Chapter 9A – Life Rafts and Lifeboats: An Overview of Progress to Date

by

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INTRODUCTION

The most under studied, under funded item and out of date piece of equipment in the helicopter over-water operation is the inflatable life raft. This was brought to the attention of the NATO community in 1998 in an RTO paper titled "The abysmal performance of the inflatable life raft in helicopter ditchings" by this author [9]. On the marine side, the introduction of the Totally Enclosed Motor Propeller Survival Craft (TEMPSC) has been an improvement over the open "Titanic" type of life boats, but these life boats still have a long way to go in design.

In general, aviation and marine engineers and operators do not consider the life raft/lifeboat/TEMPSC in their design/survival equation. This is left as a blank box "to be filled later" with the current "approved" life raft. Naturally, when it becomes time to purchase the life raft – which incidentally is a very expensive piece of equipment, management which may not be co-located with the designers and operators, do little consultation with them. They often choose the cheapest item paying little or no attention to the integration and fit on the ship/rig/helicopter and the training of the crew and passengers. The purchased item may perform very poorly in a ditching, marine abandonment procedure although, there is nothing wrong with the life raft itself!

From time to time, worried pilots and upset coxswains contact this author and request us at Survival Systems Ltd to visit their local operation and examine their lifeboats and life rafts. It becomes blatantly obvious that a purchase order has been issued for an approved lifeboat or life raft, yet no thought has been given about integration into the helicopter, the ship or the oil rig, or indeed any specific local environmental requirement. Middle and Senior Management sit back and feel happy that the lifeboat/life raft has been purchased and approved, but at the working level everyone struggles to fit a very expensive square peg into a round hole. Requests for returns, modifications, etc., are immediately rejected until the first incident/accident/loss of life occurs. A very serious accident was recently just avoided when it was discovered that the roof of a new free fall TEMPSC compressed in on a launching. The distance of travel was enough to cause serious injury to any occupants sitting in the upper row of seats. Fortunately these were not manned on the first launch!

This self-denial attitude is common in all aspects of safety management. It has been addressed extensively by Professor Reason in his textbooks on human error and Professor Leach's textbook on the Psychology of Survival. This topic is discussed in a separate lecture in this RTO series. This is the perfect example of where human engineer consultation should be brought in at the design stage, when it costs very little to do. Implementation of design change and retooling for manufacturing at a later stage adds unnecessary costs. Band-aid solutions that don't really work are often hastily instigated, but are necessary because the high cost of re-design is prohibitive. Professor John Kozey will present a lecture to you in the series on this very problem.

A recent visit to an FPSO gas/oil rig tanker revealed that even though a TEMPSC had been fitted at the stern to allow escape of the engine room staff, there was no coxswain posted back aft to launch the boat, none of the engineers had a clue how to do it either. Until the problem was pointed out to them, they had never even thought about how to escape! There was a variety of other simple physical problems with the boat itself such as no de-icing equipment on the release mechanism and the windshield – all simple things that should have been taken into consideration when ordering the boat, indeed in the initial design of the boat.

The next section contains a reprint and modification to the original paper submitted to RTO in 1998 – "The abysmal performance of the inflatable life raft in helicopter ditchings" by this author [9].

INTRODUCTION OF THE LIFE RAFT INTO FIXED WING AIRCRAFT

The inflatable life raft or dingy was introduced into aircraft in the 1930s. The Royal Navy Fleet Air Arm and the Royal Canadian Air Force [30] suspended it between the longerons at the aft end of the biplane fuselage. Just prior to World War II, the free-floating multi-seat dinghy was added to the inventory of aviation lifesaving equipment [40]. Llano [29] reviewed 35% of the 4 – 5000 ditchings in World War II and the Korean War. He concluded that the life raft had been of great value, but in virtually every case there was reference to **a struggle to get into it**. This was only made worse if the crewmember was injured or simply exhausted. Many survivors recommended deflating the life raft before entry and/or climbing into an uninflated life raft before inflating it.

In 1965, Townshend [41] reviewed inflatable life raft performance in commercial fixed wing aircraft accidents and concluded that often the installation of life support equipment had been done as an after-thought when the rest of the aircraft design had been completed, and in many cases, imperfect installation had not improved survival. There are many similar comparisons with introduction of the inflatable life raft into helicopters post World War II.

INTRODUCTION OF THE LIFE RAFT INTO ROTARY WING CRAFT

Post WWII, once the helicopter became proven and reliable, military organizations commenced to fly them over water. There have been a steady number of ditchings, but the Boards of Inquiry appear to have paid little attention to trends, good or bad in the performance of the inflatable life raft, and until the 1990s there does not appear to have been any formal publications on their performance. With the offshore oil industry boom in the early 1970s, there was a rapid increase in the use of the helicopter to do short flights over water for servicing the rigs and transfer of crew. They also experienced ditchings and problems with the life raft became public. In 1984, Anton [4] completed the first review of the performance of the life raft in seven survivable commercial helicopter accidents in the North Sea. He confirmed the worst fears expressed by Townsend. Such problems with stowage of the life raft not close to exits in the fuselage; poor engineering designs for quick deployment; difficulty with securing the raft to the fuselage; little protection from puncture; poor design causing difficulty with entry. Like introduction into fixed wing aircraft, introduction into the helicopter had come as an afterthought from the original helicopter design. In addition, the training aircrew received was poor and virtually non-existent for passengers.

A brief review of the success/failure of launching is presented in Table 9A-1 below. Even after the life rafts were launched, Anton reported on a "rather gloomy picture" and this is presented in Table 9A-2. Thus in only one (G-BEID) of the seven accidents did the life raft perform as specified, and even in this case it was difficult to retain it to the side of the helicopter for boarding.

Table 9A-1: Life Raft Deployment (Courtesy of Dr. D.J. Anton)

G-ASNM	Difficult to launch due to weight and small exit.
G-AZNE	Pilot chose to swim to ship rather than to attempt to release life raft, helicopter sank rapidly.
G-ATSC	Launched by passengers.
G-BBHN	Unable to deploy due to inversion and raft trapped.
G-BEID	Deployed by crew, difficult to retain against side of helicopter.
G-BIJF	Life raft broke free from mounting. Not used.
G-ASNL	Both life rafts launched by crew.

Table 9A-2: Life Raft Damage (Courtesy of Dr. D.J. Anton)

G-ASNM	Punctured by contact with tail rotor. Upper compartment deflated, canopy would not erect.
G-ATSC	Life raft boarded prematurely. Boarding passengers interfered with correct inflation. Unable to top up due to lack of correct adapters. Tear in side of life raft, plugged with leak stoppers.
G-ASNL	Both life rafts punctured by contact with aircraft.

In 1984, the Civil Aviation Authority [38] produced 40 recommendations from the Helicopter Airworthiness Review Panel (HARP) for improving helicopter safety. This included improvements to boarding ramps in life rafts, protection from puncture and recommendations to remove external protuberances from helicopter fuselages that could snag or damage the raft.

The four U.K. helicopter operators (Bristow, Bond, B.A.H. and B. Cal.) collaborated with RFD Aviation and produced a new life raft [24]. The great advantage of the new Heliraft is reversibility, the inflated fender tube that becomes the structure for the canopy, the ease of entry and rescue from, and compartmentability in case of puncture. The entire North Sea Fleet of 150 helicopters was fitted out with the Heliraft by the end of 1995 which was no mean feat.

LIFE RAFT PERFORMANCE IN HELICOPTER DITCHINGS SUBSEQUENT TO 1983

In 1984, Brooks reviewed the Canadian Air Force water survival statistics for the previous 20 years [7]. Out of the nine helicopter accidents, there were three Sea King accidents where problems were noted. In one case, the helicopter rolled over on top of the six-man life raft and rendered it useless; in one case it was difficult to launch the multi-placed raft; and, in one case, it was impossible to launch at all. In one of these three cases, it was reported that all the crew had difficulty boarding the raft.

In 1995, the Cord Group [19] completed a retrospective examination of helicopter life raft performance in a mixture of civilian and military up until 1995 for the National Energy Board of Canada. This is quoted in total for the use of survival instructors in training establishments.

In May 1984, a Boeing Vertol G-BISO [21] was en-route to Aberdeen from the East Shetland Basin with a full load of 44 passengers and three crew. Following a flight control system malfunction, it ditched eight miles north-west of the Cormorant Alpha Rig and capsized 82 minutes after touchdown. The First Officer turned the aircraft 40° to the right of the wind to see if this would provide better conditions for launching the life rafts from the right side. However, the aircraft started to roll an estimated $\pm$ 10° and the blades could be seen disturbing the water as they passed close by. The aircraft was turned back into the wind. All crew and passengers evacuated successfully. The first life raft had been launched through the forward right ditching exit with the painter secured around the arm of one of the passenger seats. After some passengers had entered the life raft through the forward right exit, it was either dragged or blown out of reach. More passengers went through the rear right exit and clambered forward along the top of the sponson in order to reach the life raft. Approximately nine passengers had boarded when the painter parted allowing the life raft to drift behind the aircraft. The second life raft was also launched through the forward right exit and the painter similarly secured. Two passengers had entered this life raft when its painter also parted and one and one-half hours later both rafts had drifted clear of the aircraft. Approximately 10 minutes later, the remaining passengers escaped through the rear right exit into the water and drifted behind the aircraft where they were picked up either by surface vessels or, by one of three rescue vessels.

In March 1985, an S61 helicopter en-route from the offshore oilrig SEDCO 709 to Halifax airport ditched following loss of transmission oil pressure [14]. All 17 occupants boarded two life rafts, but most consider themselves very lucky that they survived. It was a calm day and the sea state was also calm. The following day, there was a raging blizzard and no aircraft flew offshore. The narrative reads as follows:

> *"After the pilot in command had shut down the helicopter engines and stopped the rotor, he moved aft to the passenger cabin. Once he had passed the airframe mounted ELT to the passengers,*

the life raft was pushed away from the helicopter. As the raft moved into the outer limit of the rotor arc, the rotor blades were striking the water dangerously close to the raft and the occupants had difficulty keeping the raft from being struck by the rotor blades. After launching the No. 1 life raft, the pilot, co-pilot and remaining passengers inflated the No. 2 life raft beside the aircraft and stepped directly into it. The raft was then pushed away from the helicopter and it drifted under the tail pylon. The three occupants had difficulty keeping the raft clear of the stationary tail rotor blades as the helicopter was pitching and rolling in the water. The No. 1 life raft had a 4-inch tear from rubbing against helo and as a result, the lower buoyancy chamber deflated. By the time the rescue helicopter arrived, the occupants were sitting in 18 inches of water."

In 1987, the E. and P. Forum reviewed two accidents [22]. The first was a Bell 214ST helicopter (G-BKEN) that made a controlled ditching into the sea 16 miles North of Rosehearty, Scotland (15 May 1986). Eighteen passengers and two crewmembers successfully transferred to two life rafts. The second accident occurred in December 1986 and was just survivable. In this case, a Puma 330J flew into the sea off Western Australia, it overturned rapidly and sank, and no life rafts were deployed. Thirteen of the fifteen crew and passengers escaped and were rescued from the sea. This latter accident emphasized the point that in a poorly controlled ditching in very turbulent water, the likelihood of deploying life rafts, which are stowed within the fuselage is virtually impossible [8]. Moreover, if the helicopter is inverted and flooded, no one can proceed backwards underwater to release the life raft from its stowage.

In March 1988, a Bell 214ST helicopter (VH-LAO) [6] ditched off Darwin, Australia rapidly flooded and inverted. The two 12-man life rafts, which can be released by the pilots from the console in the cockpit, were not deployed because the rotor blades were still turning. It was too late and not possible to do it later with the rapid flooding and inversion. So, 15 passengers and crew evacuated into the sea. The crew then decided to duck dive into the fuselage to get one raft out. After several attempts, this was successful. After it was inflated, five to six survivors got onboard, then the bottom flotation tube was punctured by contact with one of the helicopter doors. The raft then partially filled up with a mixture of seawater and Avtur making everyone violently sick from the fumes. The raft could accommodate no more than six survivors in this punctured condition. The rest of the survivors remained in the sea for approximately one hour and ten minutes before rescue.

In October 1988, while on a SAR mission off the northwest coast of Scotland, the pilot of a S61N helicopter G-BD11 became disoriented, and the helicopter struck the sea and immediately rolled over [1]. The life raft inflated as advertised, but the boarding ramp was very slow to inflate, rendering it useless at the critical time that it was needed. Once on board, it needed the combined effort of the four survivors to free the canopy from its stowage. An analysis following the accident revealed that an incorrect procedure had been conducted, and that the painter line should have been cut before attempting the canopy erection.

In November 1988, an S61N helicopter (G-BDES) was tasked on a non-scheduled public transport service from Aberdeen to three oil installations [20]. On return to Aberdeen, it suffered a sudden loss of main transmission oil pressure and the pilot had to ditch ninety miles North East of Aberdeen. The two pilots and four passengers scrambled onboard the first life raft after activating the external release lever, but the remaining seven passengers were unable to reach or deploy any life raft; they spent 41 minutes in the sea before rescue. The co-pilot in the raft had to fend it off from an aerial and the tail rotor which both came close to puncturing it.

In 1989, the E and P Forum reviewed a further three more accidents [23]. The first was a S61N helicopter (G-BEID) en-route from the "Safe Felicia" in July 1988 that did a controlled ditching off Sumburgh, Scotland.

With rotors fully run down, the forward cabin passengers egressed with no problem, but the passengers in the rear cabin had difficulty launching and boarding their life raft. Ultimately, two crew and nineteen passengers were rescued.

The second accident was a Super Puma (LN-OMC) that ditched in the North Sea also in July 1988 and floated for ten minutes. The first life raft was blown by the wind against the fuselage and rendered useless. All 18 passengers and crew evacuated into the second life raft.

The third accident was a Bell 206 EI that ditched in February 1987 into the Gulf of Mexico in a six to eight foot sea. The sharp corner of the front door punctured the life raft rendering it useless. The pilot and passenger remained onboard until rescued by boat.

In 1989, Reader [35] published the British military experience with 94 helicopter ditchings for 1972 to 1988. He reported that the biggest problems with safety and equipment in order of frequency were:

a) Problems with life raft inflation;

b) Inadequate seat belt restraint; and

c) Loss of a life raft.

There were ten accidents where he specifically cited difficulty with life rafts (Sea King – 4; Wessex – 5 and Wasp – 1) and in a further seven Sea King accidents, he noted that all the life rafts were lost.

In November 1991, a Bell 214ST (VH-HOQ) with fifteen passengers onboard departed the Skua Venture helipad for Troughton Island, Australia, but through mechanical problems had to ditch barely twenty feet above the pad [5]. The pilot made a controlled water landing and deployed flotation bags. The co-pilot activated the two life rafts, which were both launched. However, only the starboard one cleared the floats and inflated. The port life raft slid into the water and did not inflate automatically. One of the survivors while still in the fuselage pulled on the life raft painter and inflated it. Whereupon the 17 crew and passengers evacuated into the two rafts. At this point, the starboard float burst, the helicopter rolled over and the rotor blades came down on top of the starboard life raft. The Lady Cynthia's rescue boat came to the rescue and towed the life raft clear of the blades before rescuing the survivors.

In March 1992, a Super Puma (G-TIGH) shuttling 15 passengers from the Cormorant Alpha platform to the accommodation vessel "Safe Supporter" 200 hundred metres away crashed into the sea only 47 seconds after lift-off [2]. The life raft in the right cabin door was released from its stowage, shortly after the door had opened on impact, the inflation probably being initiated by the short painter. It suffered major damage. It did, however, inflate at least partially and provide support for possibly six personnel. Because it was so badly damaged, it was extremely unstable in the water and overturned on several occasions. The second life raft, under Seats No 5 and No 6 adjacent to the left cabin door, was not deployed. One crew and ten passengers perished. This precipitated a further examination by the C.A.A. of helicopter offshore safety.

In 1993, the F.A.A. [16, 31] published two reports on 77 rotorcraft ditchings between 1982 and 1989. The National Transportation Safety Board investigated 67 of them and the U.S. Army investigated the remainder. In the first report, there was only a small observation section on the availability, use and performance of person flotation equipment. The details on the performance of life rafts were very scant. Out of a total number of 204 occupants, 111 used some form of personal flotation device and only 24 made use of a life raft. The overall summary was that in the cases studied, the people did not generally use life rafts. In the second report, the findings were as follows:

"Life rafts stored near the chin bubble are often lost when water flows out the chin bubble. The rapid overturning of the rotorcraft requires occupants to egress immediately rather than locate the life raft then egress. The effects of wave action on the floating helicopter often preclude re-entry for the purpose of extracting the life raft. Re-entry is not advisable with current systems because of the frequency of delayed separation of the floats from the rotorcraft. Access to the life raft should be improved in the common event of the overturned helicopter. Locations to consider include exterior of the rotorcraft, exterior access panels, near the rotorcraft floor by an exit and integrated with the flotation system."

In March 1995, a Super Puma helicopter (G-TIGK) en-route to the East Brae production platform experienced a tail rotor lightening strike and the pilot conducted an immediate ditching [3]. The 16 passengers and two crewmembers made a miraculous escape into one life raft. Unfortunately, the second life raft was deployed and blew up against the side of the fuselage and was rendered useless. Also in 1995, a Bell 214ST helicopter ditched in the Timor Sea and immediately rolled over. The two pilots onboard egressed safely, but one had to dive back into the fuselage to release the life rafts.

Finally for 1995, the Civil Aviation Authority [18] published their review of helicopter offshore safety and survival. The findings related to the life raft were:

"As a result of previous shortcomings in the performance of life rafts carried in helicopters, the new 'Heliraft' was developed in 1985 and is now in service throughout the offshore fleet. Its reversible design is sandwiched between and a hood, which can be erected on either side, with all equipment and attachments duplicated; it thus avoids the problem of accidental damage (as was demonstrated in the Cormorant Alpha accident), is of a size and weight that permits it to be handled by one person in reasonable wind and sea states, and is more readily boardable by survivors from the sea by means of a ramp and straps."

PROGRESS POST-1995

When a helicopter ditches and the crew and passengers have a matter of a minute to make a decision, they have four options how to evacuate the fuselage into the life raft. The first choice is on which side to abandon the helicopter, the leeward or the windward side. Attitude and direction that the helicopter has landed on the water during the accident may have predetermined this choice. Exiting from the leeward side causes more difficulties with clearing the life raft from the fuselage and the strike envelope of the blade because the helicopter will drift quicker than the human can paddle, whereas exiting on the windward side causes more likelihood of the life raft being blown up against the side of the fuselage and difficulty with keeping it close to the side for entry.

The second choice is whether to inflate the life raft immediately on launching and wait the critical 30 seconds for full inflation prior to boarding in a dry condition (dry shod or dry method), or to launch the life raft in its package using the first survivor out to swim it clear of the strike envelope prior to inflation, each subsequent survivor swims out along the painter to join the first one out (wet shod or wet method).

Because no formal scientific evaluation had been completed on the problem, the National Energy Board of Canada tasked the CORD Group to evaluate the current training standards, the direction of evacuation and the two techniques for inflation, the dry method or wet method. The first experiment conducted using the Nutec Super Puma helicopter simulator in the Bergen Fjord [12, 19] recommended that the dry method be taught as the method of choice. The wet method should be taught as an alternative method in case there is no time to wait for the life raft to inflate and the helicopter is potentially about to capsize. Evacuation, wherever possible, should be conducted on the windward side and that pilots required more realistic training than simple wet dinghy drills in the swimming pool.

A second series of experiments [13] were conducted to increase the subject data pool from the first experiment and to evaluate the advantages and disadvantages of using both the traditional aviation life raft and the new RFD Heliraft. The original findings from the first experiment were confirmed. In addition, it was concluded that the Heliraft had many distinct advantages over the traditional raft: it was reversible and needed no righting and it was far easier to enter from the pitching helicopter. It was noted that both styles of life raft needed relocation of the painter to insure the life raft hauls up tight to the fuselage without the boarding ramps in the way. Finally, in order to assist training of aircrew, a ditching survival compass was designed for decision making as to which side of the helicopter and which method of evacuation should be used.

In January 1996, the Norwegians had a Super Puma LN-ODP accident into the North Sea [26]. In four metre seas, the crew first deployed the starboard life raft on the windward side where it was blown on its side up against the fuselage. The crew then decided to deploy the second life raft on the port side. This life raft was launched on the leeward side and a dry evacuation was attempted. It was impossible to paddle the life raft clear of the fuselage because the helicopter drifted faster than the survivors could paddle. As a result, the life raft was struck by the tail rotor, was punctured and sank. Those already in the raft then swam back to the still floating helicopter (one passenger nearly drowned when pushed underwater by the tailskid). Once back in the fuselage and after much effort, the pilots forced the original starboard life raft down onto the water, but in the process of cutting the entangled sea anchor, inadvertently cut the painter. As a result, the survivors nearest to the door did not have the strength to hold it in position close to the fuselage because the helicopter was drifting faster than the life raft; only three survivors and one pilot were able to get into it before it drifted clear on the windward side. The personnel in the life raft were hoisted by a rescue helicopter before the remaining pilot and 13 passengers were hoisted from the floating fuselage 50 minutes after ditching.

In 1996, Kinker, et al. [28], completed an analysis of the performance of US Naval and Marine Corps life raft performance over a 19-year period. Mishaps involving the AH-1, UH-1, H-46, H-53 and H-60 helicopters were studied between 1977 and 1995. They also confirmed the poor performance of the life raft. In only 26% of the 67 survivable over-water accidents was the life raft deployed. They further concluded that for the last 20 years there has been a unique and dangerous circumstances surrounding raft accessibility and helicopter egress which had not been addressed. Life rafts were too large and cumbersome, not only to lift, but to fit through emergency exits; they were inaccessible for rapid launching and often positioned 10 to 15 feet from the visible exits; and, even if launched, in the case of the multi-placed raft, often float several feet underwater before inflation (if the inflation ring has not been pulled), so making locating the raft difficult.

DISCUSSION

A literature review of the performance of the aviation life raft in helicopter ditchings has been presented. Records just post-war are scant, but in the last 20 years more complete. It is clear from the more recent civilian and military data that modified inflatable marine raft has simply been fitted into the cockpit and/or fuselage of the helicopter as an after-thought following the design of the helicopter.

Thirteen years ago, the first purpose built helicopter aviation raft was put into service. This has only partially solved the problem because there has been no regard for the human dynamics involved in the requirement for split second decisions in the ditching process, and the problem with difficulty with boarding is just as serious as it was when the original marine inflatable life raft was introduced 60 years ago!

In 50% of accidents, the helicopter will capsize and sink rapidly and, in the remainder of the cases, balance precariously on the water surface. The crew and passengers are thus faced with imminently drowning from the in-rushing water. This is compounded by disorientation from inversion and inability to see underwater, inability to locate levers to jettison doors and hatches and worst of all, a 50% reduction in breath holding ability in water below 15°C [11, 17, 25]. There is no time left for them to locate a life raft, struggle to maneuver it to an exit, which is often at some distance away, heave it out and wait for inflation. Even when it is inflated, it is not easy to board or be rescued from, and while tethered to the helicopter runs the serious risk of puncture from sharp edges on the fuselage or a blade strike. There is now good evidence to support these comments.

Anton's series reported only one out of seven accidents where the life raft worked as advertised. Brooks and Reader both reported problems with Canadian and British military life raft deployments. The data presented in this paper of 15 civilian helicopter accidents between 1984 and 1996 shows that only one accident in which the life rafts worked as specified; and finally Kinker and his colleagues published the USN/Marine data over the last 19 years where the life raft was utilized only 26% of the time.

Considering the rapid advance in technology for the helicopter engines and airframes, the life supports systems have not only lagged behind by 40 years, but in recent years have not been considered in the fundamental design of new airframes. Two approaches should be taken, first consideration be given to keeping the helicopter or a portion afloat and using this as the primary safe haven for the crew and passengers from drowning and hypothermia (and there has been some preliminary work on this); however, this does not solve the problem of the fly-in where a life raft is necessary or for capsizing in heavy sea states. In this case, a whole new concept is required to design a person-mounted life raft that may incorporate personal flotation and hypothermia protection, and most important of all be easy to board, and be strong enough to resist puncture. NATO countries, in conjunction with helicopter manufacturers and human factors research laboratories, should jointly fund such a programme.

One would have thought that all that had happened and been written about the philosophy for when and when not to evacuate the helicopter into the life raft and the unsuccessful performance of the inflatable marine helicopter life raft over the last 25 years, that things should have been improved by now. This does not seem to be the case.

State Supervision of Mines
Health & Safety Information Bulletin
21st November 2006
NOGEPA rescue helicopter

"As a result of a total power failure on a offshore platform on the evening of 21 November 2006, 13 persons were evacuated from the platform to Den Helder, departing from the mobile drilling installation that was located adjacent to the platform (and was connected to it by a bridge). During the evacuation, the NOGEPA rescue helicopter used for this purpose (call sign G-JSAR), had to make an emergency landing on the sea around 23.30 hrs due to technical problems, approximately 12 nautical miles to the North West of Den Helder. All passengers and the two pilots left the helicopter by jumping into the sea. The two other crew members were able to activate a small life raft and made use of this. After 75 minutes, all passengers, pilots and crew members were rescued and taken to a safe location by a ship belonging to Rijkswaterstaat [the Directorate General for Public Works and Water Management]".

So this is the state of affairs at present. It is rumored that there is a new square section in development by a French manufacturer, but no one has seen this in operation yet. In summary, the key issues for helicopter operators, some of which are under investigation at present are:

- Consideration to make the helicopter float. The Civil Aviation Authority are looking into the potential of side floating helicopters.

- If this is not feasible and there is a future for the helicopter aviation life raft, then:

  a) It should be stowed external to the fuselage.

  b) Positioning of painter lines should be carefully thought out and maybe have to be made interchangeable depending on the helicopter type.

  c) Boarding the life raft from the open ocean is very difficult and an improved system is needed. Don't believe the manufacturers when they say it is easy to board their life raft – it may be easy in a warm swimming pool and this gives students a false sense of security!

  d) Erection of the canopy, particularly in any increase in sea state and wind conditions is either very difficult or impossible especially with cold hands or gloved hands. New designs are required.

  e) The life raft must be designed as an integrated part of the whole helicopter operation, i.e. stowage, deployment, and the steps to conduct a dry shod or wet evacuation from the cockpit and the cabin, wearing different types of immersion suits, and under typical weather conditions, sea and air temperatures.

ISSUES WITH THE TEMPSCs

Structural Problems

All appeared to be well with the design of the new totally enclosed motor propelled survival craft (TEMPSC) until the Alexander Kielland and Ocean Ranger accident. Certainly in the former and likely in the latter, the "off load" release mechanisms proved totally unsatisfactory [32]. Since then there have been a number of accidents where people have been killed because of problems with the on-load release hooks. Through premature or unexpected opening, one or both hooks lets go. Thus the lifeboat becomes suspended vertically or drops completely into the water. A lifeboat incident study was done by OCIMF, INTERTANKO and SIGTTO in 1994 and 2000 [33]. The causes of the accidents were:

a) Design fault;

b) Equipment failure;

c) Failure to follow correct procedures;

d) Lack of proper communication;

e) Lack of proper maintenance; and

f) Lack of proper training.

In 2006, a large study was conducted by Burness Corlett for the British Maritime Coastal Agency [34]. They concluded that the unstable nature of some current hook designs is a direct cause of many serious and fatal lifeboat accidents; and it is entirely possible to design an on-load release hook which has stable characteristics.

Incidents continue to happen and six free-fall lifeboats on the Kirstin platform in the Norwegian Sea and the Vesle Grikk B platform in the North Sea sustained structural damage during testing [39]. Furthermore, 56 lifeboats have been re-enforced since June 2006 following the roof compression problem alluded to earlier.

In summary, we still have a long way to go in the design of new lifeboats and considerations that humans have to operate them and survive in them for potentially many hours.

Human Factors Problems

Manufacturers have forgotten that humans have to drive them and that there is a requirement to sit in them for many hours as survivors. Also, the regulators, the International Maritime Organization (IMO) are using out-dated anthropometric data for allocation of seat space and weight allowance.

The book "Rescues on the High Seas" is highly recommended to all course attendees and survival instructors [15]. This describes what really happens in the life threatening situation of rig abandonment into a TEMPSC. This will set the scenario for what human requirements are essential on board a TEMPSC. It might encourage manufacturers to consult with more human engineers and operators of lifeboats before finalizing the design of a lifeboat. For instance, in some lifeboats the coxswain has to sit athwartships in the vessel – what sense is there in this? In some lifeboats, in order to obtain approval for a certain maximum load requirement, all sorts of nooks and crannies have been assigned as seat positions and an appropriate set of colored seat harnesses have been screwed to the bulkhead. In these positions, even a gnome in an immersion suit would have difficulty fitting in there! Below is an excerpt describing the difficulties experienced by people immersed in water trying to board a life raft:

> **Seward Phoenix Log, August 21, 1997**
> **By Roger Kane**
> **Sail S Sank in Bering Sea (Tug)**
>
> "A patrolling C-130 happened to be in the area and dropped life rafts and we made some effort to get into the life rafts, but we couldn't. The rafts are almost impossible to board, especially if you are in a weakened state."

In 2006, SOLAS regulations require every person on board a cargo ship to be provided with an immersion suit. This is an excellent step forward. But, it has created several problems. The first is that the space and weight allocation defined in the 2003 IMO Life Saving Appliance (LSA) Code [27] are too low. The 430 mm buttock width and 75 kg average weight were established many years ago, before people started to grow taller and expand their girth. For many years now, most survival training schools have realized that it has not been possible to load any of the lifeboats to full capacity, even when the students were just wearing work coveralls and no lifejackets. So the addition of the immersion suit only compounds the problem.

In 2005, a typical maritime offshore oil training class of 41 people was measured in Dartmouth, Nova Scotia (39 male, 3 female) [10]. Their ages ranged from 18 – 56 years. Over 70% of the group measured in **work clothes only** exceeded the 430 mm space allocation at the hips, and the shoulders were even wider. The average weight was 87 kg, 12 kg over the IMO specification.

Currently there is an impasse between the ship owners, the manufacturers of the lifeboats, and the IMO on revision of the LSA Code. IMO has postponed any action until 2008. What more can I say!

Work has also been done at Survival Systems Ltd. by Reilly, et al. [36, 37] on the decrease of functional reach when wearing immersion suits inside a TEMPSC [10]. The important findings critical for lifeboat and immersion designs are:

1) Wearing the immersion suit produces a significant reduction in the maximum reach envelope in regions other than immediately in front of the worker.
2) Measure of circumference yield the largest increase followed by vertical measures, breadths, and lastly depths.
3) The heavier the individual, the less of a contribution the suit makes to the increase in circumference measurements.
4) Suit sizing for the smaller subjects should be reviewed, as there is excess material in regions of the chest and waist circumference, in particular.
5) If boots are designed to be integrated with the suit, boot sizing is critical because it dictates the suit size.

The lecture started off noting the poor progress made with the development of the lifeboat and inflatable life raft. Two more accidents were reported in the Safety at Sea journal in May 2006 and July 2006. How many more lives will be lost before our regulators and industry get serious about improving the safety standards.

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"During a routine drill the brake lever arm dropped to its stops and there was no braking effect whatsoever. The boat ran down to the water and was dragged alongside at 16 knots. The painter was ripped free, the forward falls torn away, and the boat was struck by the propeller…This is another unfortunate case of the failure of a lifesaving device now more noted for mechanical problems, injuries and deaths, rather than lifesaving."
(Safety at Sea May 2006)

There rests my case.

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