FINAL REPORT

AAIU Report No:- 1999/008
AAIU File No:- 19980042

Aircraft Type and Registration:	Sikorsky S61N, EI-MES
No. and Type of Engines:	2 General Electric CT58-140-2
Aircraft Serial Number:	61776
Year of Manufacture:	1977
Date and Time (UTC):	24 August 1998, 14:10 hrs
Location:	Dublin Port
Type of Flight:	Public Transport Category
Persons on Board:	Crew 4 Passengers 9
Injuries:	Crew 0 Passengers 9
Nature of Damage:	No damage to aircraft
Commanders Licence:	Airline Transport Pilots Licence (Helicopters)
Commanders Age:	27 years
Commanders Flying Experience:	Total Time 3042 hrs Total Time on Type 2615 hrs Total Time Previous 90 days 51 hrs Total Time Previous 28 days 26 hrs
Information Source:	National radio news AAIU Field Investigation

Synopsis

EI-MES was performing a demonstration in Dublin Port, in association with the Tall Ships Event which was being held in Dublin. The demonstration consisted of dropping a team of nine swimmers of the Irish Naval Service Diving Section, from the helicopter into the River Liffey. When they jumped from the moving helicopter, the swimmers suffered varying injuries. Two of the injured swimmers were hospitalised for more than 48 hours.

FINAL REPORT

Factual Information

Background

The Irish Marine Emergency Service (IMES) of the Department of Marine and Natural Resources awarded a contract to supply an East Coast SAR Service, located in the Dublin area, to a civilian helicopter operator. This service was inaugurated on 1 July 1998, and consisted of a Sikorsky 61N helicopter based at Dublin Airport. The same company have been operating a similar service, based at Shannon since January 1997. Many of the contractor's personnel had previously worked for another contractor, at Shannon, who had provided the service for some six years prior to 1997.

Background to the Flight

The organising committee of the Tall Ships Event at Dublin Port had originally requested the Air Corps to provide a SAR Demonstration during the event. As the Air Corps, by this stage, did not have a helicopter on East Coast stand-by, the request was passed to IMES.

In response to the request, IMES agreed to provide a SAR demonstration. Following consultations with the contractor, it was agreed that a standard SAR demonstration would be conducted, in conjunction with a boat provided by the RNLI, on the River Liffey, just east (down-river) of the East Link Toll Bridge,opposite the Poolbeg Yacht Club. The Tall Ships fleet was tied up along the quays to the west of the bridge, but the contractor considered this area to be excessively restricted by ships masts, buildings etc., for a SAR demonstration. The contractor's Chief Pilot (Dublin Base) carried out an aerial recce of the Poolbeg Yacht Club area on the Saturday before the demonstration.

On the weekend before the demonstration, the contractor's operations manager advised IMES of a SAR winch failure. Consequently, a spare winch was not immediately available, and that for this reason he advised that only one winch lift would be conducted in the SAR demonstration. Normally a SAR demonstration would consist of several lifts. The recommendation was based on the need to preserve the SAR capability.

IMES were of the opinion that a single lift would not produce an effective SAR demonstration. Consequently IMES contacted the Naval Service Diving Section, on Sunday 23 August 1998. This Section had been positioned in Dublin to support the Tall Ships Event. The objective of this contact was to provide an alternative demonstration which would not require the use of the helicopter's winch. IMES were aware that the Naval Service Diving Section had previously jumped from the Shannon based S61, and that the members of the Section had also jumped from Air Corps helicopters in demonstrations.

A demonstration consisting of dropping members of the Naval Service Diving Section from the S61 was proposed. The officer in charge of the Diving Section agreed to the request, having consulted with his superiors. IMES staff advised the officer in charge of the Diving Section that the Naval Service personnel would be briefed by the helicopter crew before the demonstration.

On the Sunday, the day prior to the demonstration, the revised plan was then put to the contractor's duty pilot, who initially declined the task as it had not been rehearsed. However, following further discussion with the Dublin-based training captain and acting chief pilot, the task was accepted. A salient point in this re-consideration was the successful exercise conducted with the Shannon-based S61, about one month previously, albeit with a different aircrew. At this point it was still understood that the demonstration would take place near the Poolbeg Yacht Club.

The training captain was aware that the on-duty commander and co-pilot who were to perform the demonstration had no previous experience of dropping personnel from helicopters, but he did stipulate that a full briefing should be conducted by the Naval Service Diving Section leader and the aircraft commander before the demonstration flight.

History of the Flight

The Naval Service Diving Section arrived at the contractor's facility at Dublin Airport at approximately 13.00 hrs on the day of the demonstration. A briefing took place between the Naval Service Diving Section leader and the aircraft crew. At this briefing it was agreed that the demonstration would now take place in the river area to the west of the East Link Bridge, and that the Diving Section members would jump from the helicopter into the centre of the River, on a line from the East Link Bridge towards the Matt Talbot Bridge, which is approximately 1 nm upstream of the East Link Bridge. This area was chosen as this was where the tall ships were docked, and where the vast majority of on-lookers would be gathered. Because the Diving Section members were to be dropped while the aircraft was moving forward, rather than hovering, the commander felt that the limitations that had applied to the original SAR display, which would have involved considerable hovering, did not apply. The commander had reconnoitred the area, both by land and air, on the previous Saturday.

Immediately before the flight, there was a meeting/briefing session between the officer in charge of the Diving Section and the aircraft crew, where the location of the drop and other matters were decided. It was agreed between the Naval Service Diving Section leader and the aircraft crew that the Diving Section members would jump from the aircraft at intervals of 5 seconds.

With regard to the target height and target speed to be used in the demonstration, there is marked divergence in the recollections of those involved as to what was agreed. The rest of the aircrew and the other members of the Naval Service Diving Section were briefed.

Again there is divergence of recollection as to the contents of this briefing. The Naval Service Diving Section members were also instructed by the section leader that they would not wear their foot fins, but should hold them under their arms. This was a standard procedure used by the Naval Service Diving Section on high jumps, in order to prevent leg injuries.

The commander arranged to have the 500 kg of fuel removed from the aircraft, to ensure adequate single engine performance in the event of an emergency.

The aircraft then departed Dublin Airport at approximately 13.30 hrs. On arrival in the Port area, it initially flew up the River Liffey to a point approximately 1.5 nm west of the East Link Bridge, turned east, descended and performed a low fast run down the river, then climbed to clear the East Link Bridge, descended again and did a climbing left turn, to come back to the East Link Bridge from the east. As the aircraft approached the bridge it decelerated. At the same time the Diving Section members started to prepare and position themselves for the jump. The aircraft maintained a height of approximately 80 ft., to clear the lights on the Bridge and then descended to a height of 30 to 35 feet, west of the Bridge. The queue of Diving Section members were now positioned in a line leading to the forward door on the RH side of the aircraft. The winch operator, who was acting as dispatcher, advised the commander that the jumpers were ready. The commander instructed the winch operator to delay for a moment, until they reached an area where there were more spectators and he then told the dispatcher that they were cleared to jump. The winch operator then tapped each Diving Section member on the shoulder to indicate that he was clear to jump.

After the dispatch of the Diving Section members had started, the winch operator made a call to the commander to reduce speed and this was acknowledged by the commander. The FDR did not record any significant change of aircraft speed after this call.

As each Diving Section member jumped, the next member stepped into the doorway and awaited the dispatcher's signal. The Diving Section leader was the first man to jump, and he was followed by six more, at intervals of approximately 4 seconds, as the aircraft flew west along the centre line of the River. The commander noticed that the presence of a line of warehouses on the North bank of the river would obstruct the publics' view of the demonstration for a portion of the run, so he told the winch operator to delay the dispatch of the final Diving Section members until the aircraft was clear of the warehouses.

The final two Diving Section members were then dropped as the aircraft approached the next bridge, which was the Matt Talbot Bridge. The aircraft then turned and did another low run eastwards down the river, turned again and performed a steep climb over the East Link Bridge.

By this time many individuals, including onlookers on the docks' wall, crews in the rescue boats, and the leader of the Diving Section, had observed that the second man to jump was lying in the water and appeared to be unconscious. The Diving Section leader swam over to him and the injured Diving Section member was pulled into a rescue boat.

The leader then advised the S61, via a portable radio on the boat, that they had an emergency situation. The S61 then winched the injured Diving Section member onto the helicopter and took him to Tallaght Hospital.

In the meantime, other rescue boats, which had been pre-positioned along the river, recovered the remaining Diving Section members from the water. Most were severely dazed, in particular the last three dispatched from the aircraft. All eight remaining members of the Diving Section were then taken to the Mater Hospital.

Seven Diving Section members were released within the following 24 hours, but two were detained for several days, one in the Mater and the other in Tallaght Hospital.

Injuries Sustained

In general, all the Diving Section members had suffered extensive severe bruising on their left side. The second man to jump, who was holding his fins under his left arm, suffered severe bruising on the left of his body and head, and he was concussed. Another member suffered broken ribs and a pierced lung, which resulted in a collapsed lung.

None of the Diving Section members believed that they came into contact with the river bottom.

Investigation

The accident was not reported to the AAIU. The AAIU became aware of the accident via media reports at 17.00 hrs on the day of the accident, and an investigation was then commenced. The aircraft crew were interviewed the same evening and the aircraft's Cockpit Voice Recorder and Flight Data Recorder were impounded by inspectors of the AAIU.

Naval Diving Section Experience

All nine members of the Naval Service Diving Section had completed the standard Naval Service divers course. This course included jumping into the water from stationary ships or bridges, at heights of up to 40 feet.

All but one member of the Diving Section had previously jumped from helicopters, but on average only 2 or 3 times. Previous jumps from helicopters were done from the hover or with very slow forward speed, of approximately 3 to 5 kts. The normal procedure used previously was to hover the aircraft at a height of 20 to 30 feet, and drop a Diving Section member, then to move forward to clear the swimmer in the water, re-establish the hover, and then drop the next Diving Section member.

All the Naval Service Diving Section were trained Naval Service divers, but for helicopter jumping exercises they are referred to as swimmers, as they are equipped only for swimming, with dry-suits, hoods, knives, goggles and fins, and were not wearing air bottles, weights or other diving equipment.

Flight Crew Experience

The aircraft commander had several years experience as a SAR co-pilot with a civilian operation on the North Sea. He had recently joined the Irish SAR operation. The demonstration was his fourth time to be rostered as aircraft commander of a SAR aircraft. He had no previous experience of dropping personnel from helicopters.

The co-pilot was previously employed by the contractor as co-pilot on a different aircraft type, flying in support of off-shore oil rig operations. He had joined the SAR operation in June 1998, and this was also his fourth duty roster. He had no previous experience of dropping personnel from helicopters. This was his first rostered duty with this particular commander.

The winch operator/dispatcher had experience of dropping swimmers and divers, about seven years previously, when he was employed in the UK Royal Navy.

The winch man did not have previous experience of dropping personnel from helicopters.

Jumping Technique

The members of the Naval Service Diving Section were trained to concentrate on the horizon as they prepare to jump. This was because any attempt to look down could cause the swimmer to lean forward and then tumble in the fall, with serious consequences. As a result the swimmer had no role in determining if the aircraft speed and height were suitable for jumping, and he only determined if he himself was properly prepared to jump.

The normal procedure was that the commander would determine that the aircraft was in the correct height and speed envelope for jumping, and would then inform the dispatcher (winch operator) that he was clear to dispatch the jumpers.

The dispatcher would then verify that there were no hazards underneath the helicopter, would then tap each swimmer twice on the shoulder, to indicate to the swimmer that he was cleared to jump.

Aircraft Instrumentation

The aircraft was equipped with a Doppler System for the direct reading of aircraft ground speed. This information was presented to the pilot on a special instrument, known as a hover-meter, which indicated ground speed on a two axis display. The maximum scale limit of this instrument was 20 kts. This instrument was graduated in 5 kt increments.

The aircraft was equipped with a standard pressure altimeter and also with a radio altimeter, which is capable of reading aircraft's height above the earth's surface.

The aircraft was also equipped with a CVR and FDR. Data from these units was recovered by the AAIU.

Weather

The weather conditions were excellent at the time of the demonstration. Met Eireann, the meteorological service gave the wind in the Dublin Part area as 10-12 kts from a NW direction. The commander estimated that the wind was somewhat less.

Military Regulations Limitations for Dropping Personnel

The only regulations located in the Irish Defence Forces, pertaining to the dropping of swimmers or divers from helicopters, are copied from UK Royal Navy procedures for divers, showing the limitations noted below.

The UK Royal Navy limits for dropping divers (not swimmers) is given in their manual as 20 ft maximum and 5 kts maximum forward speed.

The US Coast Guard utilises swimmers dropped from helicopters as a standard SAR procedure. The limitations used by the Coast Guard are 10 to 15 feet altitude and zero forward speed.

The limitations employed by the Canadian Defence Forces for similar operations are a maximum altitude of less than 10 feet and a maximum forward speed of 5 kts.

In discussion following the accident, some of the above organisations expressed concern with the practise of holding equipment, such as fins, during personnel drops from helicopter. It was their concern that this practise can lead to injuries and loss of equipment. The possibility of leg injuries resulting from the wearing of fins in high jumps is understood. For this reason, these organisations adopted the procedure of low altitude jumps, with the jumpers wearing their fins.

Civilian Regulations and Approved Procedures

Dropping or lowering objects or people from aircraft is generally prohibited under Irish aviation regulations. In order to obtain a derogation for standard SAR operations, including winching, the contractor had to submit their operations manual for approval by the Irish Aviation Authority (IAA). This manual did not cover procedures and limitations for dropping personnel from a helicopter in flight.

The IAA were unaware of the previous personnel dropping exercise which was conducted in Shannon, or of the plans for the demonstration at the Tall Ships event, and had not approved the dropping of personnel from civilian helicopters while in flight, or while hovering.

Analysis

Data obtained from the aircraft's flight recorder show that the swimmers jumped from the aircraft when it was travelling at a forward speed varying between 26 and 31 kts, at a height varying between 22 and 31 feet. This data is shown in Annex A. The FDR evidence is supported by photographs and video taken by members of the Garda

Siochana, and members of the public. The video evidence also indicated that the initial batch of Diving Section members jumped at intervals of about 4 seconds.

The injuries to the Diving Section members were consistent with high forward speed entry into the water, in that the injuries and bruising were concentrated on the left side of their bodies, which in turn is consistent with exiting the aircraft on the right hand side facing directly out of the doorway.

The Decision to Dispatch

As noted above, the Naval Service Diving Section personnel were not in a position to determine for themselves if they were in a suitable jumping envelope, with regard to speed and height of the aircraft.

Normally, the dropping of swimmers or divers is conducted in less confined waters and the personnel are dispatched when the helicopter is established in the hover or near hover, at the end of a slow shallow approach to the drop zone. In this case the approach to the drop zone was preceded by a high speed low run, a pop up manoeuvre to clear the East Link Bridge, a climbing turn, an approach at 80 feet to clear the bridge, and finally a descent to the drop zone. In the final phase of the approach, buildings, ships and other obstacles were close to the right side of the aircraft. Furthermore the plan of the operation was to drop the swimmers while the helicopter was moving forward. The foregoing resulted in a situation where it was difficult for the dispatcher to estimate if the aircraft was in a suitable envelope for the safe dispatch of the swimmers.

Regulatory Aspects

Permission was not sought, from the Irish Aviation Authority, to engage in such a demonstration, which was outside the scope of the approved operations manual.

Planning

Many factors relating to the demonstration had not been taken into consideration, indicating a lack of planning:-.

The depth of water in the drop area was not known by the participants. Fortunately this was not a factor, as none of the swimmers appeared to have hit the bottom.

The length of the proposed drop area was approximately 1,300 meters long. If the nine swimmers were to be dropped equally spaced at 5 second intervals over this distance, as planned, the helicopter would need to maintain a speed of 64 kts. There is no evidence that anybody performed the basic calculation required to reconcile the length of the drop area, the drop interval and the target forward speed of the aircraft, i.e. 10 kts maximum.

The leader of the Diving Section stated that he was unaware, until after the event, that the cockpit crew had no previous experience of dropping personnel from helicopters into water. The commander of the aircraft stated that this was pointed out at the briefing.

Demonstration Pressures

The management levels of all three organisations involved in the demonstration, the contractor, the Naval Service and IMES, were unaware of the final format of the demonstration. The IMES co-ordinator believed, right up to the start of the demonstration, that it was to take place to the east of the East Link Bridge. The final format of the demonstration was left entirely to the leader of the Naval Service Diving Section and the commander of the aircraft.

It was proposed to perform a rehearsal of the original demonstration format, but it was decided on the Saturday not to proceed with this rehearsal. The demonstration, in its final format, was unrehearsed.

This was a demonstration to a large crowd, at a prestigious event, performed by an aircraft operated under a new SAR contract, that had recently been set up. Furthermore, the commander was very new to the operation, and this was his first large public demonstration with this contractor. The natural pressure on the commander, from both a company and personal perspective, to present a spectacular and effective demonstration, would have been considerable.

The contractor's organisation would also have been keen to give a good demonstration of it's new service.

It was also a somewhat rare opportunity for the Naval Service Diving Section to perform in front of such a large audience. Again there also would have been considerable pressure to provide a spectacular display.

IMES had undertaken to provide a demonstration using the newly established East Coast SAR service. The non-availability of the back-up winch curtailed the proposed SAR demonstration and IMES sought, at short notice, to provide an alternative demonstration.

Safety Co-ordinator

Many aviation organisations appoint non-participating safety co-ordinators or supervisors who are responsible for supervising display routines, and for approving the display and the personnel involved before the display is performed in front of the public audience. This role is a significant bulwark against air display pressures. There is no evidence of any person performing this role with regard to this demonstration.

Jumping Techniques

The helicopter jumping techniques used by the Naval Service appear to be at variance with the techniques used in comparable organisations.

Interim Safety Recommendation

Following the accident, the AAIU made the following interim safety recommendation to the IAA, on 27 August 1998 :-

> *That the dropping of persons from civil helicopters should cease, until such time as formal procedures for such activities are implemented. Such procedures should cover crew training for such operations.* **(SR 28 of 1998)**

This interim safety recommendation was copied to the Department of Defence and the Department of Marine and Natural Resources.

Dropping of Personnel

It is fully accepted that the dispatch of swimmers and divers from helicopters may well form an essential part of a SAR rescue mission. The procedure is not particularly hazardous, provided that the appropriate procedures, limitations, training and experience requirements are laid down and observed.

This report deals solely with events related to the dropping of personnel from in flight or hovering helicopters, into water. The conclusions and safety recommendations contained herein relate to this type of activity.

Conclusions

1. The injuries to the members of the Naval Service Diving Section were caused by the excessive forward speed of the aircraft.

2. The following factors contributed to the accident:-

a. Lack of aircrew experience, particularly commander's experience, in this type of operation.

b. Lack of planning, rehearsal and aircrew training for the demonstration.

c. Lack of laid down, agreed and approved procedures for dropping personnel from the helicopter.

d. Lack of management involvement and supervision, on the part of the Naval Service and the contractor.

e. Display pressure on the participants.

f. The failure to appoint an effective safety co-ordinator for the demonstration.

g. The helicopter jumping techniques used by the Naval Service.

Safety Recommendations

1. The IAA should lay down criteria and procedures for the dropping of personnel from civilian helicopters involved in the SAR role. Such criteria should pay particular attention to requirements covering training and demonstrations. **(SR 20 of 1999)**

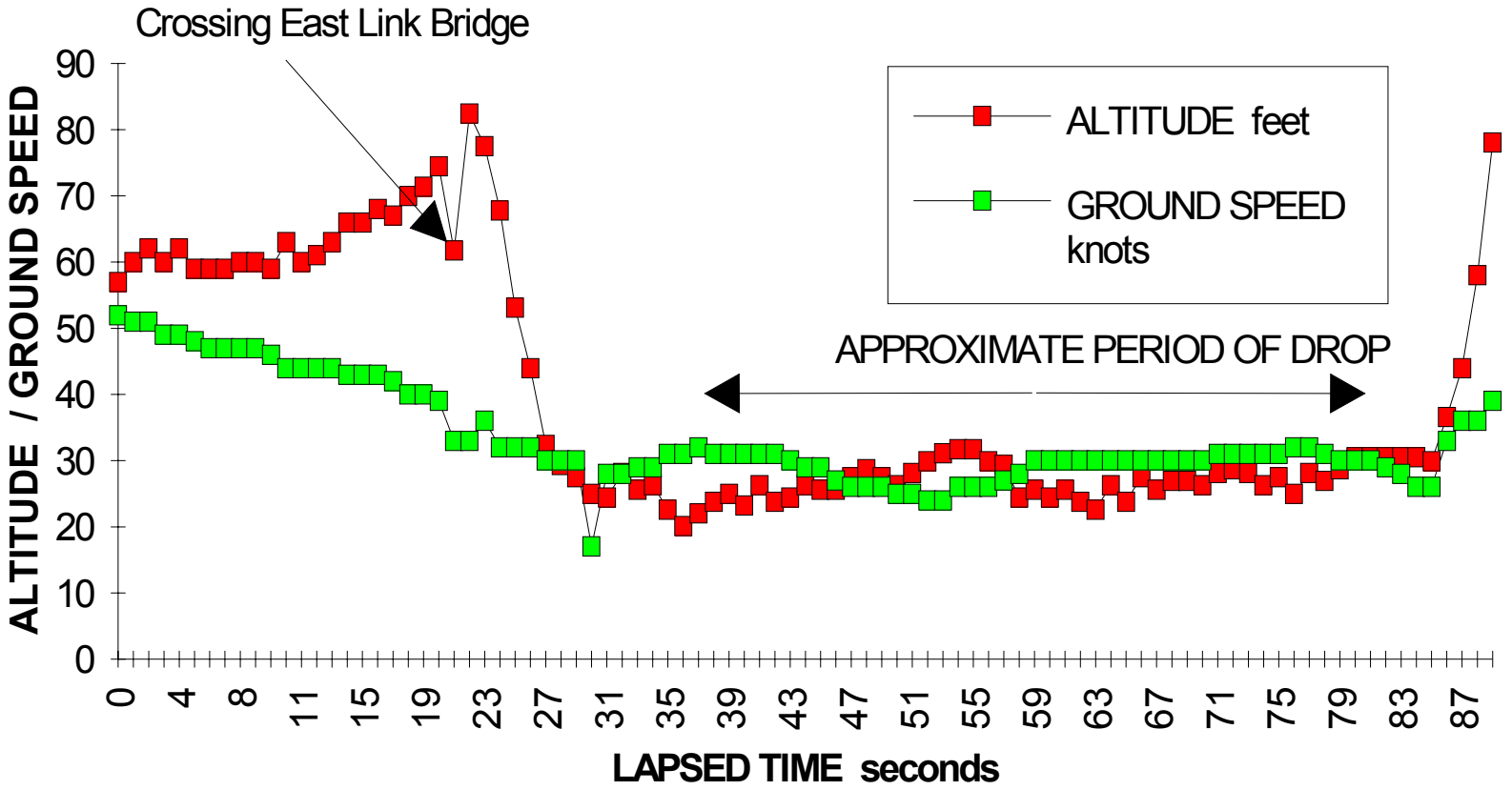
2. The contractor should be mindful of the pressures that displays and demonstrations place on participants, and should ensure that preparations for such displays include clearly specified appropriate limitations, adequate training and rehearsal. **(SR 21 of 1999)**

3. The contractor should appoint a safety co-ordinator who should be tasked to ensure that displays are properly rehearsed and that the participants are properly trained, and that appropriate limitations are laid down, before a public display is embarked upon. **(SR 22 of 1999)**

4. The Defence Forces should generate regulations covering the dispatch of Defence Forces personnel, engaged in swimming or diving activities, from helicopters. **(SR 23 of 1999)**

5. The Defence Forces should review the techniques used by Defence Forces personnel jumping from helicopters. **(SR 24 of 1999)**

ANNEX A


Crossing East Link Bridge
ALTITUDE feet
GROUND SPEED knots
APPROXIMATE PERIOD OF DROP
ALTITUDE / GROUND SPEED
LAPSED TIME seconds
0
10
20
30
40
50
60
70
80
90
0
4
8
11
15
19
23
27
31
35
39
43
47
51
55
59
63
67
71
75
79
83
87