundred and ninety-five A, B and C category accidents have been reviewed from 1962 to 1982. Thirty-seven of these were water accidents. A total of 116 crew have been involved, of which 36 died (four in fresh water and the remainder in sea water accidents). Sixteen crew died in one single Argus accident.

2. Twenty-seven accidents (73%) occurred in sea water and ten (27%) in fresh water. Nineteen of the sea water accidents occurred out of Canadian territorial water. All fresh water accidents occurred in Canadian rivers or lakes.

3. The Sea King helicopter is most at risk from sea water immersion (nine cases) followed by the Starfighter (eight cases) and the Tracker (four cases).

4. There have been five single-engine Otter accidents in fresh water.

5. Canadian aircrew have flown an average of 322,300 hours total on all types of aircraft per year from 1970 - 1981. Thus a water immersion can be expected to occur approximately once for every 170,000 hours of total flying time.

6. In 92% of cases (34), the crew had less than one minutes warning that water immersion was imminent and in 78% (29 cases) had no warning at all (less than 15 seconds) in order to make any practical response.

7. The Sea King helicopter stands the highest risks for sudden water immersion with no prior warning. Moreover, the wearing of the immersion suits (even though they leaked) certainly contributed to the safety of the crew of the Sea King which ditched 30 miles south of Shearwater in 2.2 degrees C sea water. Lack of warning of pending ditchings/water immersion contributed to the death of crew members in two Sea King accidents but not in any of the other 35 accidents (although there were eight impacts into the water with no evidence of ejection and obviously earlier warning might have improved the crews chances of survival). This lack of warning is inherent with the Sea King helicopter operations and, therefore, should be emphasized and practised in the Sea King ditching training.

8. The immersion suits were only worn in five out of 36 accidents. They contributed to survival in one Sea King accident. Wearing of this garment in the other accidents made little difference to crew survival primarily due to short rescue times.

9. The potential for sudden cold water immersion is such that the Sea King crew should continue to use constant-wear immersion suits as should Freedomfighter, Starfighter and Voodoo aircrew when flying over cold water.

10. There were two clinical cases of hypothermia. One of these required active treatment. Even though 13 degrees C and below is considered a dangerous temperature in which to be immersed, this case occurred in 16 degrees C water; it also further emphasized the fact that swimming in cold water is very dangerous and only contributes to producing a quicker loss of body heat. This is due to a reduction of body insulation through the

swimming action. These principles should be emphasized on the Sea Survival Training Course.

11. Tracker crews should continue to use the constant-wear immersion suit. The quick-donn immersion suit is not considered a practical replacement for the constant-wear suit. NDHQ and MAGHQ should review the possibility for the design of a more comfortable suit.

12. Aircrew who have received training in water survival or who have qualified on the Dilbert Dunker who are strong swimmers or sports divers have a better chance of survival in the absence of injuries.

13. Four accidents occurred during the hours of darkness. A Canuck pilot and navigator became disoriented on approach to North Bay before dawn and plunged into a lake with no survivors; one complete crew survived a planned ditching of a Tracker; however, in the two Sea King accidents (for which there was no warning), three out of four crew were lost in one case and two out of four in the other case; the fact that it was dark may have contributed to the number of fatalities.

14. Time to rescue in all cases was under three hours and in 16 out of 24 cases (66%) crew members were rescued in under 15 minutes. Of all the fatal cases, a more rapid response to the accident site would have made no difference because in each case the accident in its own right was non-survivable.

15. The general weather conditions for all of the survivable accidents has been surprisingly good and certainly contributed to the number of survivors.

16. The lifepreserver has been of very positive benefit in 13 accidents and literally life saving in four accidents. One pilot lost his life (presumed drowned) as a result of a combination of unfortunate events - ejection, presumed concussion from head injury (inferred by the condition of the helmet which was recovered); and presumed inability to activate the arm on his lifepreserver inflation device manually. This would have left him free on water entry to divest himself of the parachute harness. There is no doubt in this case that the course of events may have been altered if an automatic inflation device had been in service at that time. The introduction of the Conax automatic inflation device in 1975 saved the life of one pilot whose parachute opened simultaneously with water entry. Difficulty has been experienced in locating and grasping the manual operating toggle in 3 cases. This would indicate that a re-examination of the problem should be undertaken.

17. There were five out of seven cases (71%) where the one-man liferaft was deployed successfully. There were three cases where the one-man liferaft and survival contents were deployed and lost. Two of these cases were due to failure of the stitching in the maritime lanyard and the third was a deliberate act on the part of the pilot to disentangle himself from the parachute. There were three cases where multi-place rafts were deployed only. In each case they worked well except there was some trouble in two cases to deploy the kit. There were three Sea King accidents in which an attempt was made to deploy a mixture of one-man liferafts and the six-man liferaft. In only one case was the multi-raft boarded. In the second accident, deployment had to be abandoned due to the need to escape quickly

and in the third accident, the helicopter rolled on top of the raft before it was successfully cleared from the side. No ten, twenty or thirty-man liferafts have been deployed for operational reasons in the last 20 years nor has the performance of the one-man and multi-place liferafts been exposed to severe weather conditions for any length of time.

18. Due to very quick rescue times, desalination tablets have never been used and the question of a fresh water ration has never been a problem; sea sickness has never posed a threat to survival and there has only been a very limited use of beacons, flares and other survival aids. Therefore, these pieces of equipment have never really been tested in a prolonged survival situation.

19. Finally, caution should be exercised if consideration is given to removing a number of survival aids from the rigid survival seat kit, modifying the liferafts or changing the philosophy in immersion suits. These were developed under worst case conditions where times to rescue were not as quick or indeed ever available. The findings reported in this paper are the historical record of the last twenty years of peacetime operation.

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Table 1. CF Aircraft Types Involved in Water Immersion in Last 20 Years

Jet	Propeller	Helicopter
8 CF-104 Starfighters	5 CSR-123 Otters	9 CH-124 Sea Kings
3 CF-101 Voodoos	4 CP-121 Trackers	
2 CF-5 Freedomfighters	2 CP-104 Argus	
2 CT-114 Tutors		
1 CF-100 Canuck		
1 F-86 Sabre		

Table 2. Accident Sites and Rescue Times Presented to the Board of Inquiry In Fatal and Non-Fatal Aircraft Accidents

A/C Type	Fatal Non-Fatal	Time to Rescue	Accident Site
Otter	NF	Est Under 10 Min.	Lake of Bays, Huntsville, Ontario
Otter	NF	Est Under 10 min.	Lake Mephremagog, Quebec
Otter	NF	Est Under 10 min.	Ottawa River, 1 mi. S of Dorion, Quebec
Otter	NF	Est Under 10 min.	Montgomery Lake, Petawawa, Ontario
Otter	NW	Est Under 10 min.	Southampton Island (Duke of York Bay) N.W.T.
Tracker	NF	5 - 10 min.	Off-carrier launch, Puerto Rico
Tracker	NF	5 - 8 min.	Midway Puerto Rico and Jamaica
Tracker	F		Sheet Harbour, Nova Scotia
Tracker	NF	Est Under 10 min.	Whitewater Lake, Sudbury Ontario
Argus	F		Off Puerto Rico
Argus	F	Crewman Fell	Bay of Fundy, New Brunswick
Sabre	F		Off Tracadie, New Brunswick
Starfighter	F		Deccimomannu, Sardinia
Starfighter	F		Off Stranraer, Scotland
Starfighter	NF	15 min.	West of Sardinia
Starfighter	NF	10 min.	Off Sardinia
Starfighter	NF	23 Min.	Off Aalborg, Denmark
Starfighter	F		Vliehors Range, Holland
Starfighter	F		Off Bodo, Norway
Starfighter	NF	5 min.	Terschelling Range, Holland
Voodoo	NF	5 - 10 min.	Georgia Straights, Vancouver Island, British Columbia
Voodoo	F		Georgia Straits, Vancouver Island, British Columbia
Voodoo	NF	1.5 hr.	60 mi. off Coast of Oregon, U.S.A.
Freedomfighter	F		St. Lawrence River, 12 miles E of Forestville, Quebec
Freedomfighter	F		Frozen Lake, NE of Bagotville, Quebec
Canuck	F		Four Mile Lake, North Bay, Ontario
Tutor	NF	54 min	Old Wives Lake, Saskatchewan
Tutor	NF	5 min.	20 miles N Seattle, Washington, U.S.A.
Sea King	NF	Water Take-Off	45 mi. E Halifax, Nova Scotia
Sea King	F	Crewman Fell	12-18 mi. S Halifax, Nova Scotia
Sea King	F/NF	45 min.	At sea, NE Bermuda
Sea King	NF	15 - 20 min.	At sea, W Dominica, West Indies
Sea King	NF	Water Take-Off	Off New York, U.S.A.
Sea King	NF	2.75 hr.	At sea, off Bermuda
Sea King	F/NF	10 min.	At sea, 300 mi. SE Halifax, Nova Scotia
Sea King	NF	10 - 15 min.	30 mi. S Halifax, Nova Scotia
Sea King	NF	5 - 6 min.	Off coast of Holland

Table 3. Method of Rescue for All Fatal and Non-Fatal Aircraft Accidents

Aircraft	Fatal/Non-Fatal	Method of Rescue
Otter	NF	Walked on ice/jumped in water and swam to ice
Otter	NF	Mixed - walked on ice/swam ashore
Otter	NF	Mixed - blown ashore in raft/private boat/swam ashore
Otter	NF	Towed ashore by canoe
Otter	NF	Swam/waded ashore
Tracker	NF	Helicopter
Tracker	NF	Boat
Tracker	F	
Tracker	NF	Swam/waded ashore
Argus	F	
Argus	F	
Sabre	F	
Starfighter	F	
Starfighter	F	
Starfighter	NF	Helicopter
Starfighter	NF	Boat
Starfighter	NF	Helicopter
Starfighter	F	
Starfighter	F	
Starfighter	NF	Helicopter
Voodoo	NF	Helicopter
Voodoo	F	
Voodoo	NF	Helicopter
Freedomfighter	F	
Freedomfighter	F	
Canuck	F	
Tutor	NF	Helicopter
Tutor	NF	Boat
Sea King	NF	Took off under own power
Sea King	F	
Sea King	F/NF	Boat
Sea King	NF	Submarine
Sea King	NF	Took off under own power
Sea King	NF	Boat
Sea King	F/NF	Boat
Sea King	NF	Helicopter
Sea King	NF	Boat

Table 4. Water Temperature and Weather Conditions for Propeller and Jet Aircraft Accidents

Aircraft	Fatal or Non-Fatal	Date	Fresh/Sea Water	Air Temp.	Sea/Lake Temp.	Weather Conditions
Otter	NF	19/ 1/62	Fresh	-	-	-
Otter	NF	7/ 1/68	Fresh	-18,-20 C	-	Wind 15-20 mph
Otter	NF	7/ 5/70	Fresh	9 C	-	Wind 18-20 mph
Otter	NF	30/ 7/71	Fresh	-	-	-
Otter	NF	16/ 7/75	Fresh	10 C	-	Wind 5-10 mph
Tracker	NF	16/ 2/69	Sea	27.2 C	26.7 C	Wind - 11 kts, swell 1-2 ft.
Tracker	NF	11/ 3/69	Sea	23.8 C	22.7 C	Wind 10 kts 6 ft. swell
Tracker	F	19/ 4/71	Sea	7 C	2.2 C	Wind 11-15 kts, 4 ft. swell
Tracker	NF	15/ 9/77	Fresh	-	-	"Good"
Argus	F	12/ 3/65	Sea	-	-	Gusts to 25 kts, 5-7 ft. swell
Argus	F	24/ 3/66	Sea	-	-	-
Sabre	F	27/ 7/67	Sea	-	-	Calm Water/small waves
Starfighter	F	23/ 7/63	Sea	-	-	-
Starfighter	F	16/ 5/65	Sea	-	-	-
Starfighter	NF	5/ 7/65	Sea	26.6 C	-	Wind 15 knots, swell 4-6 ft.
Starfighter	NF	13/ 8/65	Sea	15.5 C	-	Moderate swell, 4-6 ft. waves
Starfighter	NF	18/ 7/67	Sea	-	16 C	Moderate swell, 4-6 ft. waves
Starfighter	F	11/ 9/67	Sea	17 C	-	Wind 5-10 kts
Starfighter	F	5/73	Sea	-	-	-
Starfighter	NF	27/ 8/80	Sea	19.0 C	18 C	Moderate swell, minimum waves
Voodoo	NF	18/ 2/71	Sea	-	-	8-10 ft waves from aircraft impacting water
Voodoo	F	5/ 7/76	Sea	-	-	Bright day/calm water, 5-10 kt. wind
Voodoo	NF	29/11/79	Sea	-	12.5 C	Bright day/wind 18-27 kts.
Freedomfighter	F	10/ 8/77	Fresh	-	-	Bright clear day
Freedomfighter	F	26/ 2/81	Fresh	2 C	-	Wind 8 kts
Canuck	F	17/10/73	Fresh	-	-	-
Tutor	NF	21/ 5/75	Fresh	10.6 C	10.6 C	1-3 ft waves
Tutor	NF	16/ 7/77	Sea	- "above"	15.5 C	Calm, no swell

Table 5. Water Temperature and Weather Conditions for Helicopter Aircraft Accidents

Aircraft	Fatal or Non-Fatal	Date	Fresh/Sea Water	Air Temp.	Sea/Lake Temp.	Weather Conditions
Sea King *	NF	16/10/66	Sea	6.0 C	12 C	1-2 ft. waves
Sea King	F	22/ 3/67	Sea	-1 C	0 C	-
Sea King	F/NF	1/12/67	Sea	16.1 C	21.1 C	6-9 ft. swell
Sea King	NF	22/ 2/68	Sea	26.6 C	25.9 C	Wind 10-13 kts, 3-4 ft. swell
Sea King *	NF	15/ 6/68	Sea	26.6 C	-	1-2 ft swell
Sea King	NF	24/ 6/69	Sea	26.0 C	-	-
Sea King	F/NF	7/11/71	Sea	21.6 C	21.1 C	Wind 25 kts, 4-6 ft. waves
Sea King	NF	24/ 4/73	Sea	5.0 C	2.2 C	Wind 10 kts, 1-2 ft. waves
Sea King	NF	24/ 6/74	Sea	-	mid 50s F	Wind 21 kts

* = Successful Water Take-Off


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