# FINAL REPORT ON ACCIDENT TO HELI- UNION COMPANY LTD. HELICOPTER SIKORSKY S76 C++ NEAR YETAGUN IN ANDAMAN SEA ON 11.07.2011

**REPORT ON ACCIDENT TO**

**HELI- UNION COMPANY LTD.**

**HELICOPTER SIKORSKY S76 C++**

**NEAR YETAGUN IN ANDAMAN SEA ON 11.07.2011**

| | |
|---|---|
| 1. Registered owner and operator | : Heli-Union Company Ltd. |
| 2. Aircraft type | : Helicopter SIKORSKY S76 C++ |
| 3. Nationality | : French |
| 4. Registration | : F-HJCS |
| 5. Place of Accident | : Near Yetagun in Andaman Sea<br>Latitude N 1446362<br>Longitude E 267324 |
| 6. Date & Time | : 11 July 2011 at 10 h 19 (local time) |
| 7. Type of Operation | : Off-shore Operation |
| 8. Phase of operation | : During take-off from FSO Helideck |


SYNOPSIS

On 11 July 2011 the helicopter Sikorsky S76 C++ registered F-HJCS operated by Heli-Union took-off from Kanbauk Airfield with 7 passengers and 2 flight crews bound for the Yetagun Floating Storage Offloading (FSO).
After landing on the FSO, one passenger disembarked and three passengers boarded. During this phase, the rotor was still turning.
Then the crew intended to take-off to Yetagun platform. The captain (pilot flying) climbed vertically. At 25 feet above the platform, the pilot initiated a cyclic input, then the aural warning sounded and ENGINE OUT warning light illuminated on the instrument panel. The captain noticed the left engine T5 temperature increasing to the red zone (up to 983°C) and heard a clanking noise.
He decided to ditch the helicopter. He initiated the floating devices deployment. The contact with the sea surface was rather hard and the helicopter then capsized onto its left side. Flight crew and passengers managed to get out of the helicopter. All the crew and passengers were rescued after approximately one hour. Three occupants (including co-pilot) drowned to death and two other passengers suffered serious injuries. There were no signals detected from either the emergency locator transmitter or the personal locator beacons worn by the occupants of the helicopter.


## 1) FACTUAL INFORMATION

## 1.1) History of the flight

### *1.1.1) Pre-flight preparation*

The morning of the occurrence, the crew completed their flight planning and prepared the helicopter. The first part of the flight consisted in landing on the FSO helideck which is about 110 NM from Kanbauk. The height of the helideck is estimated to be 50 feet.
The helicopter refuelled completely and hydro test. Seven passengers were on board. They received the required pre-flight safety briefing. The crew and passengers were provided with lifejackets for the offshore flight.
(For the flight, the captain occupied the right seat and was the pilot flying (PF). The co-pilot was seating on the left seat and was the pilot not flying (PNF).

### *1.1.2) Departure and En-route*

The pilot took off from Kanbauk at about 09h00 local time. He flew along the route over the Andaman sea and made call at the designated reporting point wh 1, wh 2. He landed at 10h13 on the helideck of the FSO. A passenger disembarked and three passengers boarded. The FSO was oriented on a 215° heading, the wind was from 228° for 17-18 knots. The pilot hovered on heading 125° before take off. He then climbed vertically to 25 feet and took off to Yetagun platform located one nautical mile from the FSO.

### *1.1.3) Recognition of emergency and ditching*

At 10h19, CVFDR and EVXP recorded that after take off passing 25 feet vertically, the aural warning sounded and ENGINE OUT warning light illuminated. The left engine temperature T5 was in the red zone (983°C read by the pilot) and the pilot felt the helicopter loosing power and heard a clanking noise. Because of the low height of the helicopter the pilot decided to ditch. He inflated all the four floating devices before touching the water surface.

### *1.1.4) Helicopter sinking and rescue*

The contact with the sea was rather hard but the ditching took place without any problem. At that time the swell was approximately 2 meters and the wind resistance was approximately 90° right of the helicopter. Consequently after ditching, the helicopter capsized onto its left side. At that moment the roof windows were opened and water poured into the cockpit. The crew and passengers opened some jettison doors and got out within a few minutes by helping each other. All the life jackets and two life rafts were inflated and the PF managed to help his co-pilot and passengers.
The person on the FSO threw life buoys and positioned a ladder. Approximately 30 minutes later, the field standby boat assigned to Yetagun field, which was localised between FSO and the platform, arrived and continued the rescue operations.

After approximately 60 minutes, all crew and passengers were onboard. Co-pilot and two passengers drowned to death and other two passengers were seriously injured.

### 1.2) Injuries to persons

| Injuries | Crew | Passengers | Others | Total |
|---|---|---|---|---|
| Fatal | 1 | 2 | - | 3 |
| Serious | - | 2 | - | 2 |
| Minor/none | 1 | 5 | - | 6 |
| Total | 2 | 9 | - | 11 |

### 1.3) Damage to the aircraft

The helicopter was slightly damaged by the impact with the sea and it toppled just after ditching and the prolonged salt water immersion. The main rotor blades and tail rotor blades were broken. The right crew door, the window of the right sliding door, the right front window and the window of the left side door were missing, probably due to actions of the crew and passengers during evacuation.


### 1.4) Other Damage

There was no other damage.

### 1.5) Personnel information

*1.5.1) Captain*

| | |
|---|---|
| Age: | 45 |
| Licence: | Airline Transport Pilot's Licence |
| Helicopter Ratings: | Sikorsky S76 C++, AS332, SA365 |
| S76 rating validity: | valid to 31/12/2011 |

| | |
|---|---|
| S76 base check: | valid to 30/11/2011 |
| Line Check: | valid to 30/04/2012 |
| Medical certificate: | valid to 30/09/2011 |
| HUET | Valid to 28/02/2014 |
| Flying experience | Total all types: 5158<br>Total on type: 529<br>Total multi-engine: 4641<br>Last 30 days: 18<br>Last 24 hours: 1 |
| Offshore experience | 1 173 |

The captain has been a helicopter pilot in the French army for 20 years. He has worked for civil operators specialized in offshore operations for 3 years. He is Flight Instructor (1555 flight hours in instruction) and Type Rating Instructor rated.

*1.5.2) Co-pilot*

| | |
|---|---|
| Age: | 57 |
| Licence: | Airline Transport Pilot's Licence |
| Helicopter Ratings: | Sikorsky S76 C++, SA365 |
| S76 rating validity: | valid to 30/04/2012 |
| S76 base check: | valid to 31/10/2011 |
| Line Check: | valid to 29/02/2012 |
| Medical certificate: | valid to 08/12/2011 |
| HUET | Valid to 24/02/2013 |
| Flying experience | Total all types: 6338<br>Total on type: 3165<br>Total multi-engine: 3732<br>Last 30 days: 28<br>Last 24 hours: 1 |
| Offshore experience | 2 675 |

The co-pilot has been a helicopter pilot in the Myanmar Air Force for 21 years. He has worked for civil operators specialized in offshore operations for 10 years . He was a Flight Instructor (350 flight hours in instruction).

## 1.6) Aircraft information

*1.6.1) General*

| | |
|---|---|
| Manufacturer: | Sikorsky Aircraft Corporation |
| Type: | S76C++ |
| Aircraft serial number: | 760740 |
| Year of manufacture: | 2008 |
| Number and type of engines: | Turbomeca Arriel 2S2 engine n°1 S/N-42266<br>Turbomeca Arriel 2S2 engine n°2 S/N-42265 |
| Total airframe hours: | 1186.27 hours |
| Total airframe landings: | 1867 cycles |

Certificate of Registration: France registered on 10/07/2009
Certificate of Airworthiness: issued by the European Aviation Safety Agency on
. 20.July 2009
Airworthiness Review Certificate: expiring on 9 July 2012
Certificate of Release to Service: issued on 11 July 2012 following a daily inspection

*1.6.2) Aircraft description*

The Sikorsky S76C++ is a twin-engine medium size helicopter, certificated by EASA Part 29 standards and capable of undertaking passengers or freight transport operations. It can be used in offshore oilfield support due to its long range. This helicopter has a four bladed main rotor.
The flight crew seats were equipped with five-strap retaining harnesses, with manual and automatic blocking system for the torso harness. The passenger seats were equipped with four-point seat belts with an automatic blocking system. Survival aspects are described in section 1.15 of this report.

*1.6.3) Aircraft history*

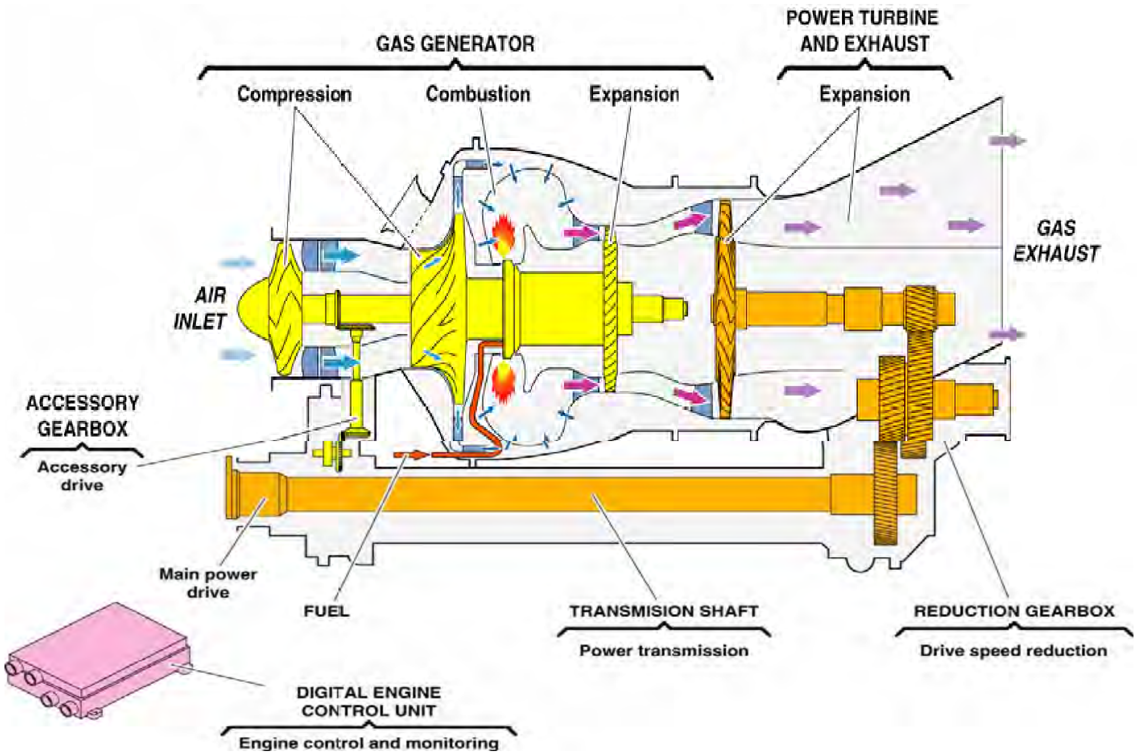
The helicopter was registered by French Civil Aviation (DGAC) on July 2009. The noise certificate and Certificate of Airworthiness were issued on 20 July 2009. The Air Operator Certificate (AOC) was delivered on 20 July 2009. The helicopter arrived in Yangon base on 12 August 2009. The last maintenance operation was carried out on 2 July 2011.

*1.6.4) Recent activity*

On 10 July 2011, the helicopter flew from Yangon to Kanbauk. The duration of the flight was 01h32.
On 11 July 2011, flight crew was performing the first flight of the day from Kanbauk to FSO which had duration of 55 minutes. During this flight, there were no anomalies.

*1.6.5) Engines*

The Arriel 2S2 engine is a turbo-shaft engine with a single-stage axial compressor, a single-stage centrifugal compressor, an annular combustion chamber, a single stage high-pressure turbine, a single stage power turbine, and a reduction gearbox with a nominal output at 6400 rpm. The engine is rated 923 shp (688 kW) at takeoff power and 833 shp (629 kW) at maximum continuous power.
The ignition system includes one high-energy generator, two injectors, and two igniters.




Last significant maintenance tasks:
5 July 2011 – Time Since New (TSN) = 1175 hrs: Torque stabilisation check in accordance with Maintenance Manual (iaw MM) task 71-02-00
25 June 2011 – TSN = 1164 hrs: Engine Power Check: Power margin = 4.5%, ΔT45 = 26°C
A 300 hours periodic maintenance check was performed on 19 January 2011 at TSN = 898 hrs.

*1.6.6) Weight and balance*

Due to the meteorological condition (monsoon), the helicopter refuelled completely at Kanbauk (1790 lbs) and the take off weight of the helicopter was 11 295 lbs. Before take off for Yetagun, the weight of the helicopter was 10 919 lbs.

| | KBKAF | FSO |
|---|---|---|
| OEW | 8279 lb | 8 279 lb |
| Pax / payload ↘ | | 1/235 lbs |
| Pax / payload ↗ | 7 | 3/526 lbs |
| Pax total | 7 | 9 |
| Payload tot | 1236 | 1517 |
| ZFW | 9505 | 9796 |
| TO Fuel | 1790 | 1123 |
| TOW | 11295 | 10919 |
| LDG Fuel | 1183 | |
| LW | 10688 | |
| CG (ok) | ok | ok |
| Endurance | 2h50 | 1h47 |
| Meteo | | |

*1.6.7) Avionics*

The S76C++ helicopter SN : 760740 F-HJCS is equipped with an offshore standard avionics system package with additional equipments which include an Automatic Flight Control System (AFCS) with a four-axis autopilot, 1 Traffic alert and Collision Avoidance System (TCAS), 1 Enhanced Ground Proximity Warning System (EGPWS), 4 Electronic Flight Information System (EFIS), 3 Integrated Instrument Display System (IIDS), Sky track system, 1 Multifunction Flight Display (MFD), 1 radio altimeter, GPS, Mode S Transponder, 1 EVXP Health and Usage Monitoring System and a weather radar. This aircraft is also equipped with the AFDS for flotation.

RADIO RECEPTION :
-**COM1**: Enables VHF 1 radio receive audio and volume control.
-**COM2**: Enables VHF 2 radio receive audio and volume control.
-**COM3**: NPX 138N - High Band VHF-FM
-**COM4**: HF radio receives audio and volume control.
-**COM5**: Sky Track ISAT 100

*1.6.8) Caution and Warning Panel*

1.6.8.1) Master warning panel

Captain and co-pilot have a master warning panel on their own instrument display. The master warning panel consists of an amber Master Caution light, four red lights (ENG1 FIRE, ENG 1 OUT, ENG 2 FIRE, ENG 2 OUT) and spaced outboard, two blue “ENG CONTROL PRESS TO DIM” lights. To direct the pilot’s attention to the IIDS displays when a warning or caution light goes on, the MASTERCAUTION PRESS TO RESET light will also goes on. After the condition has been noted, the master caution should be reset to allow it to light again if another caution light should go on. The master caution light does not lit when an advisory light on the performance display goes on.


1.6.8.2) Engine failure warning system

When the n°1 or n°2 ENG OUT red warning light goes on a tone (550 Hz and 700 Hz) will be heard in the headset in two cases:

- When the DECU engine failure detection logic detects an engine out condition for that engine or
- When N1 for the corresponding engine drops to 48%.

The alternating tone signal is inoperative when the helicopter is on the ground; however, the warning lights will be on whenever N1 is less than 48%.

*1.6.9) Emergency Locator Transmitters*

The helicopter is equipped with two Emergency Locator Transmitter (ELT) 406 AF. A fixed one(ADT406)is installed in the tail boom and has a G-switch.The second one (500-12Y) is portable and installed between the two pilots seats.The ELT can be detected by S&R Satellite constellation and located with a precision of 2 km. The contact with the sea was too smooth to activate the fixed ELT. Neither the PF nor the PNF have activated the portable ELT. No signal was recorded during the event.

## 1.7) Meteorological information

*1.7.1) Synoptic situation*

Due to the full monsoon seasons, weather of Kanbauk was raining lightly.

*1.7.2) Available forecasts*

Wind direction was south westerly, speed 16 to 21 knots with gust, swell direction south coast, swell height 2 meters.

1.7.3) Platform weather

Yetagun Field weather observation: on 11 July at 10h38, surface wind was 228° 17 to 18 knots, temperature 28.2°C, QNH 1006.2 Mb, sea was moderate, swell was westerly 2 m, ceiling was overcast.

## 1.8) Aids to navigation

*1.8.1) Platform navigation aids*

FSO is equipped with Non Directional Beacon. The frequency is 529 MHz.

*1.8.2) airborne navigation aids*

The S76C++ is equipped with a Collins ADF 462. This system permanently informs the crew of the bearing of a ground transmitter. The information is displayed on the EHSI, which enables its reading directly in the form of a QDM.

## 1.9) Communications

The S76C++ makes first contact with the FSO on FM chanel 6 then the second contact on frequency 118.7 MHz.

## 1.10) Airfield information

The helideck is located on the Yetagun FSO which is a tanker. The location is N13°3.85'and E096°51.22'. The height is 50 feet with maximum mass of 9 tons. The FSO is 1 NM away from Yetagun Platform. In case of engine failure and flight on single engine, the alternate airfield is Dawei located at 100 NM away.

## 1.11) Flight recorders

### *1.11.1) SSMVDR*

The helicopter was equipped with one Solid State Memory Voice/Data Recorder.
Manufacturer Honeywell
Model 6021
Part Number 980-6021-066
Serial Number ARCOMBI-12023

The SSMVDR is the mandatory flight recorder on board. This records 110 hours of data and 2 hours of audio. The audio recordings include the Captain's and co-pilot's communications, radio transmission, passenger announcements and audio from the cockpit area microphones (CAM). The SSMVDR and its recordings were successfully recovered. The data and audio recording stopped a few seconds before the impact.

The recorder was equipped with an Underwater Locator Beacons (ULB) attached. These devices are set on contact with water and must transmit a signal for at least thirty days.

Read-out operations of the SSMVDR were performed on 12 December 2011 in the BEA. All the data was recovered from the flight data file by reading out the memory chips. The flight of the event is recorded. Preliminary data were plotted and listed.

The file containing the voice data was then decompressed with Playback tool software utility (998-3414-507) into the standard audio wave files.
The four audio files could be identified as follow:
- three files containing the last two hours of recording of captain (track 1), co- pilot (track 2), every one mixed with VHF communications, and a third channel usually called 'flight engineer-or public address' (no data on this channel for this helicopter - seems to be not connected as per design),
- One file containing the last two hours of recordings of the Cockpit Area Microphone (CAM).

Transcription is in appendix A (CVR transcription)
Technical report of the SSMVDR examination is in appendix B (Tech: doc SSMVDR)

*1.11.2) HUMS*

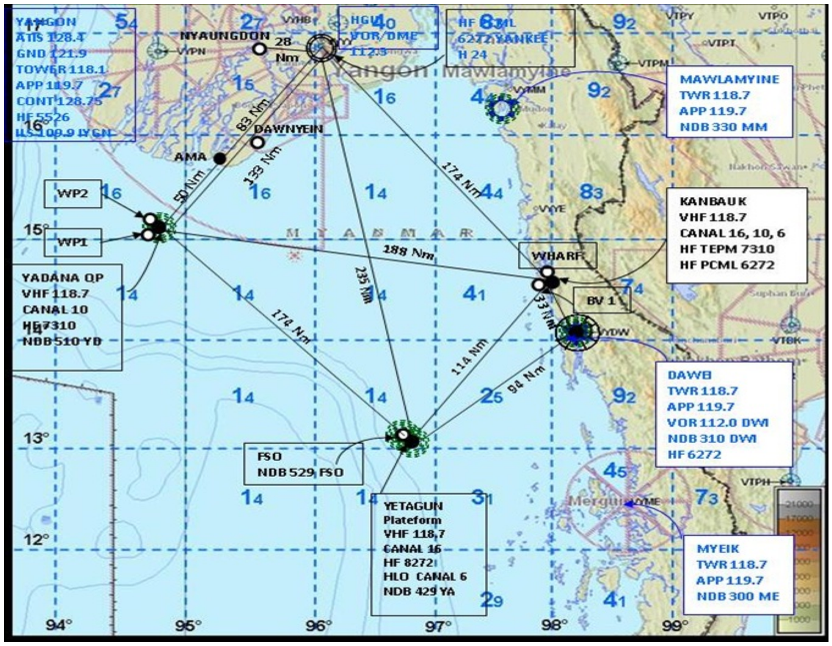
The helicopter was equipped with a Health and Usage Monitoring System (HUMS Honeywell eVXP). This equipment records additional parameters which are not recorded by SSMVDR.
The data provided by the eVXP are consistent with the ones provided by the SSMVDR.
It shows that engine #1 torque reached 150% as engine #2 torque went to 0%.
The pilot initiated a cyclic input and simultaneously the engine #2 failure occurred. The helicopter was at a height of 25 feet above the helideck.
Technical report of the EVXP examination is in appendix C (Tech: doc eVXP exam)

## 1.12) Wreckage, site and impact information

*1.12.1) The site*

The coordinates of accident site are latitude N13°04.05' and longitude E096°51.52'
The depth is around 100 meters.
The helicopter ditched near the FSO, at approximately 50 meters. Then it drifted about 700 meters. The wreckage was located at 940 meters in the 328° direction from the last known position. No particular debris were found and the seafloor is flat.

The helicopter was put in a cargo net and was lifted out of water.




*1.12.2) Initial visual examination*

The airframe was in good general condition. The tail boom was damaged and partially separated from the cabin probably due to the contact with the sea surface and then with the seabed and increased by the recovery operations. The main gear box was severely damaged due to its housing corrosion. The main rotor head came off during the recovery operation.

All four main rotor blades were broken off from the rotor head and the remaining sections still attached were approximately 50 cm in length. The blades were not recovered.

The tail rotor blades were broken off from the tail rotor assembly and not recovered.The cabin and cockpit including instrument panel and controls were in good condition.

*1.12.3) Engines visual examination*

The general aspects of the engines appeared in good condition and were locally covered with deposits which were a consequence of the time spent in sea water. Engine #
1 (s/n 42266) did not exhibit any pre-accident damage with no particular findings to report.

The on-site boroscopic examination of engine #2 (s/n 42265) revealed damages to the blade tips of both high pressure turbine (gas generator) and power turbine (free turbine). The pipes at the accessories gearbox breather gear output and at the bleed valve output were found disengaged. The moment of their disengagement could not be established. The disengagement of those pipes does not affect the engine's ability to deliver the required power. There were no other significant findings on engine #2.

## 1.13) Medical and pathological information

The co-pilot and two passengers passed away of cardiopulmonary arrest due to drowning. Two persons were seriously injured, suffering back and chest pain.

## 1.14) Fire

There was no fire.

## 1.15) Survival aspects

### *1.15.1) Flotation system – inflation*

The helicopter was equipped with an emergency flotation system consisting of four inflatable units. A flotation bag was installed on each main landing gear compartment door and two were installed in compartments next to the nose landing gear. The emergency flotation system was successfully inflated by the PF just before ditching. The picture below shows that the devices were inflated.

### *1.15.2) Survival life rafts*

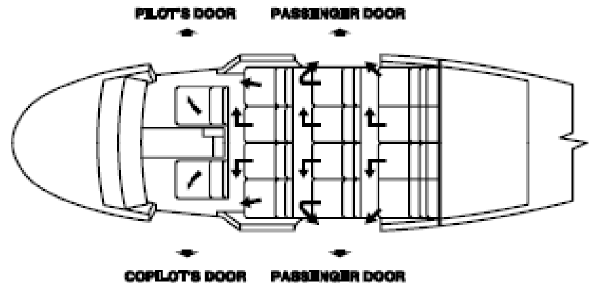
The helicopter was equipped with two identical life rafts model RFD Aerolite 10 with a rated capacity of 11 occupants and overload capacity of 17 occupants mounted on the exterior of the aircraft below the right and left hand cabin doors. The two life rafts were inflated.

### *1.15.3) Life Jacket*

The flight crew and each passenger were equipped with life jacket MK28. All passengers had their jacket inflated.

### *1.15.4) Helicopter evacuation*

All emergency exits must be usable at all times, except if an official concession is obtained. All emergency exits of F-HJCS were usable. The captain evacuated through the right pilot's door while the passengers and the co-pilot evacuated through the window of the right sliding passenger door.




*1.15.5) Survival training*

1.15.5.1) Crew training

The captain and the co-pilot had trained a Helicopter Underscape Escape Training. It consists in evacuating a generic submerged cabin with safety belt fastened, lifejacket on, inflating the lifejacket in the water and getting onto an inflated lifeboat.

1.15.5.2) Passengers training

All passengers had trained a Helicopter Underscape Escape Training as well.

*1.15.6) Search and Rescue organisation*

The International Association of Oil and Gas Producers (OGP) have issued Aircraft management guidelines in order to provide a ready reference for the management of aviation.
These guidelines and the readily available support from Aviation Advisers should assist those responsible for managing aviation, particularly if they are not aviation specialists, to plan, develop and control, safely and efficiently, air transport operations that are best suited to their needs.
The part 12 describes the emergency response planning. "*Each OGP Member's site operation or asset using aviation services should make provisions for aviation emergencies in their Emergency Response Plans (ERP) and communicate these plans to all relevant personnel.*"
For both FSO and Yetagun platform, an ERP was available.

1.15.6.1) Floating Storage Offloading (FSO)

The FSO arrangements Manual, Chapter 2 Emergency Response, section 5 Helicopter emergencies, part 1.2.2, describes the procedure in case of Helicopter Ditching in the vicinity of the FSO. "*Preferably, the field stand-by boat will be in close support around the FSO with the fast zodiac ready for immediate launch. If the stand-by boat cannot be in close support, i.e. because there is an offload taking place, and she is secured to the export tanker or she is deployed elsewhere in the field, then the fast zodiac should still be available for launch. If the above is not possible, then the FSO starboard lifeboat should be ready for immediate launch. Should the helicopter ditch, the ability to reach the crash site*

*as quickly as possible is essential… Once personnel are recovered from the helicopter, they should be taken to a safe refuge as soon as possible, which may be the stand-by boat, the FSO or the Yetagun platform*".
Cf appendix D (Yetagun, FSO arrangement Manual, chap-2,sect-5,1-2-2)
When the accident occurred, the field stand-by boat was closed to the Yetagun Platform. The FSO personnel launched only life buoys and positioned a ladder. The FSO starboard lifeboat was not used. FSO personnel waited for the field standby boat to come from platform.

1.15.6.2) Yetagun platform

The PCML Emergency Management Plan describes in introduction that "*This Emergency Management Plan has been developed in order to provide guidelines to the on-duty emergency management team who are directly or indirectly involved, when responding to emergencies occurring at PCML operational areas. The document has been developed to complement the existing Site Emergency Response Plan, which covers in detail the required response to specific emergencies.* Cf appendix E (PCML Emergency Management plan, part-1.2)
The PCML has established specifically for Yetagun's site the "Yetagun A & B Emergency Response Plan" by PC Myanmar. The preface explains that *"This Emergency Response Plan has been developed to ensure that PCML reacts quickly and effectively in the event on an emergency in the Yetagun field".*
The objective of the Manual part 1.2 describes: "*The document describes the actions that are taken to mitigate, control, or evacuate from emergency situations and identifies responsibilities, procedures and equipment available to provide an effective response".* Cf appendix F (Yetagun A&B emergency response plan, part-1.2)

*In case of helicopter ditching – part 5.4.3 Helicopter Ditching - the On Scene Commander (this role is normally filled by the platform Offshore Installation Manager who is in charge of the emergency response on the Yetagun field – part 2.1.1) will:*

*- Instruct Radio Operator to direct the stand-by vessel to the location of the ditched helicopter.*
*- coordinate all actions necessary to assist the ditched helicopter in conjunction with the FSO and Onshore ERT.*

During the rescue operations, the OSC had several phone contacts and managed the field standby boat in order to pick up the crew and passengers.

1.15.6.3) Research and recovery of the helicopter
1.15.6.3.1) First Search campaign

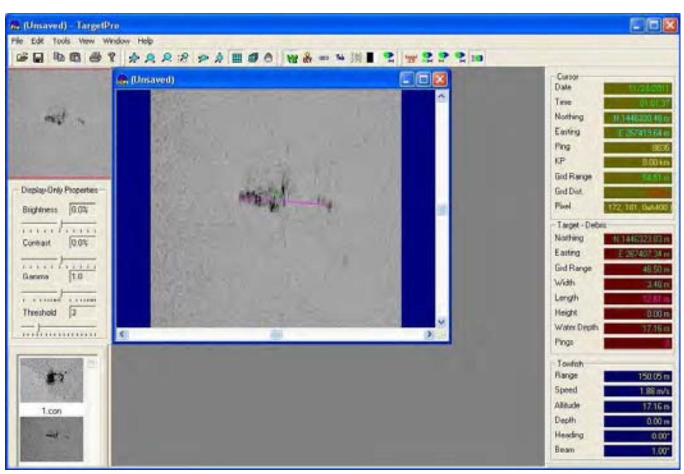
After the accident, Heli Union appointed Singapore Salvage Engineers Ltd to carry out the hydrographical survey for the search of the sunken helicopter in the Yetagun field. The objective was to locate the wreckage using Multi beam

Echo Sounder (MBES), Side Scan Sonar (SSS) and Magnetometer within the determined area. The operation took place from 22 to 27 August 2011.
No pinger signal from the CVFDR ULB was detected by the MBES during the survey.
The wreckage location could not be confirmed in MBES and SSS survey records causing delays in the survey operation.
Due to bad meteorological conditions, strong sea current and time constraint the whole pre-planned survey had to be terminated.

1.15.6.3.2) Second Search campaign

A second campaign was organised from 23 to 27 November 2011. Heli Union contracted Seascape Survey Pte Ltd to carry out the survey and recovery with a dedicated vessel. 2 ROVs, 1 GeoAcoustic Dual Frequency Side Scan Sonar and a R2 Sonic 1024 Multi beam Echo Sounder were operated on board. The hired vessel was equipped with a crane adapted for recovery operation. A technical advisor from Comex was on board to assist and advise the operations.

On 24 November, the Side Scan Sonar and Multi beam Echo Sounder survey defined two targets which were interesting and corresponding to the same position. As the multi beam was not sufficient to detect the wreck, a ROV was launched.



20 minutes later the helicopter wreckage was discovered. On 26 November, the rotorcraft was lifted out of water and loaded on board the vessel.


As soon as the helicopter had been secured, the SSMVDR, DECUs and eVXP were removed and preserved. The engines had been cleaned and protected in accordance with Turbomeca procedures. Then the vessel started the transit to Yangon Harbour and arrived on 27 November.

## 1.16) Test and research

### *1.16.1) Engines examination*

1.16.1.1) Visual examination

Arriel 2S2 engines examination has been performed in Turbomeca plant from 14 to 16 December 2011. cf appendix G (Arriel 2S2 engine Turbomeca Examination)

**Engine #1**
The accessories gearbox, axial compressor, gas generator, power turbine and reduction gearbox were in good condition and were locally covered with deposits which were a consequence of the time spent in sea water.
The HP turbine wheel assembly was analysed. All the blades and the disk were checked with dye penetrant inspection that did not reveal any cracks.

**Engine #2**
The accessories gearbox, axial compressor and reduction gearbox were in good condition and were locally covered with deposits which were a consequence of the time spent in sea water.
The gas generator
The centrifugal compressor: the centrifugal wheel exhibited light rubbing traces across the blades' top edges. The compressor front cover exhibited several local rubbing marks at inlet and outlet levels.
The combustion chamber was in good condition.

The high-pressure blade: the HP turbine wheel had one blade broken below its platform near the top of the fir tree root. All the other blades were normally positioned on the disk and exhibited impact damage and material loss above their platforms.
The HP turbine shroud and the trailing edges of the nozzle guide vane's (NGV) vanes exhibited impact marks indicative of multiple collisions with the blades' debris.
<u>The power turbine</u>
The nozzle guide vane's (NGV) vanes trailing edges exhibited impact marks.
The power turbine blades, normally positioned on the disk, exhibited impact damage and material loss above their platforms. This resulted from HP turbine blades' debris being sent down the air path and colliding with the power turbine blades.

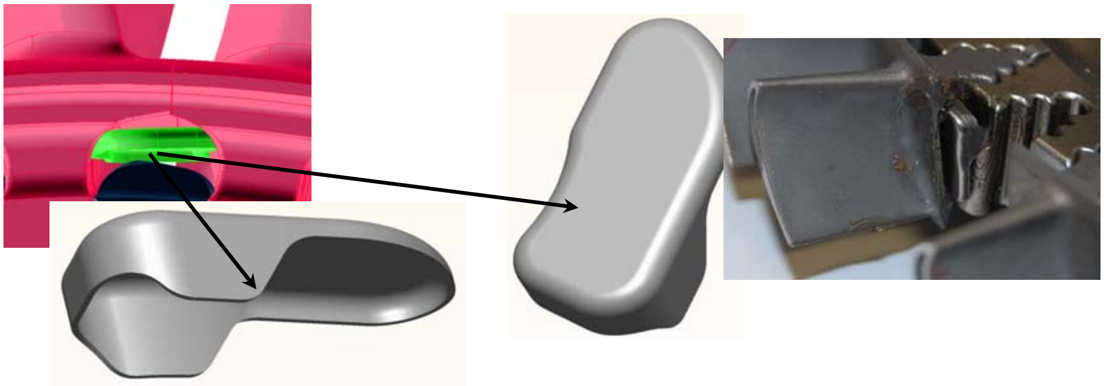
1.16.1.2) HP turbine components analysis

The engine #2 HP turbine wheel assembly was analysed. The examination identified the fatigue rupture of blade #6 below the platform. Damages to the other blades above the platform were consecutive to the rupture of this blade.
*1.16.2) Previous cases*

Turbomeca has identified blades failure phenomenon on the Arriel HP turbine since 2007.
On Arriel 2S2 engines, 7 cases of HP broken blades and 18 cases of cracked HP blades have been listed between February 2007 and December 2011.
For the year 2011, 4 cases of in-flight engine shutdowns have been registered on Arriel 2 engines (2 events on Arriel 2S2 engines including the F-HJCS accident).

The probable scenario of the blades' failure is a rupture excitation of one of the vibration modes of the HP blade in conjunction with several secondary contributing factors deemed sufficient to reduce the stress margin of the HP blade to a level consistent with the occurrences of ruptures encountered.
Turbomeca has performed corrective actions through the TU166 modification:
- Alert service letter n°2539/07/ARRIEL2/25 version 8 issued on 9 February 2012 (first version issued in April 2007) cf appendix L,
- service letter n°2784/10/AR2S version 1 of 19 November 2010 and
- service bulletin n°292 72 2166 version F of 13 May 2011 (version A issued in March 2009).

The EASA has issued Airworthiness Directives AD 2010-0198 and AD 2012-0124 mandating the accomplishment of TU166 modification.
The service letters and the service bulletins describe how to apply the TU166 modification and the applicability criteria.
The F-HJCS had not been retrofitted with TU166.
It consists of adding a damper in the inter-blade area under the platform and reinforcing inspections on new and repaired HP turbine wheels.



*1.16.3) Performance during take off*

In his check list, the pilot has two charts in order to determine if the take off will be in performance class 1 or 2.
Regarding meteorological conditions (28°C), height of the helideck (50 feet) and weight of the helicopter (10919 Lbs) for the flight of the event, the pilot had to proceed performance class 2 take off.

| MTOW - PC 1 – Elevated helipad (Unfactored wind) | | | | | | | |
|---|---|---|---|---|---|---|---|
| OAT / Helideck Height | 25° c Vw 0 to 10 kt | 30° c Vw 0 to 10 kt | 35° c Vw 0 to 10 kt | 25° c Vw 20 | 30° c Vw 20 | 35° c Vw20 | 40° c Vw 20 |
| 75 ft | 10300 | 10150 | 9850 | 11150 | 10900 | 10500 | 10150 |
| 95 ft | 10650 | 10450 | 10250 | 11650 | 11300 | 11000 | 10600 |
| 115 ft | 11450 | 11100 | 10850 | 11650 | 11650 | 11650 | 11450 |
| 135 ft | 11450 | 11150 | 10850 | 11650 | 11650 | 11650 | 11450 |

**<u>with exposure time</u>**

| MTOW - PC 2 - DPATO = 74 Kt/200ft CLEAR HELIPORT - HELIDECK | | | | | | | |
|---|---|---|---|---|---|---|---|
| OAT / HP | 15° c | 20° c | 25° c | 30° c | 35° c | 40° c | 45° c |
| 0 ft | 11700 | 11700 | 11700 | 11700 | 11600 | 11250 | 10920 |
| 200 ft | 11700 | 11700 | 11700 | 11700 | 11550 | 11200 | 10820 |
| 500 ft | 11700 | 11700 | 11700 | 11550 | 11350 | 11050 | 10680 |
| *Performance guarantied 1000 ft above heliport/helideck* | | | | | | | |

## 1.17) Organizational and management information

### *1.17.1) The operator Heli-Union*

Heli Union was founded in 1961. It has an Aircraft Operator Certificate number F-N049 valid till 20 june 2014. Following the French directives (OPS 3), it has deposited an operations manual approved by DGAC. The last authorities audit was performed in Feb 2010 for operations in Myanmar.

**Organization**

Heli Union operates helicopters on 10 sites under its own AOC:

- Issy les Moulineaux Heliport (headquarter, France)
- Toussus le Noble Airfield (Main maintenance center, France)
- Angoulème Airport (Training center, France)
- Tripoli (Lybie)
- Port Harcourt (Nigeria)
- Port Gentil (Gabon)
- Pointe Noire (Congo)
- Douala (Cameroun)
- Kanbauk (Myanmar)

The fleet is composed of 8 Sikorsky helicopters S76C++, 14 Eurocopter AS365 (N+N3) helicopters, 2 Eurocopter AS332L1.
90 pilots are authorized to perform public transport operations.

The company is organized as follow:
- Accountable Manager
- Operations Manager-(accountable post holder for Ground and Air operations)
- Training Manager
- Maintenance and Airworthiness Manager
- Quality and Safety Director
- Flight Safety Officer (FSO)

**Operations**

The company operations manual includes operational information, regulation information and instructions in order to carry out flight operations and ensure supervision of the services with trained personnel and adequate means.

**Myanmar base**

Heli-Union has an operating base in Maynmar (Yangon + Kanbauk) since 2008 with 2 S76C++ under its AOC registered. Five pilots, five engineers (A&C and avionics) and fifteen support staff are based in Myanmar. The organisation on site is built with a base manager (who is also the flight safety officer and chief of operations) and a technical manager.

*1.17.2) Performance class 2*

In 2000 the Joint Aviation Authorities Committee, representative of several European Civil Aviation Authorities, issued a document called Joint Aviation Requirements for Commercial Air Transportation (Helicopters) JAR-OPS3.
France implemented these requirements in a specific Decree, OPS3, that entered into force on 1 June 2000.

**The Subpart F –general performance**
Defines category A as multi -engine helicopters designed with engine and system isolation features specified in JAR-27/29 acceptable to the Authority and Helicopter Flight Manual performance information based on a critical engine failure concept which assures adequate designated surface area and adequate performance capability for continued safe flight in the event of an engine failure.

**The subpart H –class 2 performance**
Definition: Performance Class 2 operations are those operations such that, in the event of critical power unit failure, performance is available to enable the helicopter to safely continue the flight, except when the failure occurs early during the take-off manoeuvre or late in the landing manoeuvre in which cases a forced landing may be required.
An operator shall ensure that helicopters operated in Performance Class 2 are certificated in Category A. OPS 3.515. Cf appendix H (JAR-OPS 3, Section 1, subpart H, JAR-OPS 3.515 General, page 1-H-1)
The operators wishing to operate their helicopters in performance class 2 without an assured safe forced landing capability during the take off and landing phases (with exposure time) must obtain an approval from the competent authority in accordance with appendix 1 to OPS 3.517 (a). Cf appendix H (JAR-OPS 3, Section 1, subpart H, JAR-OPS 3.517 Operations without an assured safe forced landing capability, page 1-H-1)

**The appendix 1 to OPS 3.517 - The Advisory Circulars Joint/ACJ-1 to appendix 1 OPS3.517**
In order to obtain an approval for operations with exposure time the operator must provide a risk assessment analysis to the authorities. Cf appendix H (JAR-OPS 3, Section 1, subpart H, Appendix 1 to JAR-OPS 3.517 (a) Helicopter operations, page 1-H-3)
The ACJ introduces a power plant system reliability assessment to demonstrate the eligibility of the helicopter for operations with an exposure time to a power unit failure during take-off or landing. The eligibility requires establishing that the probability of power unit failure during the exposure time is not higher than 1 per 100,000 engine functioning hours over a five years sliding period. A higher rate not exceeding 3 per 100,000 hours of functions could be accepted by the authority after an evaluation showing an improvement.

*1.17.3) Heli -Union operations*

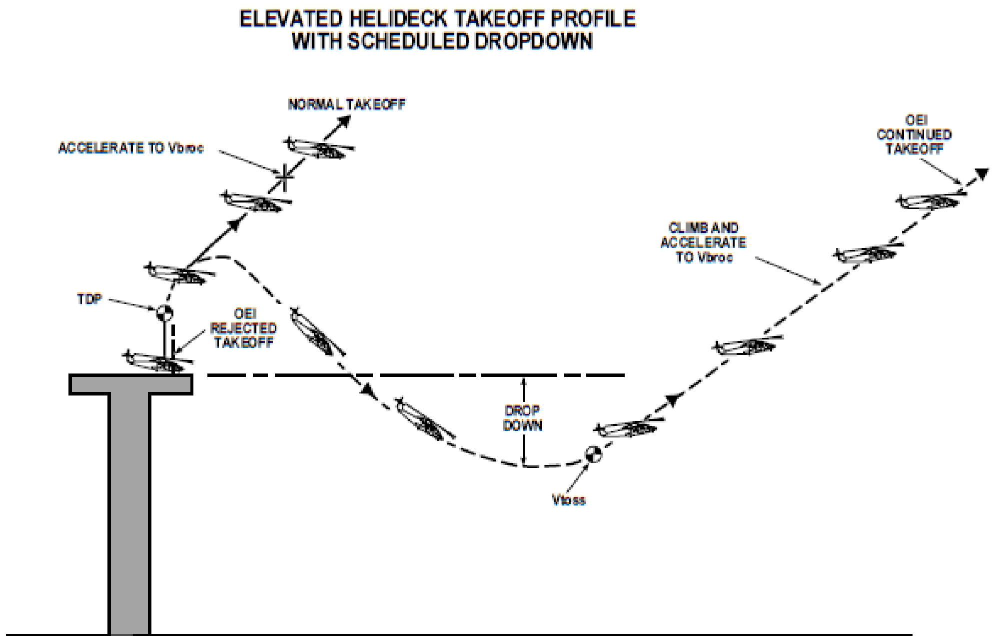
From helideck, the Sikorsky S76C++ helicopters are operated in category A and class 2 performance. Heli-Union is authorized to conduct operations without an assured safe forced landing capability during the take off and landing phases.
This approval was given by DGAC after registration of the helicopter Sikorsky S76C++ on the eligibility list on June 2009.
DGAC received data and information from the manufacturer for the period 2003-2007 between February and June 2009. The updated in-flight sudden power loss rate for engine and helicopter for each Sikorsky engine/helicopter model (S76A, S76B, S76A+/S76A++/S76C, S76C+/S76C++) was less than 1.00 per 100 000 flight hours. Cf appendix H (JAR-OPS 3, Section 2, Subpart H, ACJ-1 to Appendix to JAR-OPS 3.517 (a), page 2-H-13) and appendix I (BEA recommendation)

The DGAC, after several requests to the manufacturer, obtained at the end of 2011 the updated data for the period 2005-2009.
Following the engine examination of the F-HJCS, the BEA asked to the manufacturers (helicopter/engines) the actual data for the period 2007-2011. The figures showed an engine failure rate of 0.85 per 100,000 flight hours concerning the Sikorsky S76C++. This rate is lower than the maximum value of 1 per 100,000 and only takes into account failures that are caused by the engines. cf appendix I (BEA recommendation)
However, for the year 2011, 4 events of engine shutdowns in flight have been registered, one of which was the accident.
In January 2012, the statistics for the period 2006-2010 were neither available nor provided to the authorities.

### *1.17.4) Take off procedure from helidecks*

#### 1.17.4.1) Engine failure during take off - Flight manual

The procedure for an engine failure during take off on elevated helideck describes that: "*the procedure to follow after an engine failure during a vertical take off depends on where in the take off sequence the failure occurs. If the engine fails before the TDP, the take off is rejected and the aircraft is landed on the helideck. The TDP is 30 ft above the take off surface. If the failure occurs after the TDP, the take off will be continued*." Cf appendix J (S76C++ Flight Manual, Part 2. section IV, supplemental, performance Data page 4-59)

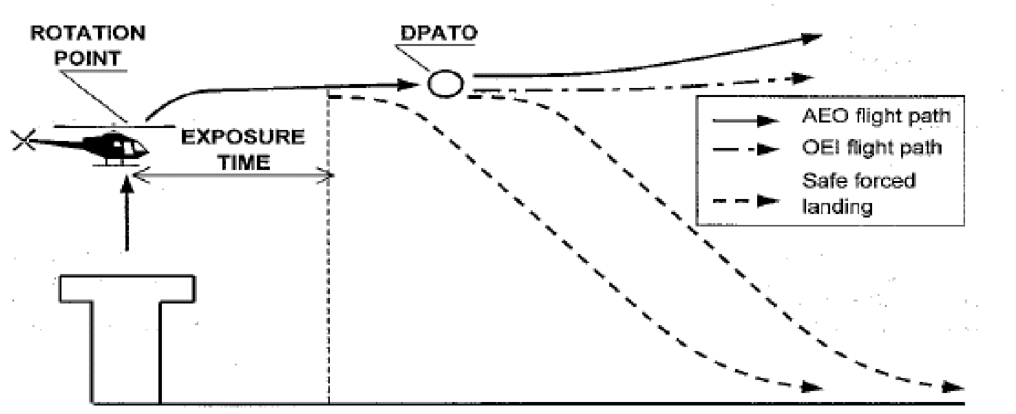



1.17.4.2) Operations regulation in performance class 2

The Interpretation Explanatory Materiel/IEM OPS 3.520 prescribes that: "*in two cases of take off and landing, exposure time is used. During the exposure time (which is only approved for use when complying with Jar OPS 3.517(a), the probability of a power unit failure is regarded as extremely remote. If a power unit failure (engine failure) occurs during the exposure time a safe force landing may not be possible*". Cf appendix H (JAR, OPS-3, sect-2, subpart H, page 2-H-19)

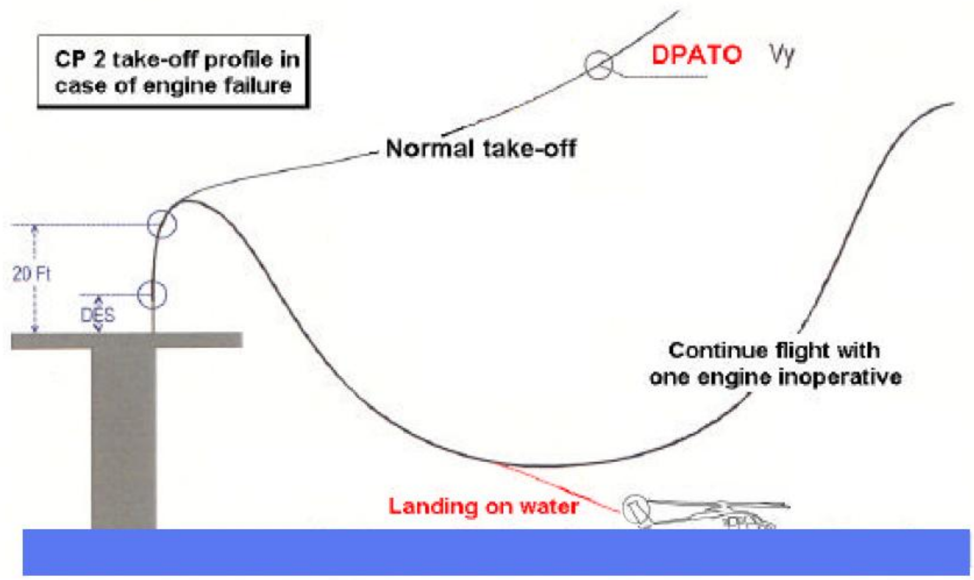
For Take Off – Non – Hostile Environment without an approval to operate with an exposure time, if an engine failure occurs, procedures are described enabling a safe landing or a safe forced landing whatever the phases of take off.

It prescribes also for "*Take Off – Non-Hostile Environment with exposure time": If an engine failure occurs after the exposure time and before DPATO, compliance with 3.520(a)(3) will enable a safe force landing on the surface. At or after the DPATO, the OEI flight path should clear all obstacles by the margins specified in OPS3.525*. There are no procedures described for engine failure before the end of exposure time.




1.17.4.3) Engine failure during take off in PC2 - Operation manual

The procedure of an engine failure during take off on a platform over water helideck describes that in case of a failure during or after cyclic input the pilot must set a nose down attitude of approximately 22° in order to avoid any contact between the rear of the helicopter and the edge of the platform. Cf appendix K (S76C++ operation Manual, part B, sect 2.1, page-27)




## 1.18 Additional information

*1.18.1 Testimony of the pilot*

The pilot explains that he took off from Kanbauk at about 9h local time with 7 passengers on board. He landed on the FSO helideck located 60 nautical miles out. The height of the helideck is estimated to be 50 feet. A passenger disembarked, with the rotor turning and 3 passengers boarded.
The FSO was oriented on a 215° heading, the wind was from 215° at 13 kt. The pilot hovered on a 125 heading before the takeoff. Then he climbed vertically to

30 feet and took off. Immediately after this, an aural warning sounded and engine out warning was illuminated. The pilot noticed an increase in the left T5 temperature, in the red zone at 983°, while the right T5 remained in the green zone. The pilot felt the helicopter drop, a loss of power and a clanking noise. Because of the low height of the helicopter in relation to the water, the pilot decided to ditch in the sea. He initiated flotation devices deployment while the aural warning was cut off by the co-pilot. Helicopter contact with the sea was rather hard but the ditching took place without any problem. Then the helicopter tilted over 180° onto its left side.

### *1.18.2 Testimony of the first witness*

FSO Helicopter landing officer (HLO) stated that, F-HJCS landed safety on FSO at 10:13 hrs. After a passenger disembarked and three passenger boarded, helicopter took off at 10:19 hrs. Helicopter hovered and move forward to the port side of FSO. He saw black smoke coming from the starboard side engine compartment and heard loud noise, immediately he radio contact to the FSO control room reported about accident. The helicopter fell towards the sea approximately 50 meter away from the FSO port side and floats inflated before touched the sea. He saw helicopter main rotor blades broken away. Eleven people come out from helicopter after 15 seconds and he maintained visual contact with the people in the water and threw life buoys.

### *1.18.3 Testimony of the second witness*

FSO safety/Medic officer stated that after he saw helicopter accident, informed to central control Room and raised alarm emergency situation. He mustered at Emergency rescues team (ERT) and proceeded to rescue. Life rafts of helicopter were floated on the water and crews and passengers were floating around. He instructed ERT team to throw life buoys. He and ERT team wait for instruction from offshore installation Manager (OIM) on the life boat. FSO crew picked up one passenger using ladder, two passengers were sitting on the export hose and some were boarding in the drifting life raft. Then stand by vessel launched first operation. After he checked three unconscious casualty, found zero blood pressure with no heart beat and respiration, so he did cardio pulmonary resuscitation about (15-20) minutes. All crews and passenger were recued but three casualties were dead of drowning and two casualties were suffered severe back pain. All were sent ashore by Medivace helicopters.

### *1.18.4 Testimony of the third witness*

One of the passengers stated that helicopter took off as usual straight up (approximately 10 meters above), then engine speed up and fly forward. Suddenly engine noise stopped and helicopter ditched into the sea near FSO. Before the helicopter ditch down, the pilot manage to say "Braise" and then helicopter ditched in to sea and tilted. Water poured into the cockpit, and he found exit door and got out of the chopper. He pull up life jacket and swan away, after then a supply boat came and rescued passengers.

## ANALYSIS

The pilot performed a CP2 with exposure time take off from the FSO Helideck. At 25 feet over the helideck, while the pilot had begun a cyclic input, the right Engine Out warning light illuminated and the engine #2 flamed out. He decided to continue in order to ditch. He pushed the cyclic for a pitch down attitude in order to avoid the tail to strike on the platform edge. Then he initiated the floating devices and ditched. The helicopter capsized immediately after contact with the sea surface. All occupants evacuated from the helicopter. The rescue team arrived after 30 minutes and three of the occupants passed away from drowning.

### 1) Engine examination

After recovery of the wreckage, the engines were examined at Turboméca facilities. The first results indicated the rupture of a HP turbine blade on #2 engine. This rupture phenomenon, identified since 2007, is the subject of corrective action by Turboméca through modification TU166. However, **the increase in the cases of failures in 2011 led the BEA to issue a safety recommendation in order to suspend operations of Sikorsky S76C++ equipped with Arriel 2S2 engines in performance class 2 with exposure time as long as their engines had not been modified with TU166 ..see** appendix ..l**. (BEA recommendation from F-HJCS report)**

### 2) TDP – Rotation point - Procedure in case of engine failure

During takeoff in category A from a helideck, the Sikorsky S76C++ flight manual defines TDP (take off decision point) as a height of 30 feet above the helideck. In case of failure of one of the engines below TDP, the pilot must land on the helideck. Beyond the TDP, the pilot must take into account the meteorological conditions and the height of the helideck in order to deduce from it the value of the resulting dropdown and consequently the maximum takeoff weight to continue the flight.

The instruction of 21 March 2011 provides interpretations and explanations for the application of OPS 3 of 21 March 2011. The ACJ relating to procedures for the use of a helicopter from a helipad does not refer to the TDP as defined by the manufacturer. A point designated as “rotation point” is the reference without being defined. Its value is variable according to the type of helicopter.

The IEM OPS 3.520 relating to takeoff procedures without precise exposure time states that if a failure occurs during climb up to the rotation point, a safety landing or an emergency landing on the helideck is planned. Concerning takeoffs with exposure time, there is no specific procedure in case of a failure before the rotation point.
It is indicated that an emergency landing for safety reasons may not be possible in these conditions.

The Héli Union operations manual, approved by the DGAC, makes no reference to the TDP nor to the rotation point in its description of the procedure for engine failure during takeoff from a helideck. However, the illustration indicates a height of 20 feet above the helideck.
The references and values in the operations manual should not be lower than those certified by the manufacturer.
The absence of any cohesion in the definition of the reference points and associated values leads to the development of erroneous procedures, source of confusion for crews.

**MAIB and the BEA recommend that DGAC ensure that its operators precisely define in their procedures and pilot training the different reference points used during helicopter take off operations in performance class 2 with exposure time.**

## 3) <u>Data and information available for eligibility</u>

In June 2009 the DGAC informed Héli Union that the Sikorsky S76C++ helicopter was eligible to exposure time in relation to the statistics supplied by the manufacturer for the period 2003-2007.
The European regulation obliges operators to provide statistics to their respective national authorities. In practice, this is rarely respected since it is the national authority that takes steps through the manufacturer to recover the data that it needs to update the eligibility list.
At the end of 2011 the DGAC finally received data from the manufacturer for the period 2005-2009 after having asked several times.
In addition, the failure to release updated statistics within a reasonable time period makes it impossible for the national authorities to rule on the continuation or the suspension of eligibility for a helicopter type.

**MAIB and BEA recommend that**

- **EASA modify paragraph 1 ACJ-1 appendix 1 JAR-OPS3 3.517 (a) so that, prior to granting an approval, the operators provide validated power plant reliability statistics for the previous 5 year moving window.**
- **DGAC transpose into national regulations the changes made by EASA to paragraph 1 ACJ-1 annexe 1 JAR OPS 3.**

**MAIB and BEA recommend that**

- **EASA modify paragraph 4 ACJ-1 appendix 1 JAR-OPS3 3.517 (a) in order to introduce a reasonable time period (annually for example) of periodically reassessed updated statistics.**
- **DGAC transpose into national regulations the changes made by EASA to paragraph 4 ACJ-1 annex 1 JAR OPS 3.**

The separation between the authorities responsible for operational oversight and continuing airworthiness does not enable a coordinated and immediate corrective action.

The helicopter and the engine manufacturers supply EASA with information relating to continuing airworthiness of the helicopter.
The European organisation in charge of continuing airworthiness was apparently informed of all of the occurrences to Arriel 2S2 engines.
The helicopter and the engine manufacturers also provide statistics for risk assessment to the national authorities in order to determine the type of operations to be undertaken by operators.
The national authority was not aware of the occurrences.
Considering the increasing number of in-flight engine shutdowns due to the failure of a HP blade as well as the increasing number of blades with cracks, and this despite the corrective action taken since 2009 (modification TU166) and the decrease in the number of engines to retrofit, the organisation responsible for continuing airworthiness should have alerted the authorities in charge of operational oversight.

**MAIB and BEA recommend that EASA study a method for release of information to the national authorities regarding sudden power loss rates of which it is aware and as soon as these rates get close to acceptable limits or show significant evolution.**

### 4) <u>Survivality</u>

Although the Yetagun platform and the FSO are subject to the application of an ERP, the emergency procedures were not followed properly. According to the procedures, the FSO should have immediately made a Zodiac or the Starboard lifeboat available as the field stand-by boat was not in the vicinity of the FSO.

**Consequently, MAIB recommends that the national authorities encourage the implementation of the procedures described in the ERP.**

## CONCLUSIONS

### Findings

- The helicopter was certified, equipped and maintained in accordance with existing regulations and approved procedures.
- The flight crew were properly licensed and qualified to conduct the flight.
- Héli-Union holds a valid AOC.
- The operations manual describes procedures in case of engine shutdown.
- One engine flame out.
- The pilot made an emergency landing (ditching).
- The helicopter capsized after contact with the water.
- All crew members and passengers evacuated.
- All crew members and passengers boarded a life boat after 30 minutes.
- Two passengers and the co-pilot drowned.
- The wreckage was recovered on 26 November, 138 days after the accident.
- Both engines were examined on 15 and 16 December.

- The examination performed on the two engines determined an engine #2 in-flight shutdown.
- The in-flight shutdown was due to a failed HP turbine blade.
- The blade failure phenomenon had been identified in 2007.
- Corrective action was current through the TU166 modification.This modification was mandated by EASA on single-engine applications, and monitored by EASA on twin-engine applications.
- The F-HJCS helicopter had not been retrofitted.

**Causes**

- The accident originated from engine n°2 failure.
- The take-off procedure in performance class 2 with exposure time (in all take-off/ landing conditions ) does not guarantee a safe emerge forced landing.

## RECOMMENDATIONS

- The increase in the cases of failures in 2011 led the BEA to issue a safety recommendation in order to suspend operations of Sikorsky S76C++ equipped with Arriel 2S2 engines in performance class 2 with exposure time as long as their engines had not been modified with TU166.

- MAIB and the BEA recommend that DGAC ensure that its operators precisely define in their procedures and pilot training the different reference points used during helicopter take off operations in performance class 2 with exposure time.

- MAIB and BEA recommend that
  - EASA modify paragraph 1 ACJ-1 appendix 1 JAR-OPS3 3.517 (a) so that, prior to granting an approval, the operators provide validated power plant reliability statistics for the previous 5 year moving window.
  - DGAC transpose into national regulations the changes made by EASA to paragraph 1 ACJ-1 annexe 1 JAR OPS 3.

- MAIB and BEA recommend that
  - EASA modify paragraph 4 ACJ-1 appendix 1 JAR-OPS3 3.517 (a) in order to introduce a reasonable time period (annually for example) of periodically reassessed updated statistics.
  - DGAC transpose into national regulations the changes made by EASA to paragraph 4 ACJ-1 annex 1 JAR OPS 3.

- MAIB and BEA recommend that EASA study a method for release of rates of which it is aware and as soon as these rates get close to acceptable limits or show significant evolution.

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(Win Swe Tun)
Investigator- In-Charge
MAIB

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