COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A-033/CENIPA/2022

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PR-LCT**
MODEL:	**S-76C++**
DATE:	**16MAR2022**

NOTICE

According to the Law nº 7565, dated 19 December 1986, the Aeronautical Accident Investigation and Prevention System – SIPAER – is responsible for the planning, guidance, coordination, and execution of the activities of investigation and prevention of aeronautical accidents.

The elaboration of this Final Report was conducted considering the contributing factors and hypotheses raised. The report is, therefore, a technical document which reflects the result obtained by SIPAER regarding the circumstances that contributed or may have contributed to triggering this occurrence.

The document does not focus on quantifying the degree of contribution of the distinct factors, including the individual, psychosocial or organizational variables that conditioned the human performance and interacted to create a scenario favorable to the accident.

The exclusive objective of this work is to recommend the study and the adoption of provisions of preventative nature, and the decision as to whether they should be applied belongs to the President, Director, Chief or the one corresponding to the highest level in the hierarchy of the organization to which they are being forwarded.

This Final Report has been made available to the ANAC and the DECEA so that the technical-scientific analyses of this investigation can be used as a source of data and information, aiming at identifying hazards and assessing risks, as set forth in the Brazilian Program for Civil Aviation Operational Safety (PSO-BR).

This Report does not resort to any proof production procedure for the determination of civil or criminal liability, and is in accordance with Appendix 2, Annex 13 to the 1944 Chicago Convention, which was incorporated in the Brazilian legal system by virtue of the Decree nº 21713, dated 27 August 1946.

Thus, it is worth highlighting the importance of protecting the persons who provide information regarding an aeronautical accident. The utilization of this report for punitive purposes maculates the principle of "non-self-incrimination" derived from the "right to remain silent" sheltered by the Federal Constitution.

Consequently, the use of this report for any purpose other than that of preventing future accidents, may induce to erroneous interpretations and conclusions.

N.B.: This English version of the report has been written and published by the CENIPA with the intention of making it easier to be read by English speaking people. Considering the nuances of a foreign language, no matter how accurate this translation may be, readers are advised that the original Portuguese version is the work of reference.

SYNOPSIS

This is the Final Report of the 16th March 2022 accident with the S-76C++ aircraft, registration marks PR-LCT. The occurrence was typified as “[LOC-I] Loss of control in flight”.

The helicopter was performing a visual traffic for landing on the 9PMM Platform (*Manati* Platform, *Cairu*, State of *Bahia*). On the final approach, there was an excessive increase of the helicopter's rate of descent, and the aircraft collided with the sea surface.

The helicopter sustained substantial damage.

The pilot Second in Command (SIC) and eleven passengers suffered minor injuries.

The Pilot in Command (PIC) received fatal injuries.

The United States of America, as the State of design and manufacture of the aircraft, appointed an Accredited Representative, by means of the NTSB (National Transportation Safety Board), for participation in the investigation of the occurrence.

France, as the State of design and manufacture of the aircraft’s engines, by means of the BEA (*Bureau d’Enquêtes et d’Analyses pour la Securité de l’Aviation Civile*), also designated an Accredited Representative for the investigation in question.

TABLE OF CONTENTS

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ABNT	Brazilian Association of Technical Standards
ADELT	Automatically Deployable Emergency Locator Transmitter
AFDS	Automatic Float Deployment System
AGL	Above Ground Level
AIS	Automatic Identification System
ANAC	Brazil's National Civil Aviation Agency
APP-SV	*Salvador* Approach Control
ARCC	Rescue Coordination Center
ATS	Air Traffic Service
ATT	Attitude Retention System
BEA	*Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile* (France)
BRMCC	Brazilian Mission Control Center
CA EBS	Compressed-Air Emergency Breathing Systems
CAA UK	United Kingdom Civil Aviation Authority
CAP	*Civil Aviation Publication* (UK)
CAT	Commercial Air Transport
CB	Cumulonimbus cloud
CENIPA	Brazil's Aeronautical Accidents Investigation and Prevention Center
CHT	Technical Qualification Certificate
CMA	Aeronautical Medical Certificate
COSPAS	*Comischeskaya Sistyema Poiska Avarivnich Sudov* (Space System for the Search of Vessels in Distress)
CRM	Crew Resourse Management
CTR-SV	*Salvador* Control Zone
CVA	Airworthiness-Verification Certificate
CVR	Cockpit Voice Recorder
DAFCS	Digital Automatic Flight Control System
DECEA	Command of Aeronautics' Airspace Control Department
DECU	Digital Engine Control Unit
DHN	Brazilian Navy's Directorate of Hydrography and Navigation
DPATO	Defined Point at Take-off
DPBL	Defined Point Before Landing
DPC	Brazilian Navy's Directorate of Ports and Coasts
EASA	European Union Aviation Safety Agency
EBS	Emergency Breathing Systems

ECL	Electronic Check-List
EGPWS	Enhanced Ground Proximity Warning System
ELT	Emergency Locator Transmitter
EMCIA	Aviation Firefighting and Maneuvering Team
EO	Operating Specifications
EPTA	Telecommunication and Air Traffic Service Providing Stations
ETSO	European Technical Standard Order
FD	Flight Director
FDR	Flight Data Recorder
FGA	Aircraft Chartering and Management
FMS	Flight Monitoring System
GOES	Geostationary Operational Environmental Satellite
GPS	Global Positioning System
HLO	Helicopter Landing Officer
HUET	Helicopter Underwater Escape Training
HUMS	Health and Usage Monitoring Systems
IAE	Institute of Aeronautics and Space (Brazil)
IAS	Indicated airspeed
ICA	Command of Aeronautics' Instruction
ICAO	International Civil Aviation Organization
IFRH	IFR Flight Rating (Helicopter)
IML	Institute of Legal Medicine (Brazil)
IOGP	International Association of Oil & Gas Producers
IPEV	Brazil's Institute for Research and Flight Testing
IS	Supplementary Instruction
ISO	International Organization for Standardization
ITCZ	Intertropical Convergence Zone
KIAS	Knots-Indicated Air Speed
LABDATA	CENIPA's Flight Recorder Data Readout and Analysis Laboratory
MCA	Command of Aeronautics' Manual
MEOSAR	Medium Earth Orbit Search and Rescue
METAR	Routine Meteorological Aerodrome Report
METS	Modular Egress Training Simulator
MGO	General Operating Manual
MGSO	Safety Management Manual
MPFR	Multi-Purpose Flight Recorder
NBR	Brazilian Norm

NORMAM	Maritime-Authority Norm
NSCA	Command of Aeronautics' System Norm
NUI	Normally Unattended Installations
OHRP	Offshore Helicopter Recommended Practices
OM	Maintenance Organization
PCMCIA	Personal Computer Memory Card International Association
PF	Pilot Flying
PIC	Pilot in Command
PLB	Personal Locator Beacon
PLH	Airline Transport Pilot License (Helicopter)
PM	Pilot Monitoring
PN	Part Number
PPH	Private Pilot License (Helicopter)
PPSP	Risk prevention program associated with the misuse of psychoactive substances in civil aviation
PRE	Emergency-Response Plan
PTO	Operational Training Program
QAV-1	Aviation Kerosene
RBAC	Brazilian Civil Aviation Regulation
REDEMET	Command of Aeronautics' Meteorology Network
RFM	Rotorcraft Flight Manual
RIG	Oil Platform
SAR	Search and Rescue
SARSAT	Search and Rescue Satellite - Aided Tracking System
SAS	Stability Augmentation System
SBSV	ICAO location designator - *Deputado Luiz Eduardo Magalhães* Airport - *Salvador*, State of *Bahia*
SGSO	Safety Management System
SIC	Second in Command
SIGWX	Significant Weather Chart
SIPAER	Aeronautical Accidents Investigation and Prevention System
SN	Serial Number
SOP	Standard Operating Procedure
TCU	Towering Cumulus
TMA	Terminal Control Area
TPX	Non-Regular Public Air Transport Registration Category (Air-Taxi)
UHF	Ultra High Frequency
UM	Maritime Unit

UOH	Helicopter Operating Unit
UTC	Coordinated Universal Time
VFR	Visual Flight Rules
VHF	Very High Frequency
VMC	Visual Meteorological Conditions
VOIP	Voice Over Internet Protocol
VSI	Vertical Speed Indication

1. FACTUAL INFORMATION

Aircraft	**Model:** S-76C++ **Registration:** PR-LCT **Manufacturer:** Sikorsky Aircraft Corp.	**Operator:** *Líder Táxi Aéreo S.A. Air Brasil*
Occurrence	**Date/time**: 16MAR2022 – 10:28 (UTC) **Location:** *Bacia de Camamu* **Lat.** 13°29'08"S **Long.** 038°48'08"W **Municipality – State:** *Cairu - Bahia*	**Type(s):** [LOC-I] Loss of control - inflight

1.1. History of the flight.

At 10:06 UTC, the aircraft took off from SBSV (*Deputado Luís Eduardo Magalhães* International Airport, *Salvador*, *Bahia*), destined for 9PMM (*Manati* Maritime Platform PMNT-1), engaged on an offshore passenger air transport flight, with two pilots and eleven passengers on board.

The flight was conducted under Visual Meteorological Conditions (VMC).

Approximately 22 minutes into the flight, during the procedure for landing at 9PMM, the helicopter sustained an excessive increase in its rate of descent on the final approach, and collided with the sea.

The aircraft sustained substantial damage. The pilot Second in Command (SIC) and eleven passengers were slightly injured. The Pilot in Command (PIC) suffered fatal injuries.

1.2. Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	1	-	-
Serious	-	-	-
Minor	1	11	-
None	-	-	-

1.3. Damage to the aircraft.

The aircraft suffered substantial damage to the main rotor, tail rotor, radome, and windshield, in addition to internal damage to the engines and deformations in the fuselage.

1.4. Other damage.

NIL.

1.5. Personnel information.

1.5.1. Crew's flight experience.

Flight Experience		
	PIC	SIC
Total	8.669:40	5.800:00
Total in the last 30 days	00:40	04:00
Total in the last 24 hours	00:00	00:00
In this type of aircraft	7.393:00	1.382:10
In this type in the last 30 days	00:40	04:00
In this type in the last 24 hours	00:00	00:00

RMK: data on the pilots' flight hours obtained from records provided by the aircraft operator.

1.5.2. Personnel training.

The PIC did his PPH course (Private Pilot – Helicopter) in 2000, at *Helischool Escola de Pilotagem de Helicópteros*, *São Paulo*, State of *São Paulo*.

The SIC graduated at the *Centro de Instrução de Aviação do Exército* (Brazilian Army Aviation Instruction Center - CIAvEx), *Taubaté*, State of *São Paulo*, in 1993.

1.5.3. Category of licenses and validity of certificates.

The PIC and SIC held PLH licenses (Airline Pilot – Helicopter), and had valid ratings for SK76 type aircraft (which included the S-76C++) and IFRH (Instrument Flight – Helicopter)

1.5.4. Qualification and flight experience.

The PIC, 58, had been a helicopter pilot for 22 years. On 1st September 2008, he started working for *Líder Táxi Aéreo S.A. Air Brasil*, and operated mainly SK76 aircraft on offshore flights in the role of co-pilot.

In 2011, by means of internal organizational evaluation and promotion processes within the referred aviation company, the PIC was promoted to SK76 aircraft captain. He successfully completed the SK76 flight-instructor training course in 2012.

On 16 May 2021, the PIC underwent the periodic proficiency check on a flight simulator with the purpose of revalidating his flight instructor rating in S-76C++ aircraft, having been approved for flight instruction activities by a company examiner. Subsequently, he was rated as an S-76C++ flight instructor, being designated by the aircraft operator to administer technical proficiency exams, in addition to giving en-route flight instructions.

On the accident flight, the PIC occupied the left pilot's position, as the Pilot Monitoring, and worked as a flight instructor as well.

The aircraft operator's SK 76 - MSG LA-116 Standard Operating Procedure, revision 00, dated 10 June 2021, section 1, item 7, p. 25, established the following definitions for PF (Pilot Flying) and PM (Pilot Monitoring):

> *PILOT FLYING (PF)*
>
> *The pilot who is:*
>
> *1. On the ground, taxiing the aircraft or,*
>
> *2. In flight, operating the controls directly or through the autopilot. He/she is the one responsible for maintaining the aircraft's speed, altitude, trajectory, and navigation.*
>
> *[...]*
>
> *PILOT MONITORING (PM)*
>
> *The pilot who is not handling the controls and is responsible for monitoring flight management, for communications, and for doing the checklist reading, as well as performing the actions requested by the Pilot Flying. He is also responsible for monitoring the PF's performance in controlling the aircraft, besides being able to take over control if necessary.*

The PIC had previously operated at the 9PMM Platform. As for his recent experience, the data provided by the operator confirmed that, during the 90 days preceding the accident, the PIC logged 61 hours and 10 minutes of flight, and 55 offshore landings, thus fulfilling the requirement established by the ANAC.

The SIC, 56, had been a helicopter pilot for 29 years. In 2008, he began his activities on offshore flights, working for the *CHC Brasil Táxi Aéreo* Company, as a first officer of SK76 aircraft. In that same company, he was promoted to captain of SK76 in 2010, and, by means of an internal selection process, he became captain of H225 aircraft in 2011.

The SIC's employment bonds within the offshore aviation activities ceased temporarily in 2016. During an approximate period of four years after that, he did not work professionally as a helicopter pilot. Then, on 11 December 2020 he joined *Líder Táxi Aéreo S.A. Air Brasil* company to operate S -76C++ aircraft mainly on offshore flights as a co-pilot.

The SIC was qualified and had met the recent experience requirements, in accordance with the regulations established by the ANAC.

On the accident flight, just over 15 months after being hired, the SIC occupied the right-hand seat as the Pilot Flying, as he was selected by the aircraft operator to undergo a level-up training process for copilots, in the phase of acquisition of operational experience en route, with the aim of being promoted to aircraft captain.

The aircraft-operator's General Operations Manual - MSG LA-04, revision 21, dated 21 October 2021, section 4, item 1.2, p. 60 - described a number of requirements for copilots to become aircraft captains, as follows:

> [...]
>
> A pilot will only be assigned to the function of Captain in the Líder company after flying the line with a company instructor and being released to perform the function, and must complete all the command progression training and be approved by the Flight Board.
>
> The enroute operational experience required by the type of aircraft to be flown will be obtained on the Company's commercial flights monitored by a Flight Instructor.
>
> Each Client's specific requirements are addressed in specific operational procedures, in accordance with the contract.

REQUISITOS DE QUALIFICAÇÃO PARA A FUNÇÃO COMANDANTE*	
Mínimo de horas**	2000h
Mínimo de horas em rota***	200h
Mínimo de horas em voo noturno	50h
Mínimo de horas IFR	30h
Licença mínima	PLAH

> *criteria must always meet the minimums prescribed in the legislation (RBAC 61.141).
>
> **it must include at least: 250 (two hundred and fifty) hours of flight as pilot in command; or 250 (two hundred and fifty) hours of flight, of which a minimum of 70 (seventy) hours of flight as pilot-in-command, plus additional flight time required as pilot-in-command under supervision.
>
> ***it must include at least 100 (one hundred) hours of flight as pilot in command or as pilot in command under supervision.

The aircraft operator's PTO (Operational Training Program) - MSG LA-05, revision 19, dated 12 April 2021, section 2, item 2.10, p. 154, contained criteria for copilots' level-up training, as follows:

> Level-up training is required for copilots with CHT and recent experience in valid equipment, who have been previously trained and evaluated with positive results by the *Líder* company, and are being assigned to perform the function of Captain on the same type of aircraft. Copilot Level-Up Training comprises theoretical training and flight training that can be carried out either on the aircraft or in a simulator.

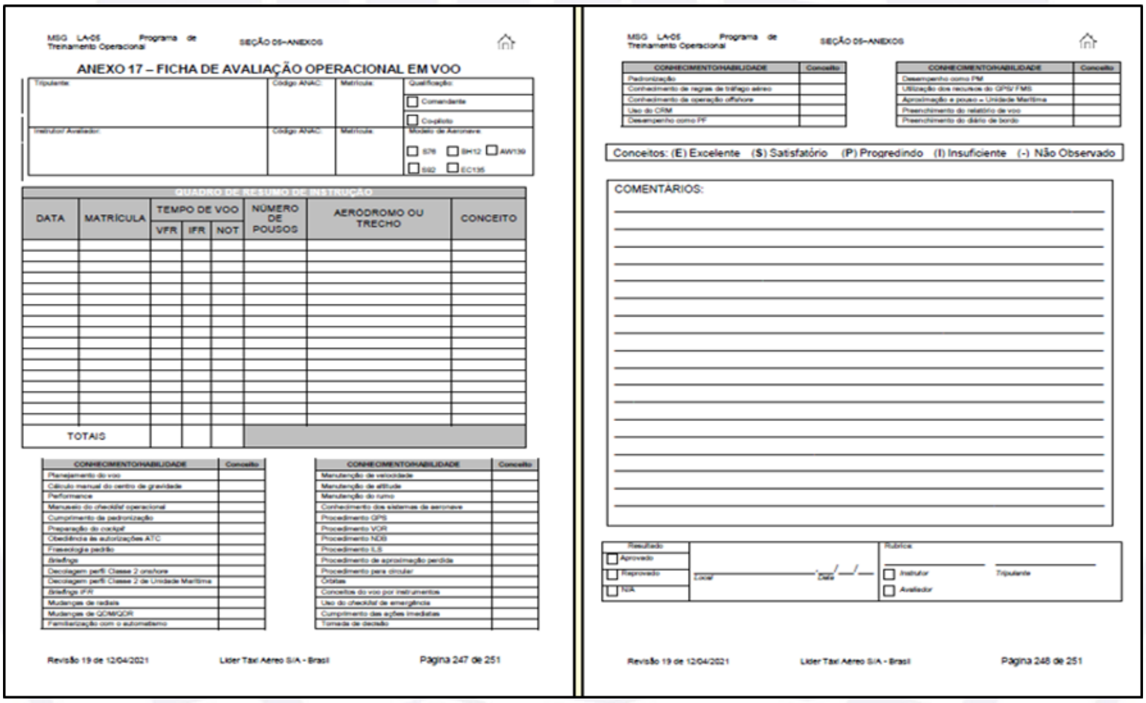
The PTO, section 2, items 2.1.33, p. 80 and 2.10, table 6, p. 155, established that level-up training for co-pilots included, among other phases, en-route operational experience training, which was composed of:

- flying an aircraft along a specific route under the supervision of a flight instructor, performed only once after the pilot is designated an aircraft captain, with a workload of 20 hours; or

- the copilot had to accomplish flight segments totaling 10 hours and 10 landings.

It is worth noting that the accident flight was the first enroute flight for the SIC under the supervision of a flight instructor in the phase of operational-experience training, in view of his being promoted to aircraft captain. Furthermore, it was the first time that the SIC was occupying the right-hand seat, after being hired by the aircraft operator, in addition to being the first time that the SIC would be operating at the 9PMM Platform.

In this sense, at the end of the en-route operational experience training, the PIC had to fill out the Annex 17 – “Flight Operational Assessment Form” of the PTO, page 247, with details of his evaluation of the SIC’s performance (Figure 1).


MSG LA-05 Programa de Treinamento Operacional — SEÇÃO 05–ANEXOS

ANEXO 17 – FICHA DE AVALIAÇÃO OPERACIONAL EM VOO

Tripulante:	Código ANAC:	Matrícula:	Qualificação: ☐ Comandante ☐ Co-piloto
Instrutor/ Avaliador:	Código ANAC:	Matrícula:	Modelo de Aeronave: ☐ S76 ☐ BH12 ☐ AW139 ☐ S92 ☐ EC135

QUADRO DE RESUMO DE INSTRUÇÃO

DATA	MATRÍCULA	TEMPO DE VOO			NÚMERO DE POUSOS	AERODROMO OU TRECHO	CONCEITO
		VFR	IFR	NOT			
TOTAIS							

CONHECIMENTO/HABILIDADE	Conceito
Planejamento do voo	
Cálculo manual do centro de gravidade	
Performance	
Manuseio do checklist operacional	
Cumprimento da padronização	
Preparação do cockpit	
Obediência às autorizações ATC	
Fraseologia padrão	
Briefings	
Decolagem perfil Classe 2 onshore	
Decolagem perfil Classe 2 de Unidade Marítima	
Briefings IFR	
Mudanças de radiais	
Mudanças de QDM/QDR	
Familiarização com o automatismo	

CONHECIMENTO/HABILIDADE	Conceito
Manutenção de velocidade	
Manutenção de altitude	
Manutenção do rumo	
Conhecimento dos sistemas da aeronave	
Procedimento GPS	
Procedimento VOR	
Procedimento NDB	
Procedimento ILS	
Procedimento de aproximação perdida	
Procedimento para circular	
Órbitas	
Conceitos do voo por instrumentos	
Uso do checklist de emergência	
Cumprimento das ações imediatas	
Tomada de decisão	

Revisão 19 de 12/04/2021 — Líder Táxi Aéreo S/A - Brasil — Página 247 de 251

MSG LA-05 Programa de Treinamento Operacional — SEÇÃO 05–ANEXOS

CONHECIMENTO/HABILIDADE	Conceito
Padronização	
Conhecimento de regras de tráfego aéreo	
Conhecimento da operação offshore	
Uso do CRM	
Desempenho como PF	

CONHECIMENTO/HABILIDADE	Conceito
Desempenho como PM	
Utilização dos recursos do GPS/ FMS	
Aproximação e pouso – Unidade Marítima	
Preenchimento do relatório de voo	
Preenchimento do diário de bordo	

Conceitos: (E) Excelente (S) Satisfatório (P) Progredindo (I) Insuficiente (-) Não Observado

COMENTÁRIOS:

Resultado		Rubrica:
☐ Aprovado ☐ Reprovado ☐ N/A	Local, Data __/__/__	☐ Instrutor ☐ Avaliador — Tripulante

Revisão 19 de 12/04/2021 — Líder Táxi Aéreo S/A - Brasil — Página 248 de 251

Figure 1 - PTO, Annex 17, Flight Operational Assessment Sheet.

Additionally, the MGO, in its section 2, item 4.2, page 39, prescribed the crewmember’s responsibilities as a captain:

> 4.2 CAPTAIN
>
> The helicopter Captain is the legal representative of the company, and acts a company’s agent, in accordance with Law No. 13,475, dated 28 August 2017, which regulates the aeronaut profession, and Law No. 7,565, dated 19 December 1986, Brazilian Code of Aeronautics (CBA).
>
> The pilot in command has full autonomy to make any decisions in favor of flight safety, without any disciplinary consequences weighing on him, if, and only if, his action focusses solely on the benefit of flight safety, which is understood as any action aimed at preventing an aviation incident/accident).
>
> His authority and responsibility begin when he receives the helicopter ready for flight, and ends upon completion of his mission, when he delivers the helicopter and flight records to the care of the company or another party determined by the company.
>
> The Captain exercises his authority over the helicopter, people on board, as well as goods and valuables entrusted to him for transportation.
>
> [...]

With respect to the requirements established by the MGO, one found that both pilots involved in this aeronautical occurrence had the qualifications and the experience required for the type of flight.

1.5.5. Validity of medical certificate.

The pilots held valid Aeronautical Medical Certificates (CMA), both of them containing the remark of corrective lenses usage.

1.6. Aircraft information.

The SN 760723 model S-76C++ aircraft (Figure 2) was a product manufactured by Sikorsky Aircraft Corporation in 2008, and registered in the Non-Regular Public Air Transport Registration Category (TPX).

Figure 2 - View of an S-76C++ helicopter.
(Photo: © sergio mendes, planespotters.net).

The aircraft had a valid CVA (Airworthiness-Verification Certificate).

The records of the airframe and engine logbooks were up to date.

On the date of the occurrence, the PR-LCT aircraft had a total of 11,164 hours. It was fitted with two 2S2 turboshaft Turbomeca Arriel engines, which ran on Aviation Kerosene (QAv-1). The helicopter had a retractable tricycle landing gear. The rotating assembly was composed of a main rotor and a tail rotor, each rotor containing four blades.

The aircraft's CVA was revalidated on 17 August 2021 by *Líder Táxi Aéreo S.A. - Air Brasil* Maintenance Organization, located in *Salvador*, State of *Bahia*.

The Maintenance Organization mentioned above also carried out the latest comprehensive inspection of the aircraft (type "C. Equalized/1,500 hours") on 28 December 2021. The helicopter flew 139 hours and 30 minutes after the referred inspection.

The aircraft underwent its latest "100-hour" inspection on 25 February 2022, at the premises of *Líder Táxi Aéreo S.A. - Air Brasil Maintenance Organization*, in *Salvador*, *Bahia*. The helicopter flew 32 hours and 5 minutes after the said inspection.

The Engine no. 1 (SN 42370TEC), installed on the left-hand side, had a total of 7,386 hours and 10 minutes of operation. It underwent its latest comprehensive "600-hour" inspection at the premises of *Líder Táxi Aéreo S.A. - Air Brasil*, in *Macaé*, State of Rio de Janeiro, on 10 October 2021. The referred engine operated 322 hours and 20 minutes after the inspection. *Líder Táxi Aéreo S.A. - Air Brasil* Maintenance Organization carried out the latest "30-hour" inspection of the engine on 09 March 2022, in *Macaé*, State of *Rio de Janeiro*. The engine operated 10 hours after the inspection.

The engine nº 2 (SN 42326TEC), installed on the right-hand side, had a total of 3,073 hours and 20 minutes of operation. Its latest comprehensive inspection ("600-hour" type) took place at the premises of *Líder Táxi Aéreo S.A. - Air Brasil* Maintenance Organization, in *Macaé*, *Rio de Janeiro*, on 24 October 2021. The referred engine operated 281 hours and 30 minutes after the inspection. *Líder Táxi Aéreo S.A. - Air Brasil* Maintenance Organization carried out the latest "30-hour" inspection of engine n º 2 in *Macaé*, *Rio de Janeiro*, on 09 March 2022. The engine operated a total 10 hours after the inspection.

Digital Engine Control Unit (DECU)

Each engine had a Part Number 70BML01000 Digital Engine-Control Unit, being the SN 5093 for the engine n° 1, and the SN 10003 for the engine nº 2 (Figures 3 and 4).

Figure 3 - Digital Engine-Control Unit of engine nº 1.

Figure 4 - Digital Engine-Control Unit of engine nº 2.

The Sikorsky Model S76C Rotorcraft Flight Manual (RFM), part 2, page 1-8, revised on 25 October 2010, described the DECU's basic characteristics as follows:

> *DIGITAL ENGINE CONTROL UNIT (DECU)*
>
> *The Turbomeca 2S2 engine control is a dual channel Digital Engine Control Unit (DECU) for each engine that controls the start sequence, normal operation, and emergency operation of the engine. The DECU is normally powered in flight by an engine driven, dedicated alternator. Aircraft DC essential bus serves as a backup power source in the event of alternation or failure but is the primary source during startup, idle, and shutdown or other regimes where gas generator speed is less than 60.0% N1. The DECU black box units are mounted on the left and right-side-inner tail cone wall near the tail cone access panel.*
>
> *Each DECU receives inputs from the engine control quadrant, a collective stick position sensor, ambient pressure and temperature sensors, engine pressure and temperature sensors, N1 and N2 sensors and the other DECU.*

Digital Automatic Flight Control System (DAFCS)

The aircraft was fitted with a model SPZ-7600 DAFCS manufactured by Honeywell, which consisted of a flight control system whose purpose was to reduce the pilots' workload. The DAFCS combined the functions of autopilot and flight director (FD).

The Sikorsky Model S76C's RFM, part 2, page 1-63, described the basic functionalities of the equipment, as shown below:

> *SPZ-7600 DIGITAL AUTOMATIC FLIGHT CONTROL SYSTEM (DAFCS)*
>
> *The SPZ-7600 is a fully coupled, four axis (pitch, roll, yaw and collective) flight control system combining autopilot and flight director functions. The system also incorporates several additional features to reduce pilot workload: auto trim, heading hold, automatic turn coordination, and auto level.*
>
> *The autopilot provides two basic modes of operation: Stability Augmentation System (SAS) and Attitude Retention (ATT). The SAS mode provides short-term rate damping during hands-on flying while the ATT mode is used for hands-on or coupling to the flight director.*
>
> *The flight director provides steering commands which can be manually flown by the pilot or can be coupled to the autopilots for fully automatic flight path control.*

Enhanced Ground Proximity Warning System (EGPWS)

The aircraft was equipped with the PN 965-1595-024 / SN 6386 EGPWS manufactured by Honeywell, which presented pilots with a combination of analog and digital interfaces, and had, among others, the following functionalities:

- alert and display of obstacle and terrain detection;
- messages of altitude, bank angle and tail; and
- basic modes for ground proximity warning.

The inspection of the equipment, performed on 09 March 2022, was within its period of validity.

Automatically Deployable Emergency Locator Transmitter (ADELT)

The helicopter had an ADELT CPT900 BEACON (PN 070-0900-001 / SN 323), designed for helicopters, capable of providing VHF homing (121.5 MHz and 243 MHz) and transmissions compatible with the UHF (403 MHz) COSPAS-SARSAT satellite.

The ADELT CPT900 BEACON allowed monitoring of the aircraft via satellite, which, in addition to the functionality of the ELT (Emergency Locator Transmitter), could be activated both manually and automatically in the event of a collision with ground obstacles or landing on the water, transmitting the aircraft's location to search and rescue services. The ELT battery (PN 101325 / SN 13784) was installed on 08 May 2020 and had a valid inspection until 01 July 2022.

Emergency Flotation System

The aircraft had an emergency flotation system designed for emergency landings on the water. It had the purpose of keeping the aircraft in a vertical position above the water line for a time long enough to allow passengers and crew to evacuate to lifeboats or rescue vessels.

The PR-LCT helicopter was configured with four urethane-coated nylon popout-floats, with valid inspections, and arranged in accordance with the configuration described in the Table 1 below:

COMPONENT	MANUFACTURER	PN	SN	LAST INSPECTION
Float Nose LH	*Sikorsky*	76251-01101-104	2485	20MAY2021
Float Nose RH	*Sikorsky*	76251-01101-105	2316	20MAY2021
Float Main LH	*Sikorsky*	D24676-109	3791	17SEPT2021
Float Main RH	*Sikorsky*	D24676-110	3274	20MAY2021

Table 1 - Configuration of the PR-LCT floats.

The emergency flotation system could be tested and deployed manually by means of switches installed in the cockpit.

The floats could also deploy automatically via the AFDS (Automatic Float Deployment System). By means of *float switches* installed in the lower part of the aircraft, the floats would inflate when in contact with the water.

Lifeboats

The helicopter was equipped with two life rafts, with valid inspections and with capacity for up to 15 people each. Table 2 below shows their configuration:

COMPONENTE	FABRICANTE	PN	SN
Life Raft LH	RFD Beaufort Ltd	00051166	42571004D0017
Life Raft RH	RFD Beaufort Ltd	00051167	4257100400489

Table 2 - Configuration of PR-LCT life rafts.

The boats were stored in different compartments outside of the aircraft, close to the passenger door and available as a survival item for crew and passengers, in the event of an emergency landing on the water (Figure 5).

Figure 5 - S-76C++ helicopter's life raft compartment.

The rafts' inflation mechanism could be activated from inside the aircraft, by means of a lever located next to the left pilot's position (*Pilot Release Handle*), or by a handle located on the lower external part of the aircraft (*Outside Release Handle*).

The activation was effected by means of cables, which acted on a valve, allowing the passage of fluid to the life raft. As a result, the equipment inflated and projected out of the compartment, remaining docked on the aircraft, close to the passenger door, thus allowing people to board it.

Seatbelts

In the cockpit, there were two seats (PN MBCS3310-1) mounted on brackets bolted to the floor in a single position, and had vertical adjustment controls for height.

Each seat had a five-point seatbelt (PN MBCS304-2) fitted with an inertial reel. The purpose of the seatbelt was to ensure the crew's safety in the event of an abrupt maneuver or aircraft crash (Figure 6).

Figure 6 - Seatbelt of the left-hand pilot seat in the S-76C++ helicopter.

The safety harnesses or belts were attached to the inertial reels located behind each seat, extended over the top of the backrest, and fastened to the seat belt buckles. The control lever for the inertia reel, on the lower left side of each seat, had a locked and an unlocked position (Figure 7).

Figure 7 - View of the S-76C++ helicopter's inertia reel control lever
of the left-hand pilot's seat.

When the inertia reel control was in the unlocked position, the safety harnesses were free to extend, allowing the pilots to lean forward. In emergencies, decelerations that produced 2 to 3G along the longitudinal axis of the aircraft, automatically locked the inertial reel and, consequently, the shoulder harnesses, which remained in that condition until one manually placed the reel control in the locked position, and then returned it to the unlocked position.

It is worth noting that *Líder Táxi Aéreo S.A. - Air Brasil* MO, located in *Salvador*, *Bahia*, replaced the seat belts of both cockpit stations with new ones on 11 May 2021.

On 06 September 2021, according to the documentation presented by the aircraft operator, the pilots and passengers' seat belts underwent exams aimed at checking their operation, safety, and assembly aspects, during a periodic airframe maintenance inspection ("600-hour" type). The seatbelts had valid inspections, and were in accordance with the operating standards specified by the aircraft manufacturer.

1.7. Meteorological information.

With the objective of analyzing the relevant meteorological conditions, one made use of weather radar and satellite images, significant weather charts, wind prognosis charts, surface charts, and METAR data of SBSV (*Deputado Luiz Eduardo Magalhães* International Airport, *Salvador*, State of *Bahia*).

Two SIGWX charts, with coverage from the surface to FL250, with validity for 06:00 UTC and 12:00 UTC of 16 March 2022, forecast (for the area of interest) the presence of thunderstorms and isolated rain showers, associated with CB (Cumulonimbus) and TCU (Towering Cumulus) clouds, with base at FL030 and tops at FL380 (Figures 8 and 9).

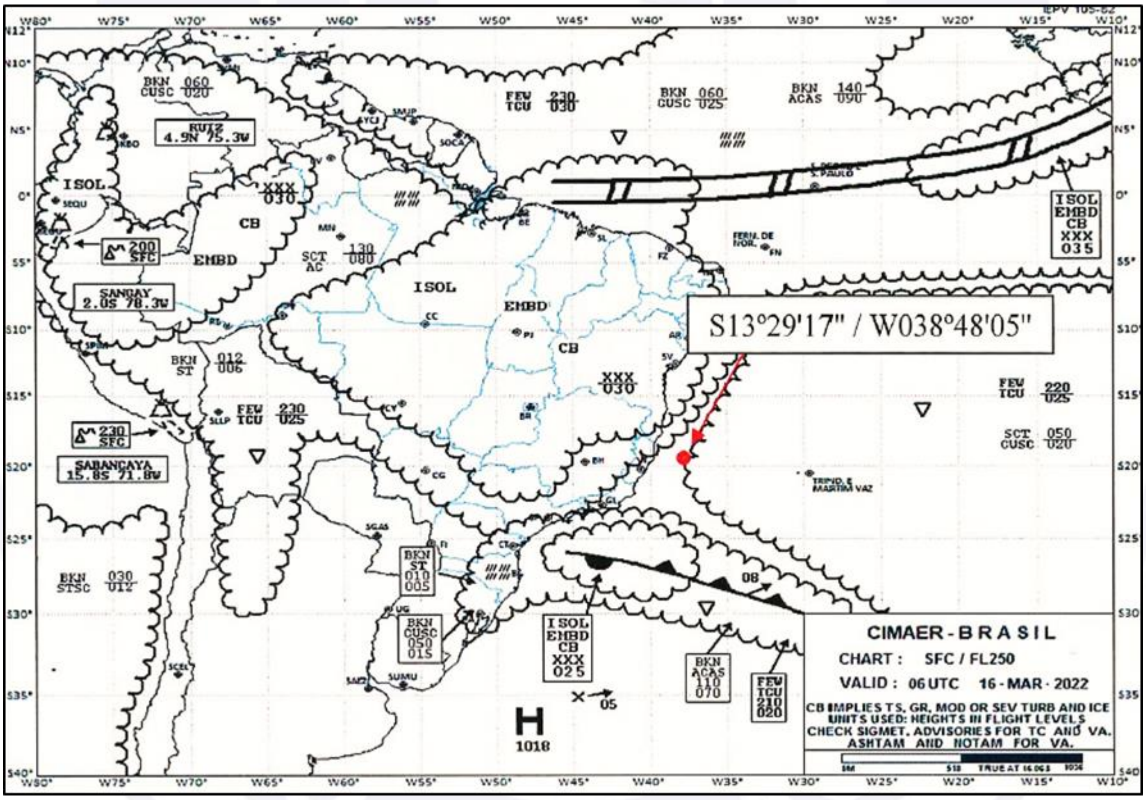


Figure 8 - SIGWX chart, covering from the surface to FL250, dated 16 March 2022, valid for 06:00 UTC.

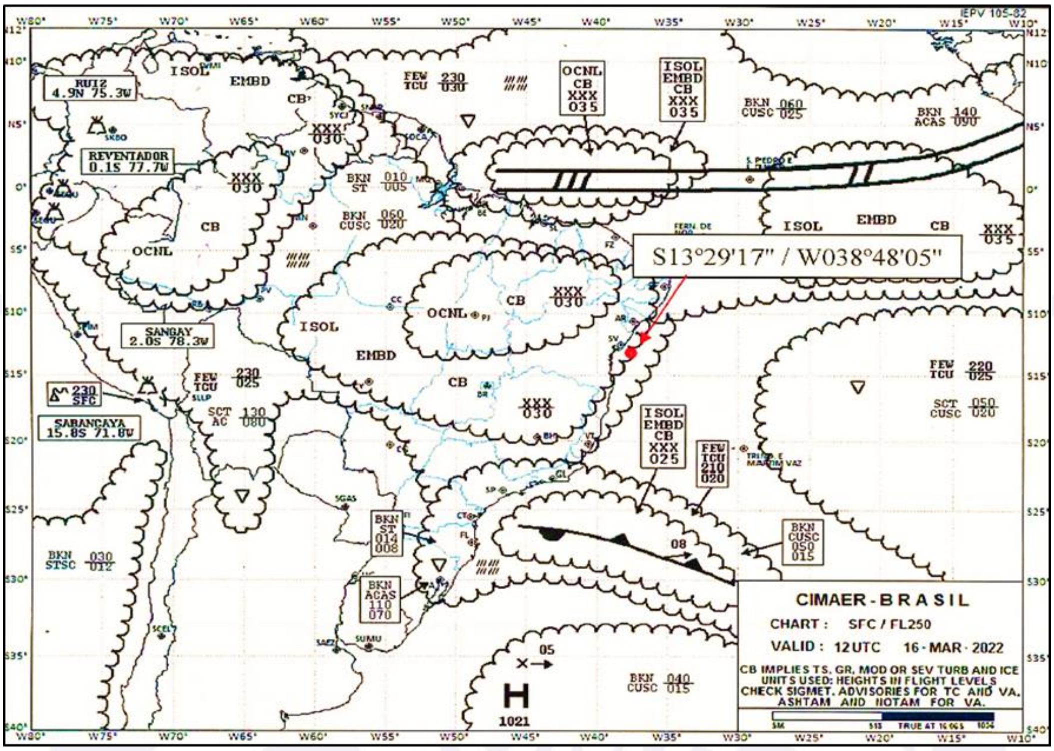


Figure 9 - SIGWX chart, covering from the surface to FL250,
dated 16 March 2022, valid for 12:00 UTC.

The 16 March 2022 Wind Prog Chart for FL050, valid for 12:00 UTC, forecast winds from the Northeast-East (NE-E), with a strength of 10 kt (Figure 10).

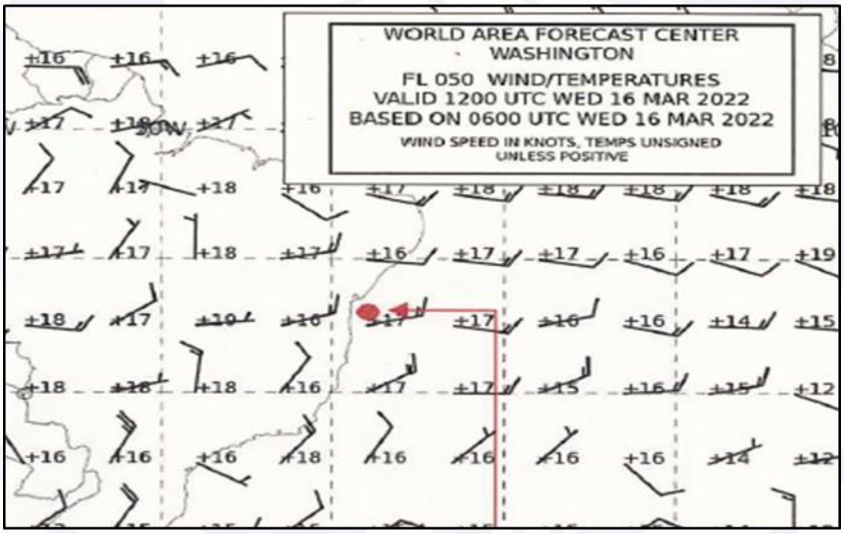


Figure 10 - FL050 Wind Prog Chart, dated 16 March 2022,
valid for 12:00 UTC.

The 16 March 2022 12:00 UTC Surface Chart did not present an active synoptic system in the area of interest. The cloudiness observed at the time was due to local thermodynamics (Figure 11).

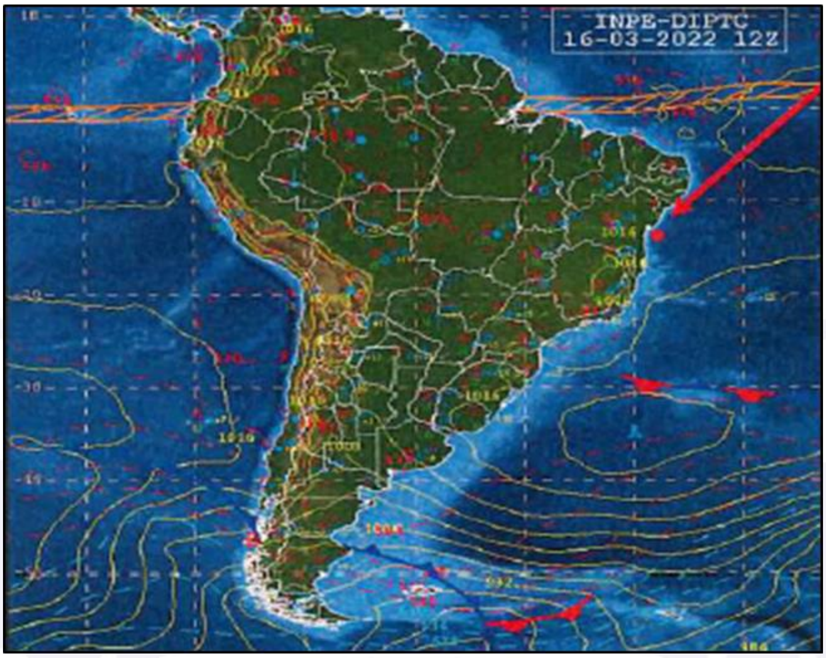


Figure 11 - 16 March 2022 12:00 UTC Surface Chart.

GOES-16 satellite images (10:40 UTC and 11:20 UTC of 16 March 2022) obtained from the REDEMET, indicated adverse atmospheric conditions, due to the presence of low clouds with possibility of rain showers, as well as TCU-type convective clouds (Figure 12).

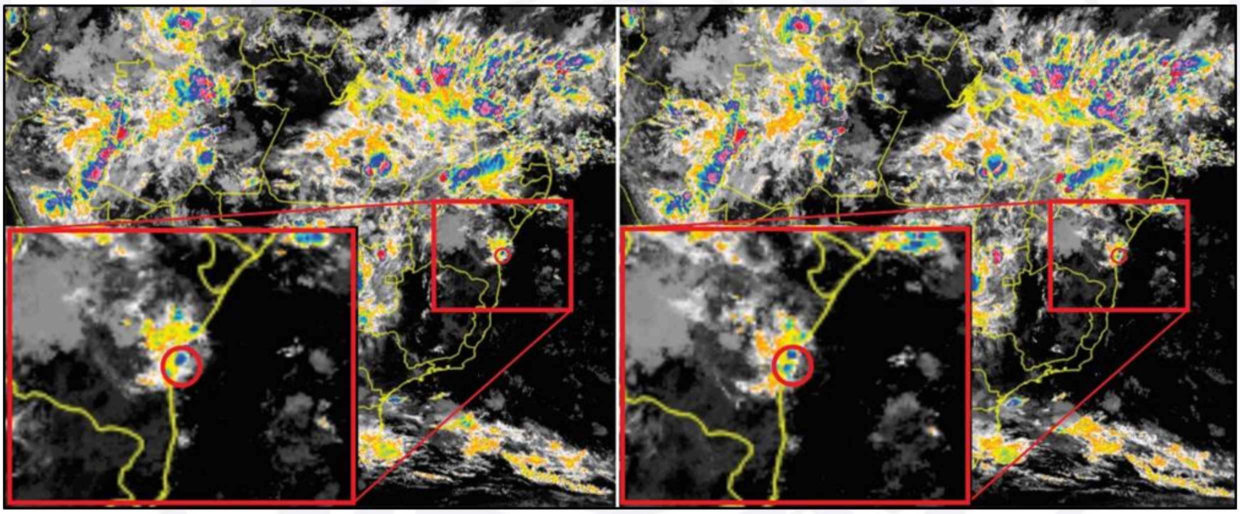


Figure 12 - Images from the GOES-16 satellite, dated 16 March 2022, time 10:40 UTC and 11:20 UTC, obtained from REDEMET.

The METARs of SBSV, located at a distance of approximately 40 NM from the investigated area, corroborate the meteorological conditions forecast for the region:

SBSV 161000Z VRB05KT 9999 BKN020 FEW023TCU BKN100 27/25 Q1013

SBSV 161100Z VRB02KT 9999 BKN020 FEW023TCU BKN100 27/25 Q1013

Given the information collected, one identified that, in the area of interest, there was no synoptic, ITCZ (Intertropical Convergence Zone) type, or cold front acting in the region. Therefore, the presence of isolated CB and TCU clouds in the region was due to local thermodynamics.

The SIC (pilot Second in Command) reported having sighted isolated rain in some parts of the route. He also pointed out that, during the final approach to the 9PMM Platform, despite not having observed precipitation, he realized that the “horizon line” was blurred due to cloudiness in the region, and that the ceiling and horizontal visibility would be within the recommended limits for VFR operations.

The image extracted from the camera installed at the 9PMM Platform shows the meteorological conditions present in the region at 11:09 UTC on the day of the accident (Figure 13).

Figure 13 - 9PMM Platform's video camera image of 16 March 2022 (11:09 UTC)

1.8. Aids to navigation.

NIL.

1.9. Communications.

According to the radiotelephony recordings, one verified that the aircraft in question maintained full radio contact with the air-traffic control agencies, and that there were no technical abnormalities in the communication equipment throughout the flight.

In order to support the analysis of the sequence of events prior to the aeronautical accident, the Investigation Committee focused attention on some transmissions carried out by the PR-LCT helicopter, as well as excerpts of communications between the pilots, in their respective piloting positions, all captured by the aircraft's CVR (Cockpit Voice Recorder).

The time reference used herein is UTC (Coordinated Universal Time).

- (10h07min11s) - initial contact of the aircraft with APP-SV (*Salvador* Approach Control) shortly after takeoff. Subsequently, APP-SV authorized PR-LCT to climb to 1,500 ft. AGL, fly direct *Manati*, and requested the aircraft to inform the ETA (Estimated Time of Arrival) when possible.
- (10h07min23s) - the PR-LCT read back to APP-SV that they would fly direct *Manati* at 1,500 ft. AGL, and informed their ETA in 9PMM as 10:28:00 UTC.
- (10h07min35s) - the APP-SV confirmed with the PR-LCT having copied the ETA, and requested the aircraft to report when leaving CTR-SV (*Salvador* Control Zone).
- (10h14min28s) - the PR-LCT called APP-SV to report having left the CTR-SV.
- (10h14min32s) - the APP-SV instructed PR-LCT to call on the free frequency for coordination and informed not being aware of any other traffic along their route.

- (10h14min40s) - last contact of the aircraft with APP-SV, PR-LCT confirmed having understood the previous message, and thanked the ATC agency for the support.

Once the aircraft left the CTR-SV and entered class "G" airspace, there was only flight information service available (when feasible). From that point on, air traffic coordination in the region surrounding the 9PMM Platform was under the responsibility of the contingent aircraft involved.

- (10h21min00s) - the SIC (PF) remarked that the aircraft was 9 NM away from the landing helideck.
- (10h22min55s) - the SIC remarked that the aircraft was 4 NM away from the landing helideck.
- (10h23min47s) - the crew performed the *before landing offshore check*.
- (10h24min55s) - after the crew assessed the meteorological and operational conditions, the SIC defined that visual traffic for landing at 9PMM would be performed with right-turns.
- (10h25min15s) - the PIC (PM) suggested that the landing be carried out by the SIC, due to the wind direction.
- (10h25min16s) - the SIC agreed.
- (10h25min23s) - the PIC performed reconnaissance the platform, and said to the SIC, "*nove-papa-mike-mike*", corresponding to the identification of the 9PMM Platform.
- (10h25min34s) - the SIC informed the PIC that he was turning to the right.
- (10h25min48s) - while turning for alignment with the downwind leg of the visual traffic circuit for landing, the PR-LCT informed, via VHF, for purposes of traffic coordination with other aircraft that might be flying nearby, as well as for information of the support vessel of the 9PMM Platform, that they were joining the landing circuit.
- (10h25min55s) - the 9PMM support vessel acknowledged having received the message.
- (10h26min23s) - the SIC informed the PIC that they were on the downwind leg for landing.
- (10h26min26s) - the PIC replied to the SIC, "*Perfect*".
- (10h26min33s) - on the downwind leg, the SIC informed to the PIC having identified the helideck and said that he would perform a standard "class 2" approach.
- (10h26min45s) - the PIC answered, "*Okay*", and informed that the landing weight would be 11,200 lb.
- (10h26min49s) - the SIC, at the beginning of the base leg, remarked that he would "get a little further away".
- (10h27min16s) - the SIC said: "*two-five-zero*" (magnetic heading 250º, defined by the crew for the final approach).
- (10h27min18s) - the PIC replied to the SIC, "*Okay*".
- (10h27min19s) - the SIC stated, "*Reducing to seventy*" (speed of 70 kt).
- (10h27min20s) - the PIC answered to the SIC, "*Okay*".

- (10h27min41s) - the SIC, upon aligning with the final approach, informed that he would uncouple the FD and start descent.
- (10h27min45s) - the PIC told the SIC that he would be awaiting confirmation on the final leg.
- (10h27min46s) - the SIC responded to the PIC, "*it's Ok*".
- (10h27min47s) - the PIC informed the SIC that he would arm the life rafts.
- (10h27min49s) - the SIC answered, "*Okay*", and stated that he would perform a go-around if he felt any discomfort with height and position.
- (10h27min57s) - the PIC informed the SIC that the rate of descent was a bit high.
- (10h27min59s) - the SIC commented that the aircraft was high.
- (10h28min01s) - the PIC warned that the SIC was losing speed.
- (10h28min02s) - the SIC commented that the aircraft was high.
- (10h28min05s) - the PIC warned the SIC, "*Speed! Speed!*"
- (10h28min06s) - the PIC made the last transmission before impact with the sea, "*Speed!*"

1.10. Aerodrome information.

The PMNT-1 *Manati* Platform (9PMM) was an unattended fixed maritime platform for production of natural gas under the administration of PETROBRAS (*Petróleo Brasileiro S.A.*). The platform had a private helideck.

In accordance with the ANAC's Ordinance nº 1042/SIA, dated 03 April 2019, the referred helideck operated VFR during daytime, and, on an emergency basis, during nighttime. It had the following characteristics: pavement resistance 5,100 kg; maximum length of the largest helicopter to operate: 17.46 m; and an altitude of 27.9 m (91.53 ft.) in relation to sea level (Figure 14).

Figure 14 - Aerial view of the PMNT-1 Manati Platform (9PMM) helideck.

The platform featured a wind direction indicator (windsock) installed and in operation.

1.11. Flight recorders.

The aircraft was equipped with a Penny & Giles MPFR (Multi-Purpose Flight Recorder), PN D51615-102 / SN 001152-001.

Under normal operating conditions, the MPFR operated in the functions of CVR (Cockpit Voice Recorder) and FDR (Flight Data Recorder).

In the FDR function, the equipment allowed for 25 hours of flight data recording time, with provision of recordings of data from the HUMS (Health and Usage Monitoring System).

The CVR function made it possible to store voice data or any other sound in the cockpit, including audible alarms, for up to 120 minutes during which the CVR remained energized.

Additionally, one recovered a PCMCIA* 256 data-storage card *(Personal Computer Memory Card International Association). The PCMCIA 256 card consisted of a volatile memory intended for acquiring, formatting, processing, and recording flight data.

<u>Data Extraction</u>

The PCMCIA 256 card was unpacked and opened by the Cenipa's Flight Recorder Data Readout and Analysis Laboratory (LABDATA) team.

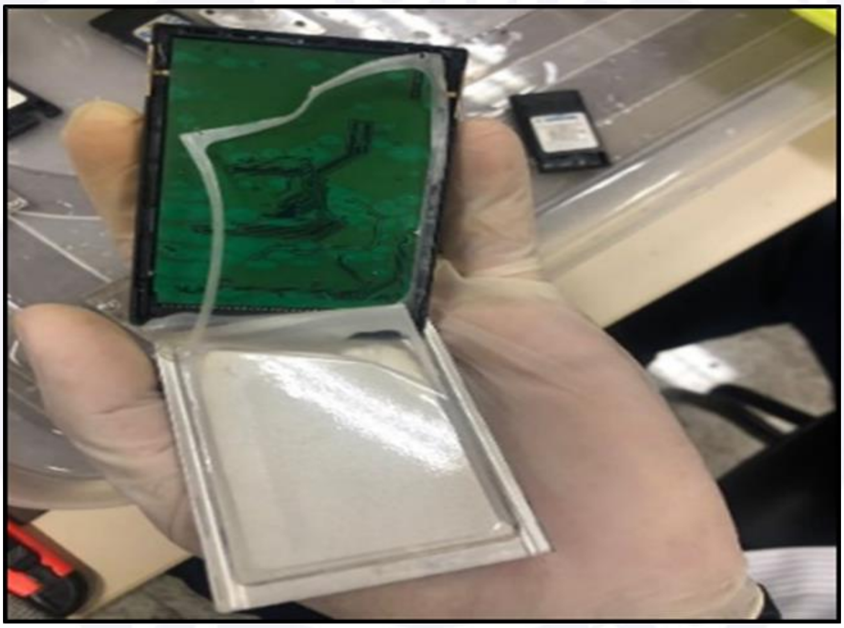


Figure 15 - Opening of the PCMCIA256 card at the LABDATA facilities.

One verified that there was no major damage sustained by the card after exposure to seawater. After being dried with a residue-free absorbent fabric, the material was cleaned with isopropyl alcohol.

Next, the cardboard was placed in the oven to dry for a period of 18 hours, at a nominal temperature of 40°C, with application of an upward (heating) and downward (cooling) ramp of 30 minutes each, as recommended by the manufacturer.

During the opening process, one observed the presence of humidity in the internal part of the MPFR (Figure 16).

Figure 16 - View of the internal part of the MPFR at the LABDATA facilities.

The salt water, which penetrated the MPFR memory compartment, initiated a corrosion process in some of the internal components (Figure 17).

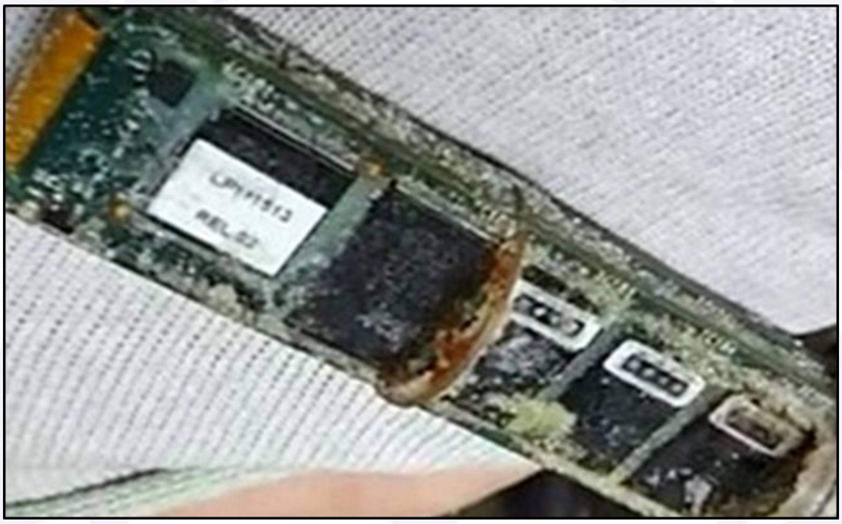


Figure 17 - MPFR memory under a process of corrosion.

LABDATA technicians cleaned up the memory board in order to prevent the occurrence of short circuits with the equipment connected to a source of power (Figure 18).

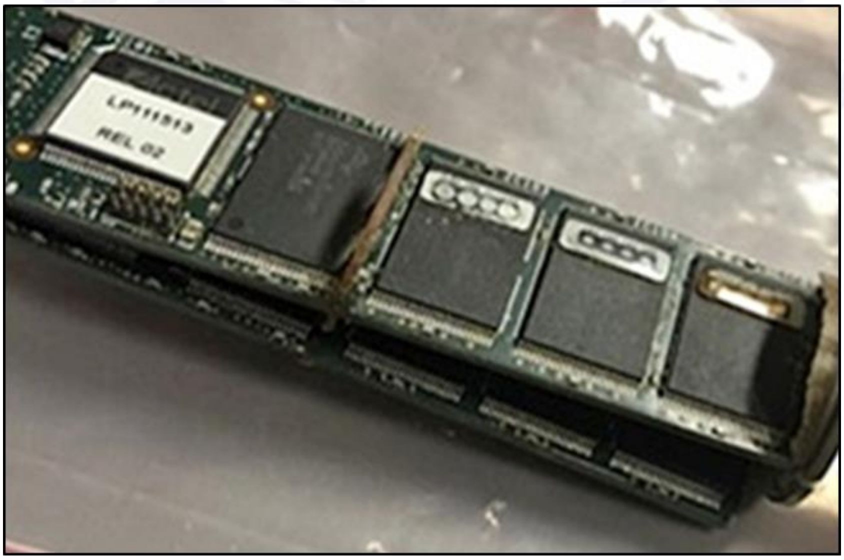


Figure 18 - MPFR memory after being cleaned up at the LABDATA.

The cleaning process obtained satisfactory results.

Subsequently, the memory board underwent a drying procedure, in which it was placed in an oven for a period of 14 hours at a nominal temperature of 80°C, and submitted to alternate rising (heating) and descending (cooling) ramps of one hour each. The drying procedure followed the specifications contained in IPC/JEDEC J-STD-033 (*Handling, Packing, Shipping and Use of Moisture / Reflow Sensitive Surface Mount Devices*) and IPC/JEDEC J -STD-020 (*Moisture/Reflow Sensitivity Classification for Non-hermetic Solid State Surface Mount Devices*) (Figure 19).

Figure 19 - Oven for drying the memory board, in operation at the LABDATA.

The technical work done by the Cenipa's LABDATA staff made it possible to retrieve the flight data and audio recordings from the PR-LCT's MPFR.

1.12. Wreckage and impact information.

The accident occurred on 16 March 2022 at 10:28:06 UTC, and, according to data extracted from the MPFR, at the coordinates 13º29'8.42"S / 038º48'8.66"W, at a distance of 0.63 NM away from the 9PMM Platform, and 6.5 NM from the coast. The information relative to the geographic coordinates and horizontal distances lacked accuracy on account of the technical specificities present in the process of extraction of the MPFR data.

The retractable tricycle landing gear of the PR-LCT was in the extended position. After the collision, the emergency floats kept the aircraft on the sea surface, in an upside-down position.

According to the aircraft operator, the helicopter sank at 21:35 UTC at the coordinates 13º26'32.28"S / 038º48'48.39"W. On 05 April 2022, in an operation under the coordination and responsibility of the aircraft operator, the wreckage of the helicopter was located at the coordinates 13º26'5.66"S / 038º48'35.02"W, and retrieved from a depth of 50 m by means of a crane installed on a vessel. These latter coordinates corresponded to a distance of approximately 3.5 NM away from the accident site (Figures 20 and 21).

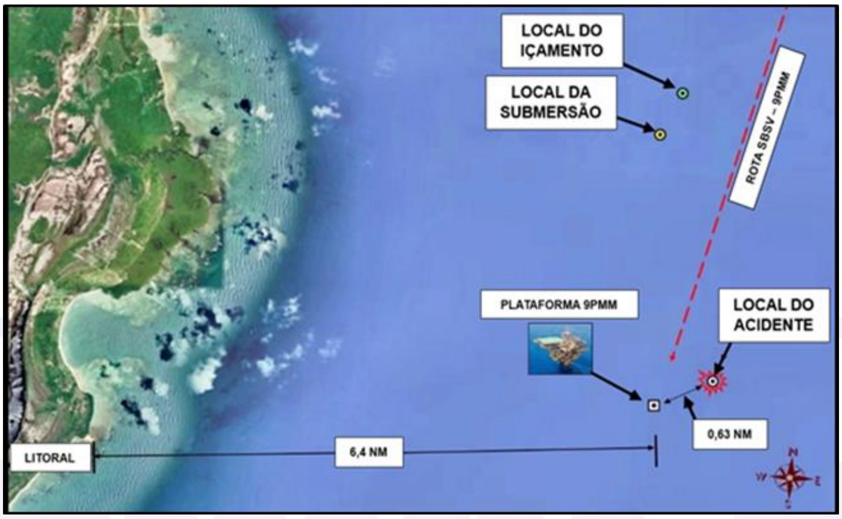


Figure 20 - Croquis of the PR-LCT wreckage site.

Figure 21 - View of the PR-LCT's removal from the sea.

1.13. Medical and pathological information.

1.13.1. Medical aspects.

On 15 March 2022, the PIC and the SIC arrived in the city of *Salvador*, *Bahia*, on distinct regular airline transport flights, in order to start their scheduled fortnight period of work on the following day.

The SIC reported having joined the PIC for dinner the night before the accident, and that, after finishing the evening meal, at around 10:00 pm (local time), they both headed for the hotel booked in advance by the operator of the aircraft.

On the day of the accident, the crew started their activities at around 6:00 am.

After the accident, the SIC underwent toxicological tests, which presented negative results for a number of substances. Alcohol concentration tests also revealed negative results.

The SIC reported that he and the PIC wore glasses with corrective lenses throughout the flight.

The PIC's autopsy report, issued by the Regional Technical Police Coordination of *Valença*, an organization of the Public Security Secretariat of the State of *Bahia*, attested that tests for alcohol, cocaine, amphetamines, and carabinoids presented negative results for the referred substances.

In addition, the aforementioned document informed that the PIC’s cause of death was mechanical asphyxiation due to immersion of the airways in liquid medium.

1.13.2. Ergonomic information.

NIL.

1.13.3. Psychological aspects.

Two pilots made up the crew of the PR-LCT helicopter, with availability to work throughout the scheduled fortnight period with the flights defined by the aircraft operator, in compliance with the demand of PETROBRAS, as the contracting company.

Based on an analysis of the information provided by a number of sources, such as the operator, psychological assessments, performance-evaluation forms from flight simulators and actual flights, interviews with other crew members, check flight logs, among others, it was observed that the PIC demonstrated ease in interpersonal communication. However, a tendency to seek support in his interpersonal relationships was noted, which could lead to dependent behaviors.

As for the PIC’s characteristics as a crewmember, his fellow airmen associated his profile with that of an extrovert, determined person always focused on operational safety. In the reports, one could note information on the PIC's predisposition to give advice to his peers and contribute to the company’s objectives.

At an interview, a member of his family reported that the PIC was happy with his own professional situation because of his operational progress in the company.

The SIC, in turn, affirmed at an interview that in his career as pilot he had achieved operational accomplishments in the rotary-wing aviation with a lot of effort and dedication.

He declared his commitment to diligently studying in order to keep up to date with the operational and technical procedures of the aircraft he was operating.

He recalled that, before joining the offshore aviation, he had been certified by a Brazilian Army rotary-wing aviation unit to serve as a helicopter flight instructor. He highlighted that, throughout his life, he developed psychomotor skills for practicing water sports, especially diving and swimming.

The SIC pointed out that in his first stint in offshore aviation (in the period between 2008 and 2016) he averaged over 70 hours of flight per fortnight period.

With regard to his operational background, after being hired by the aircraft operator, the SIC underwent initial simulator training in a flight simulator, conducted by a company’s accredited examiner, in the period from 22 to 30 January 2021, totaling 36 flight hours in nine sessions, each session with duration of four hours.

At the end of the last training period, he earned an “acceptable” concept, with the comment: “minimally qualified to perform his duties on board...” As a performance measuring parameter, the grades included five ascending concepts: unsatisfactory, poor, acceptable, good, and excellent.

One should note that the initial simulator training consisted of seven sessions with duration of four hours each. The SIC did two extra four-hour training sessions, with the aim of reaching the minimum requirements.

The SIC reported that, on that occasion, during the initial training sessions on the flight simulator, he had some trouble due to the automation of the S-76C++ helicopter.

In February 2021, the SIC started his offshore air activity, flying 26 hours and 10 minutes in fifteen consecutive days of work. It is worth noting that the PIC gave instruction to the SIC on all the flights conducted during the period in question. However, such flights were not subject to evaluation, because the SIC had not yet reached the minimum number of hours established by the company for validation of the instruction.

In the following month, between 16 and 31 March 2021, the SIC accumulated 78 hours and 10 minutes of flight together with 62 offshore landings. All the flights during that period had the same flight-instructor. At the end of the working period, the instructor judged the SIC capable performing co-pilot duties in SK76 aircraft.

On 16 August 2021, in consonance with the PTO, the SIC did his biannual PF training in a flight simulator under the supervision of a flight-instructor of the company, totaling three hours of flight in one training session, and earning an “acceptable” result, which contained the following comment: “*performance at the minimum level required for approval*”.

In the training mentioned above, the instructor's guidance to the SIC had the objective of leading him to evolve in terms of Crew Resource Management (CRM), working the Electronic Check List (ECL), as well as becoming more assertive in his requests to the Pilot Monitoring. Furthermore, he alerted the SIC to define the primary actions to be taken in emergencies, in line with the recommendations contained in the company's SOP.

It should be noted that, according to the aircraft operator, both the SIC and PIC had a valid annual CRM training status. Their training in the simulator covered the following content: communication and decision-making process; team training and maintenance; individual factors, stress and its effects on performance; automation; and concept of error.

In the period from 19 to 21 November 2021, the SIC did periodic flight-simulator training given by a flight instructor of the company, totaling 12 hours of flight in three sessions of four hours each. The SIC earned, upon completion, an “acceptable” grade concerning the exercise of his functions on board.

The investigation found that that the aforementioned sessions were carried out by the SIC together with the PIC, with the two pilots alternating in the roles of PM and PF.

The SIC reported having a relationship of respect and cordiality with the PIC, resulting from previous professional contacts they had in the company.

In relation to the dynamic of the accident, the SIC pointed out having uncoupled the *Flight Director* on the approach for landing on the helideck, and, from that moment onward, he began the descent with effective handling of the helicopter's flight controls (cyclic, collective and pedals).

He commented that, during the approach to land, he focused his “attention on maintaining the profile of the descent ramp, maintaining visual contact with the platform, while the PIC would prioritize monitoring the flight instruments”.

The SIC said that he did not identify any visual or audible alarms indicating some type of aircraft failure during the entire flight, nor did he notice any malfunctions of the helicopter's systems.

The SIC also reported having full confidence in the PIC's technical-operational skills to perform the role of flight instructor.

He stated that, according to his perception, the flight was under control until the final approach phase and then, suddenly, the aircraft began to lose altitude in an abrupt fashion. He added having only noticed the PIC's speed warnings when the helicopter was close to falling into the sea, but, at that moment, he no longer had control of the aircraft.

The SIC finally pointed out that, to his mind, the dynamic of the events during the final approach was very fast and that he did not remember some of the details.

In relation to the rescue of the passengers, the SIC considered that his attitudes in directing the rescue actions were positive.

The Investigation Committee analyzed pieces of information received from a number of different sources (namely, aircraft operator, psychological assessment documents, performance evaluation sheets, interviews with other crewmembers, and the very SIC). Such analysis led the Investigation Committee to observe that the pilot in question had an operational technical profile, and was recognized by his peers and superiors as a pilot who sought to keep up to date with the technical-operational procedures of the air activity.

With respect to his interpersonal relationships, he demonstrated to be discreet and observant, showing a behavior tendency marked by acquiescence in relationships, always willing to collaborate with others.

One also verified that the SIC had, predominantly, a personality profile prone to carrying out orders and tasks in periods of greater tension, demonstrating low resourcefulness in imposing himself and defending his opinions in times of pressure.

1.14. Fire.

There was no evidence of in-flight or post-impact fire.

1.15. Survival aspects.

The S76C Sikorsky RFM, part 1, page 3-53, revised on 25 October 2010, described the procedures for landing on water, with emphasis on the emergency flotation system, as follows:

> *DITCHING (FLOTATION SYSTEM)*
>
> *The optional emergency flotation system is designed only for emergency landing on water. The system maybe expected to keep the helicopter upright long enough to allow passengers and crew to exit to life rafts or rescue boats. A subsequent takeoff or long-term towing should not be attempted.*
>
> *When it appears that ditching is likely, consideration must be given to such factors as wind direction and velocity, sea state conditions, and helicopter power available for ditching. The maximum permissible water entry conditions are 33 knots water speed at 300 feet per minute rate of descent in a calm sea. Optimum ditching conditions would occur in a calm sea state with the forward speed of the helicopter reduced to as close to zero as possible, and with little or no lateral drift component. Minimum touchdown forces will be achieved when touchdown is made on the crest or back of a wave with a minimum rate of descent. Greatly increased touchdown forces will be experienced if the landing is made on the front or rising face of a wave. Every effort should be made to land the helicopter with as little sideward drift as possible as the roll rate after touchdown increases sharply with any increase in lateral motion. Ditching with power available (such as when fuel starvation is imminent or a loss of transmission oil pressure dictates such action) will greatly increase controllability, reduce touchdown forces, and assist in preventing the helicopter from rolling after impact. Power off ditching (autorotation) should be avoided if possible. With sufficient power available to fully control the helicopter descent rate, sideward drift and forward speed to near zero values, successful ditching may be accomplished in sea states up to and including Sea State 4 (wave height 6.5 feet, wavelength to height ratio - 10 to 1) depending on wind conditions.*
>
> *All possible control available from the rotor system should be used to prevent rolling after impact. Consideration should be given to extended power on water taxi, if wave conditions make rotor to water contact unlikely. Power-on water taxi will greatly increase the roll stability of the helicopter and will allow yaw and heading control. The floats may be inflated at any time during the ditching procedure (below 75 KIAS). Allow sufficient time for full inflation be for water contact. Float inflation time is within 10 seconds.*

The floats of the PR-LCT deployed automatically after the crash and kept the helicopter afloat in an upside down position, with the fuselage partially submerged (Figure 22).

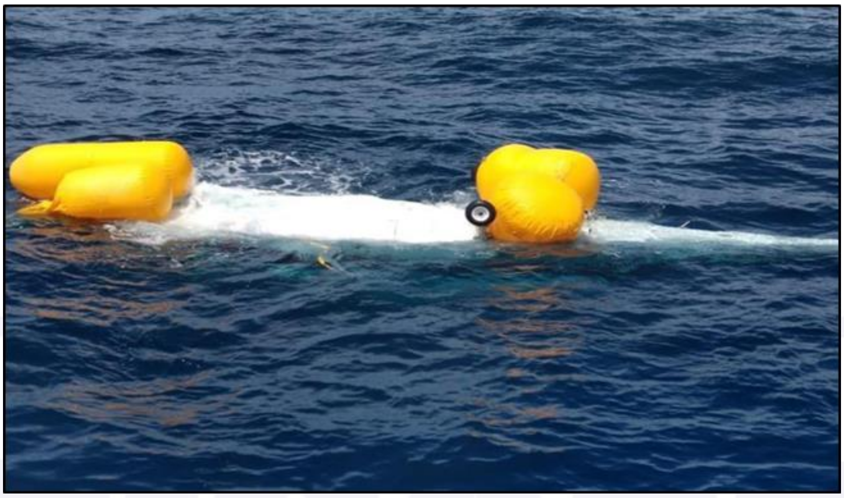


Figure 22 - View of the PR-LCT after the crash, showing the four inflated emergency floats, which kept the helicopter afloat just below the sea surface.

The right-hand life raft inflated adequately after external activation by means of the Outside Release Handle, and accommodated the PR-LCT's crew and passengers until they were rescued.

Figure 23 - View of the PR-LCT's inflated boat, shortly after the rescue of the crew and passengers.

The accident flight was the PR-LCT's first flight of the day destined for the 9PMM Platform, and there were no people on board the unattended maritime unit.

Personal Locator Beacon (PLB)

Either pilot carried a PLB (*Personal Locator Beacon*) manufactured by Ocean Signal, (PN 101275-1, SN 4320 and SN 4504), which had a 406 MHz transmitter, providing VHF homing signal (121.5 MHz and 243 MHz) and transmissions compatible with the COSPAS-SARSAT UHF satellite (403 MHz).

The referred devices, fitted on the pilots' life jackets, could be activated either manually or automatically.

In the event of a collision with land obstacles or in the event of landing in water, the PLBs would broadcast their geographic positions to the search and rescue services.

On 28 January 2022, the batteries of the PLB underwent inspection, and were within their period of validity.

After the accident, the PLBs of both pilots automatically sent their respective geographic locations to the Rescue Coordination Center (ARCC), located in *Recife*, State of *Pernambuco*.

The NORMAM 27/DPC, chapter 7, article 0706, prescribed the following basic requirements for preventing and fighting fires on helidecks located on platforms and vessels:

> 0706 – UNATTENDED PLATFORMS
>
> The helideck located on a fixed unattended platform having a reduced rescue capability should only be used for occasional landings.
>
> When there are people on board, the platform should have at least one person with the ALPH course (Helicopter Launch and Landing Agent), carrying a portable aeronautical and maritime VHF radio transceiver, on the frequency agreed with the crew during the briefing. The other persons on board are not required to have the BOMBAV (Aviation Firefighter) course, however, they need to know how to use the equipment and be equipped with firefighting attire.
>
> Unattended platforms, as they do not have a Telecommunications and Air Traffic Control Service Provider Station (EPTA), are not required to have a voice recorder. In unattended units, the extraction of video images may be done in a remote fashion.
>
> When there are no people on board, unattended platforms should receive personnel qualified to staff the helideck. The transport of the EMCIA (Aviation Maneuver and Fire Fighting Team) to the unattended platform, and withdraw from it, will take place, respectively, on the first and last flights.
>
> The wind direction indicator (windsock) will comply with item 0503 of this norm.
>
> A sensor indicating wind direction and strength (anemometer) may be available, but every unattended platform must have a portable anemometer.
>
> An external temperature sensor may be installed close to the helideck.
>
> Note: if there is a support vessel, it must transmit the platform's wind and temperature conditions to the relevant aircraft.
>
> The items below compose a minimum list that should be available for immediate use:
>
> **a) Tools**:
>
> 1) 1 (one) firefighter's ax for rescue operations (over 3 kg);
>
> 2) 1 (one) crowbar of at least one meter;
>
> 3) 1 (one) rebar cutter of at least 0.60 m;
>
> 4) 1 (one) manual metal saw;
>
> 5) 1 (one) universal, insulated, 8 (eight) inch pliers;
>
> 6) 1 (one) 10 (ten) inch screwdriver;
>
> 7) 2 (two) belt cutters; and
>
> 8) 3 (three) portable flashlights.
>
> **b) Support material**:
>
> 1) 3 (three) pairs of chocks;
>
> 2) a minimum of 4 (four) metal or nylon straps, specific for aircraft mooring, whose couplings are compatible with the burikas;
>
> 3) 1 (one) articulated or support ladder, with a height compatible with the dimensions of the largest helicopter operating on board; and
>
> 4) 1 (one) closed helideck signage tarpaulin, Annex 5-H.

c) Rescue material:

1) 1 (one) portable first aid kit;

2) 1 (one) floating rigid stretcher with head immobilizer; and

3) 1 (one) portable oxygen ampoule and 2 (two) masks.

d) Firefighting material:

1) 3 (three) 6 kg portable dry chemical extinguishers;

2) 3 (three) 6 kg portable carbon dioxide fire extinguishers; and

3) 1 (one) firefighting system equipped with a "foam monitor" that guarantees application throughout the helideck and meets the requirements set out in the table in paragraph c of article 0703.

e) Firefighting clothing:

Every EMCIA member, except the ALPH shall have a fire-fighting suit composed of:

1) approach- and fire-fighting clothing or 7/8 cover for approach and fire-fighting firefighters;

2) balaclava mask;

3) ear protector;

4) firefighter helmet;

5) firefighter gloves; and

6) firefighter boots.

f**) Life raft**:

Approved in accordance with the requirements set out in the International Convention for the Safety of Life at Sea (SOLAS) and with a capacity compatible with the aircraft that can operate on that helideck. This raft must have a device for rapid launching if necessary.

It is worth noting that in the regulation in question, relatively to air operations on helidecks located on unattended platforms, one could not find a definition for the expression *occasional landing*.

On this theme, through the third revision of the NORMAM 27/DPC, which took effect on 01 June 2023, the article 0706 had the expression "*occasional landing"* removed. The referred regulation established, among other changes, that, henceforth, one could use the helideck for landing in up to three weekly flight schedules and in VMC conditions.

It should be noted that, among the PR-LCT's passengers, there were five professionals hired by the platform operator, who, after disembarking, would compose the Aviation Maneuver and Fire Fighting Team (EMCIA), with the purpose of staffing the helideck of the 9PMM Platform.

According to information gathered, the PR-LCT had taken off from the aerodrome of origin with the following seating arrangement (Figure 24):

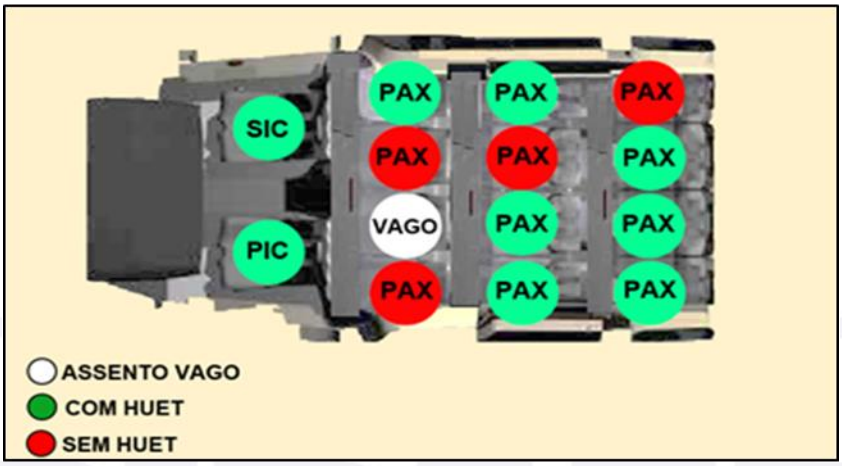


Figure 24 - Arrangement of seats for crewmembers and passengers of the PR-LCT helicopter at the time of takeoff.

The aircraft operator provided information showing that the pilots had valid training for helicopter evacuation and escape, as well as water survival techniques for aircraft crewmembers. Such training was in consonance with the recommendations of the Supplementary Instruction nº 135-003D of 01 July 2020 relative to the ANAC's Brazilian Civil Aviation Regulation nº 135 ["*Public Air Transport Operations with Airplanes with a Maximum Certified Passenger Seating Configuration of up to 19 Seats and Maximum Paid Cargo Capacity of up to 3,400 Kg (7,500 Lb.) or Helicopters*."]

It is noteworthy that a similar training process had the international name of Helicopter Underwater Escape Training (HUET).

The training performed by the PR-LCT's pilots had duration of one day and presented the following programme content:

- protection and safety equipment;
- physical and psychological issues related to survival;
- resources available in the helicopter's life raft;
- personal survival techniques, individual swimming, and group swimming (*crocodile*);
- hypothermia and thermal shock;
- means of preventing hypothermia, *help* position, group position, and survival circle;
- procedures for boarding the life raft, initial actions, and vital actions;
- straighten an overturned life raft;
- means signaling and search & rescue;
- evacuation and abandonment of aircraft, preparation for emergency landing, and impact positions;
- controlled evacuation after emergency landing on water surfaces, on land and on helipads;
- procedures for escaping from a submerged helicopter;
- practice water survival exercises; and
- practice exercises on escaping from a submerged helicopter.

On this subject, according to information provided by the company operating at the 9PMM Platform, seven of the eleven passengers who were on board the PR-LCT helicopter had completed the HUET training.

In this context, it is worth mentioning that the ANAC's IS 135-003D did not have a recommendation of HUET training for passengers on offshore commercial helicopter flights.

In relation to the accident flight in question, the SIC reported that the PIC held the safety briefing for the passengers outside the aircraft, moments before boarding. However, the SIC did not attend the briefing and therefore did not witness the presentation of the items discussed by the PIC on that occasion, for being in the cockpit preparing the aircraft for the flight.

In accordance with the MGO, item 3.1, page 73, the following procedures and notice models (*briefings*) should be delivered to passengers before the flight (*paraphrased*):

> [...]
>
> Before starting the briefing, the crewmember should ask whether any of the passengers does not speak Portuguese. If so, delivery of the briefing will be made in Portuguese and in English.
>
> The crewmember must hold the briefing close to the aircraft (in order to demonstrate his instructions) in a safe manner and close enough to the passengers to allow them to understand the information.
>
> The briefing must contain:
>
> (a) Introduction of the crew;
>
> (b) Confirmation of the destination unit(s);
>
> (c) Questioning whether any passenger is boarding for the first time;
>
> (d) Asking passengers whether they have HUET training (Helicopter Underwater Escape Training) and placing the one(s) who do have it close to the aircraft's emergency exits;
>
> (e) Ensure that all passengers wear life jackets correctly;
>
> (f) Give instructions regarding the use of a life jacket in case of emergency;
>
> (g) Give instructions regarding the use of seat belts;
>
> (h) Give Instructions regarding the use of emergency exits;
>
> (i) Demonstrate the correct way to open the doors and inform that, on the helipad, they will be opened by the HLO of the maritime unit;
>
> (j) Question whether the seat belt is the same as the one presented in the briefing. If different, demonstrate how to fasten and unbuckle it;
>
> (k) Explain how the flotation system works;
>
> (l) Show where life rafts are located and instruct passengers on their use;
>
> (m) Show where emergency equipment is located (fire extinguishers, first aid kit, etc.); and
>
> (n) Questions and answers regarding possible safety issues on the part of the passengers.
>
> Before proceeding with the briefing, the crewmember must decide whether it will be inside or outside the aircraft. This decision depends on the number of passengers or the noise level outside the aircraft.
>
> If it is not possible to demonstrate all instructions to all passengers in a clear fashion on board the aircraft, the briefing must be conducted outside the aircraft.

According to Figure 24, one noticed that the two passengers who did not have HUET training occupied the seats close to the emergency exits, in contrast with the recommendation of letter “d” above mentioned.

On this topic, survivors reported that it was common practice for the crew to ask passengers whether they had ever received HUET training, but on the accident flight, such question was not asked.

In accordance with the contents of the MGO, item 3.4.6, p. 54, the following emergency and survival equipment should be part of the equipment installed on S-76C++ aircraft:

> (a) Life raft;
>
> (b) Life vest;
>
> (c) ELT (localizer);
>
> (d) First aid (first aid kit);
>
> (e) PLB (portable locator);
>
> (f) Portable fire extinguisher; and
>
> (g) Cabin fire extinguisher.

The RBAC-135, amendment nº 9, dated 01 March 2021, page 58, established the following requirements concerning emergency equipment for operations over large expanses of water and offshore operations with helicopters:

> 135,167 Emergency equipment: operation over large expanses of water and offshore operations with helicopters.
>
> (a) operation of an aircraft over large expanses of water is only allowed if such aircraft has the following equipment installed in a visible or visibly marked location, which is easily accessible by the occupants in the event of water landing:
>
> (1) for each occupant, an approved life jacket fitted with a survival locator lamp. The life jacket must be easily accessible from each occupied seat; and
>
> (2) Approved life rafts in sufficient numbers (with respect to buoyancy capacity) to transport all occupants of the aircraft.
>
> [...]
>
> (c) operation of an aircraft over large bodies of water is only allowed if a watertight, floating, portable or survival ELT in operating condition is attached to one of the life rafts required by paragraph (a) of this section, and that meets the requirements of paragraphs 91.207 (c) and (g) of RBAC nº 91. (Wording given by Resolution nº 546, of 03/18/2020).
>
> (d) Helicopters that operate on fixed or floating offshore platforms, in addition to complying with the provisions of paragraphs (a), (b) and (c) of this section, must be of a type certified for normal landing on water (have floats or have a "hull" fuselage).
>
> (e) For the purposes of this section, operation over a large body of water means:
>
> [...]
>
> (3) for a helicopter, an operation conducted over water at a horizontal distance from the coastline (or shore) of more than 93 km (50 nautical miles) and more than 93 km (50 nautical miles) from a fixed or floating helipad in the water ("*offshore*").

Despite the platform's distance from the coast (7NM), the PR-LCT aircraft, along with its crew and passengers, had, at the time of the accident, the emergency equipment listed in the RBAC-135 and in the MGO.

In addition, it should be noted that each of the pilots' life jackets was equipped with a PLB, an item used to locate people and issue warning signals to search and rescue units.

The eleven passengers did not have such piece of equipment on their life jackets. The RBAC-135, amendment nº 9, dated 01 March 2021, p. 58, did not establish obligatory use of the PLB in life jackets of passengers transported in helicopter offshore operations.

The operator the 9PMM Platform was a member of the aviation subcommittee of the IOGP (International Association of Oil & Gas Producers). The IOGP, by means of the Report 690, version 1.1, of February 2021 - *Offshore Helicopter Recommended Practices* (OHRP), recommended a number of practices to assist in the safe and effective management of commercial offshore transport operations with helicopters, in accordance with the following scope:

The scope of the OHRP is limited exclusively to offshore helicopter Commercial Air Transport (CAT) operations and replaces those elements in IOGP Report 590 v.2. IOGP Report 410 has been withdrawn upon publication of this Recommended Practice and the legacy material from Report 590 that relates to aviation activities other than those covered in the OHRP will be subject to a future revision of that document.

The OHRP provides supplemental practices to those legislated by National Aviation Authorities (NAA). The national regulations or ICAO requirements are followed when they exceed any of the practices contained within this report.

The recommended practices contained within this report represent the minimum required practices. All users of this document are encouraged, through formal risk assessment, to identify additional controls that may be required to assist managing the risk and localized conditions.

The OHRP is available for use by contractors (including aircraft operators, Aviation Maintenance Organizations (AMO) and subcontractors) in order to meet the expectations of IOGP Members when they are contractually stipulated to adhere to these practices.

In this sense, the IOGP Report 690-2, *Aircraft Operations*, recommended the following practices in relation to personal protective equipment and HUET training for crewmembers:

10. CREW - PERSONAL PROTECTIVE EQUIPMENT

10C.1 All crew wear lifejackets meeting ETSO-2C504 with Personal Locator Beacons (PLBs) and Compressed Air Emergency Breathing Systems (CA EBS).

10C.1.1 PLBs with 121.5 MHz, GPS and 406 MHz capability, Advanced Automatic Identification System (AIS) are desirable.

10C.1.2 PLBs are assessed for compatibility with the aircraft ELT.

10C.2 Immersion suits are worn when required by regulation or by contract.

10C.2.1 Immersion suits meet ETSO-2C502 or ETSO-2C503 or national aviation authority approved TSO and which have been tested for compatibility with the lifejacket.

48. ROLE SPECIFIC TRAINING - HELICOPTER UNDERWATER ESCAPE TRAINING (HUET)

48C.1 Flight crew complete a HUET course to a recognized standard (e.g., OPITO) that includes the use of a Modular Egress Training Simulator (METS) at least every four years, unless local regulation requires greater frequency.*

48C.2 In HUET devices the emergency exit types and sizes are representative of the aircraft flown in offshore operations.

48C.3 All HUET trained personnel or their companies maintain a documented record of the training completed.

49. ROLE SPECIFIC TRAINING - EMERGENCY BREATHING SYSTEMS (EBS)

49C.1 HUET includes training in the use of the CA-EBS to ensure user proficiency at least every four years, unless local regulation requires greater frequency.

49C.2 The CA-EBS is compatible with the lifejacket (and immersion suit, if required).

49C.3 An appropriate Maintenance Program (including pre-flight inspection) is in place for these items.

[...]

Furthermore, the IOGP Report 690-3, *Support Operations*, recommended the following practices in relation to personal protective equipment and HUET training for passengers: (*emphasis added*)

[...]

6. PASSENGER - PERSONAL PROTECTIVE EQUIPMENT

6C.1 All passengers are issued constant wear lifejackets meeting ETSO-2C504 with Personal Locator Beacons (PLBs) and Compressed Air Emergency Breathing Systems (CA EBS).

<u>6C.1.1 PLBs transmit on 121.5 MHz and/or AIS.</u>

<u>6C.1.2 PLBs are assessed for compatibility the aircraft ELT and Crew PLBs.</u>

6C.2 Immersion suits are worn when required by regulation or by contract, meet ETSO-2C502 or ETSO-2C503, or national aviation authority approved TSO, and which have been tested for compatibility with the lifejacket

6C.3 Information is displayed on passenger clothing requirements, including the type and number of layers required under immersion suits, if applicable to the operating region.

6C.4 Hearing protection is provided for passengers together with instructions for its use.

[...]

11. PASSENGER TRAINING - HELICOPTER UNDERWATER ESCAPE TRAINING

11C.1 Passengers complete a HUET course to a recognized standard (e.g., OPITO) that includes the use of a Modular Egress Training Simulator (METS) at least every four years, unless local regulation requires greater frequency.

11C.2 This training is completed in conjunction with wet dingy drills using emergency equipment similar to that installed on the aircraft.

11C.3 In HUET METS the emergency exit types and sizes are representative of the aircraft flown in offshore operations.

11C.4 HUET trained personnel or their companies maintain a documented record of the training completed.

12. PASSENGER TRAINING - COMPRESSED AIR EMERGENCY BREATHING SYSTEM

12C.1 Passenger training in the use of the CA-EBS to ensure user proficiency is completed every 4 years.

12C.2 The CA-EBS is compatible with the lifejacket (and immersion suit, if required).

12C.3 An appropriate Maintenance Program (including pre-flight inspection) is in place for these items.

[...]

* OPITO - Offshore Petroleum Industry Training Organization

In order to facilitate the understanding of the scope of the *Offshore Petroleum Industry Training Organization* (OPITO), one should refer to the text below extracted from the organization's website:

OPITO is the global, not-for-profit, skills body for the energy industry.

Up to 450,000 people are trained to OPITO Standards every year in more than 50 countries through 230 accredited Centres.

With operating hubs in four regions - UK and Europe, Middle East and Africa, Asia Pacific and the Americas - OPITO is driving safety and competence improvements to benefit the industry.

The industry-owned organisation also works with governments, national oil companies, operators and contractors, offering a range of services and products to meet international skills needs and support workforce development.

https://opito.com/about-us/what-we-do, accessed on 05JUN2023.

Similarly, the CAA UK (*United Kingdom Civil Authority Aviation*) published the CAP 1386, 2016, "*Safety review of offshore public transport helicopter operations in support of the exploitation of oil and gas"*. The referred CAP addressed, among others issues, a number of considerations relating the use of an emergency breathing system to the increase in underwater survival time, an action that would increase the chances of helicopter crewmembers and passengers escaping from a submerged aircraft, as described below:

> *FOREWORD*
>
> *Between 2009 and 2013 there were five significant accidents in the UK offshore Helicopter aviation sector, two of which tragically resulted in fatalities. Following these accidents, the CAA Board commissioned a comprehensive review of the safety of offshore Helicopter operations (CAP1145, published 20 February 2014). The review resulted in a number of wide ranging recommendations and actions to improve safety standards. The review made clear our determination to implement these actions and recommendations as swiftly as possible.*
>
> *In January 2015, we published CAP 1243, a Progress Report outlining the advances being made against the actions and recommendations. The report described how significant and important progress had been made towards improvements in offshore helicopter safety, such as flights no longer taking place over the most extreme sea conditions and passengers being equipped with new and Emergency Breathing Systems (EBS) with the associated training having been completed.*
>
> *Chapter 1*
>
> *Passenger safety and survivability*
>
> *The evidence presented in the Review showed that just over half of the accidents in which offshore helicopters impacted the sea between 1976 and 2012 in the UK were potentially survivable. However, these accidents led to 38 fatalities. CAP 1243 highlighted several areas where significant progress had been made in improving the protection of passengers in the event of an accident, including:*
>
> *[...]*
>
> *increasing underwater survival*
>
> *increasing underwater survival time to improve the chances of escape from a capsized helicopter through the introduction of new improved Category A Emergency Breathing Systems (EBS) for all passengers;*
>
> *[...]*
>
> *Note: Category A EBS is one that may be deployed underwater within the breath-hold time of the user and using only one hand. CAA published CAP 1034 in May 2013 to define a draft technical standard for these systems. CAA is currently participating with EASA in the development of a European standard that will incorporate the draft CAA standard and the experience gained during the CAA approvals of EBS for passengers and crew.*

Still on the subject, the CAA UK, by means of the CAP 1034, 2013, *Development of a Technical Standard of Emergency Breathing Systems*, p. 36, described the CA EBS as follows:

> *The Compressed air device consisted of a gas cylinder, a high-pressure hose, regulator and mouthpiece. The mouthpiece was fitted with a system of valves to help prevent water entering the mouth and reduce the need for purging during underwater deployment. The regulator was also fitted with an integral nose clip. The device was carried in a zipped pouch, strapped around the waist. This device was originally designed for use without practical training.*

Compressed Air Emergency Breathing System (CA EBS).

The CAA UK, in 2020, by means of the CAP 1877, annex “A”, item A10, published the following requirement on the use of the CA EBS in offshore helicopter operations:

> *With effect from January 2015, the CAA will prohibit helicopter operators from conducting offshore helicopter operations, except in response to an offshore emergency, unless all occupants wear Emergency Breathing Systems that meet Category 'A' of the specification detailed in CAP 1034 in order to increase underwater survival time…*

It is worth mentioning that, in accordance with the provisions of item 135.167 of the RBAC-135, the use of life jackets equipped with CA EBS (Compressed-Air Emergency Breathing System) was not included in the list of safety emergency equipment of mandatory use by crews and passengers on offshore helicopter operations.

As for the dynamic of aircraft evacuation and the survival procedures of the PR-LCT’s crew and passengers, the SIC reported that he and the PIC had been wearing seat belts and harnesses fastened since the engine startup preparations. The SIC also reported that, after the crash, the helicopter rolled to the right, and seawater flooded the cockpit. The crewmember also noted that the floats kept the helicopter on the water surface, in an upside down position.

The SIC also recalled that, after the helicopter crash, and upon noticing the almost immediate flooding of the command cabin, he had little time to fill his lungs with air and remain in apnea.

At that moment, the SIC noted that, he was “upside down”, strapped by his seat belt in the right-hand pilot seat, with his body completely submerged in water and with limited visibility due to the dark color of the sea water. He also mentioned that initially he kept one hand on the seat belt release buckle, without opening it, though.

He then attempted to jettison or open the helicopter door with his free hand, but was unable find either the jettison lever or the door-opening handle.

The crewmember said he subsequently released his seat belt, an action that caused his body to revolve 180º. This movement allowed him to see a light coming from the acrylic bubble located behind the pedal flight controls, close to the handle of right-hand front door.

The SIC recalled that he then managed to open the handle of the right-hand front door and escape from the aircraft. He also added that upon reaching the water surface, he inflated his own life jacket, as well as the ones of other passengers who were floating around.

Passengers reported having difficulty opening the emergency exits and jettisoning doors and windows, possibly due to the counter pressure of the water, which required a longer period of time underwater than the one observed by those who had taken the HUET training. They also reported that an “air pocket” formed inside the cabin, which allowed at least one of the passengers to take breath again and escape from the aircraft.

The SIC and one of the passengers recalled that the life raft located on the right-hand side of the helicopter was then deployed manually, and all the survivors boarded it. They also recalled that after boarding the life raft, the survivors realized that the PIC had not abandoned the aircraft.

The SIC said that he took off his inflated life jacket, and dived to rescue the PIC. He removed the PIC from the submerged cockpit through the left front door of the aircraft. He had found the PIC unconscious, floating inside the control cabin, with his seat belt and harness loosened.

After the rescue, they placed the unconscious PIC in the life raft, and started the resuscitation procedures began, with the use of “mouth to mouth” breathing and cardiac massage.

The commander of the UT 750 support vessel, call sign LUMAR 20, sailing in the area close to the 9PMM Platform, reported not having sighted the helicopter crash.

The survivors, by means of a cell phone, made contact with the aircraft operating company, transmitting the necessary information so that the support vessel approached the life raft. After the survivors boarded the support vessel, the PIC's resuscitation maneuvers continued.

With regard to supervision procedures for flights carried out by the aircraft operator, the relevant MGO, item 3.4, p. 52, read the following:

> 3.4.1 FLIGHT LOCATION REQUIREMENTS
>
> Flight Coordination has two systems for the supervision of flights:
>
> (a) Flight Following System - shows the aircraft's geographic location map via satellite; and
>
> (b) SOL System - the Coordinator enters data relevant to flight supervision in order to track any inconsistencies in the mission.
>
> The combination of the two systems gives the *LÍDER UOH* company the ability to obtain (in a quick fashion) the location, flight deviations, times, and routes not planned for the flight.
>
> If there is any interruption in the transmission of the aircraft's location, the Coordinator must seek the position of the aircraft immediately, contacting the destination platform (via VHF radio, VOIP or satellite phone call, self-positioning command from the monitoring system). If contact is not possible, the company's emergency response plan must be initiated.
>
> [...]
>
> 3.4.3 RESPONSIBILITY OF THE FLIGHT COORDINATOR ASSIGNED TO FLIGHT SUPERVISION FUNCTIONS
>
> Continuous attention and supervision by the Flight Coordinator assigned to the role are essential to the success of this task.
>
> The Flight Coordinator must monitor the flight from the start-up and takeoff to the landing on the platform, as well as its return, using the systems available for this procedure and providing all necessary assistance for the success of the mission.
>
> [...]
>
> 3.4.5 MEANS OF COMMUNICATION
>
> Aircraft of the *LÍDER* UOH Company fleet have a satellite communication system with global coverage for provision of timely information and communication. This system is capable of supporting missions in locations deprived of means of communication.

The satellite monitoring system, in addition to the Emergency Locator Transmitter (ELT) system, can be activated remotely, providing the aircraft's precise location to search and rescue services.

LÍDER UOH Company's survival and emergency information and procedures are made available via the intranet and in physical forms, and can be accessed at any time in the event of an emergency and search and rescue missions.

In the event that an aircraft becomes inactive in Flight Following, the assigned Flight Coordinator must immediately attempt to communicate with the aircraft via VOIP or Satellite Phone. An unsuccessful attempt initiates the *Lider* UOH Company's Emergency Response Plan. Therefore, there is no established time for the absence of communication.

The ELT of the PR-LCT aircraft activated automatically after the crash, sending the aircraft's geographic position to the ARCC-RE.

At 10:35 UTC, by means of the MEOSAR (Medium Earth Orbit Search and Rescue) satellite, Beacon Frequency 406.0276 MHz, the ARCC-RE received a signal of the PR-LCT ELT at the coordinates 13°28.7'S/038°47.8'W, approximately 40 NM south of Salvador, Bahia. From then on, the ARCC-RE started the coordination recommended by the legislation in force, with the purpose of locating the aircraft.

After the alert message, the COSPAS-SARSAT BRMCC (Brazilian Mission Control Center) sent the beacon record linked with the PR-LCT helicopter to the ARCC-RE, which, after analyzing the content of the alert message, made some unsuccessful attempts to contact the aircraft operator by means of the telephone numbers listed in the beacon records.

At 10:40 UTC, the ARCC-RE made contact with the APP-SV, which reported that the PR-LCT aircraft had estimated landing at 10:28 UTC and a new takeoff from the 9PMM Platform bound for SBSV at 10:30 UTC.

At 10:50 UTC, the ARCC-RE contacted the aircraft operator, via telephone, with the purpose of obtaining information on the PR-LCT aircraft.

At 11:07 UTC, the ARCC-RE received a PLB signal from the PR-LCT crew, hexadecimal code 58CF628208FFBFF, at coordinates 13°28.7'S/ 039°02.9'W. The alert received was convergent with the one of the ELT described above, and the recorded information from that beacon was linked to the PR-LCT aircraft.

According to the aircraft operator, the flight coordination attempted to communicate with the PR-LCT aircraft at 10:50 UTC, having received the aircraft position via the company's flight tracking system at 10:53 UTC.

At 11:12 UTC, the ARCC-RE received another PLB signal from the PR-LCT's crew (hexadecimal code 58CF628234FFBFF) at coordinates 13°27.4'S/ 038°47.3'W. The signal received was in consonance with the previous ones transmitted by the ELT and PLBs, and linked to the PR-LCT aircraft. According to information provided by the aircraft operator, the flight coordination managed to contact the LUMAR 20 support vessel at around 11:00 UTC.

At 11:04 UTC, the crew and passengers of the helicopter were rescued by the LUMAR 20 support vessel. At 11:10 UTC, the vessel requested to proceed to the port of *Valença*, Bahia, located at a distance of approximately 10 km from the site of the occurrence.

At 11:18 UTC, the flight coordination communicated with the ARCC-RE, informing about the aeronautical accident, the rescue of crew and passengers, and their respective physical conditions.

At 12:34:00 UTC, during the transport of the survivors from the accident site to the city of *Valença*, the PIC, the SIC, and three passengers were transferred from the LUMAR 20 support vessel to a speedboat, in order to reduce travel time to the medical center.

According to the SIC, the survivors remained taking turns doing the PIC's attempted resuscitation maneuvers on the speedboat, despite having observed that the PIC's vital signs (pulse, breathing and body temperature) had weakened.

Upon arriving at the city port, the five survivors on the speedboat were taken by an ambulance not staffed with health professionals to the airport, where a medical team confirmed the PIC's death. Later, the other survivors arrived at the airport transported by ambulance.

The PIC's corpse was taken to city's Legal Medical Institute (IML). The SIC and the eleven passengers, underwent evaluation by the medical team at the airport. Later, they were flown to *Salvador*, *Bahia*, in aircraft of the *Air Group of the Military Police of the State of Bahia* (GRAER - BA). In Salvador, the twelve survivors were taken to a hospital, from which all of them were discharged in less than 48 hours.

One found that the aircraft operator's Emergency Response Plan (POP LA-207, revision 04, dated 05 July 2021) did not describe the emergency-response resources available in the city of *Valença*.

According to technical reports produced by the DECEA, it was possible to verify that the ARCC-RE carried out the actions prescribed in the MCA 64-3/2019 - "*SAR Search and Rescue Coordination Manual*", as well as ICA 64-2/2018 - "*Warning Signals of the COSPAS-SARSAT System*".

1.16. Tests and research.

Vortex Stall Research

The IPEV (Brazilian Command of Aeronautics' Flight Testing and Research Institute) performed a study to verify whether the helicopter involved in this accident suffered the aerodynamic effect known as Vortex Stall during the final approach phase.

It is worth highlighting that the technical analyses conducted by the referred Institute were based on classical theory of aerodynamics and rotor dynamics. There were no analyses of experimental results or computational analyses.

- Summary description of the occurrence:

The SIC reported that, during the final approach to the 9PMM Platform, the aircraft began to lose altitude abruptly and, after the "speed" warning issued by the PIC, he reported that he no longer had control of the helicopter. The aircraft did not make it to the platform, and collided with the sea.

- Flight data.

Initially, considering a more critical condition of the scenario in which the accident occurred (altitude-pressure of 1,000 ft. and temperature of 30°C), in accordance with the S76C Sikorsky Helicopter's RFM, part 1, date of revision 25 October 2010, the maximum weight for hovering out of ground effect was 11,700 lb. At the time of the accident, the helicopter weighed approximately 11,020 lb.

As described in the wind charts on the day of the occurrence, it was estimated that, during the helicopter's approach to the platform, there was a headwind component of approximately 10 kt. From the information extracted from the aircraft's MPFR and PCMCIA, it was possible to identify the following approach ramp values, presented in Table 3 below:

INDICATED AIRSPEED (KT)	HEIGHT (ft.)	RATE OF DESCENT (ft./min)	RAMP (º)
75	554	-264	-1.99
66	500	-600	-5.13
53	411	0	0
40	279	-2,200	-28.46
34(1)	200	-1,840	-28.11
30	150	-1,950	-32.68
20(2)	100	-1,830	-42.24
8.3	75	-1,750	-64.33

Table 3 - Estimate of the aerodynamic ramp.

(1) At this moment, the torque of both engines was close to 0%, and the pilot began to actuate on the collective command in a gradual manner.

(2) From this moment on, the aircraft was 100 ft. high and it is possible to hear the callout from the RADAR altimeter (*one hundred*), and the SIC effectively actuates on the cyclic control, varying the aircraft's pitch-up longitudinal attitude from 16.0º to 0.0º attitude in a matter of 1 second. At this moment, the application of collective control exceeded the prescribed limit regarding the manual torque transient (115% on each engine), reaching 140% on the number-1 engine and 139% on the number-2 engine. The time interval between moments 1 and 2 described above is 6 seconds.

In accordance with the data presented in Table 3, it was possible to verify that:

- The aircraft made an approach not in line with the parameters prescribed in the RFM, even reaching zero torque (0%) during the descent (autorotation profile). In accordance with the S76C Sikorsky Helicopter's RFM (part 1, date of revision 25 October 2010, page 4-24), a controlled approach with a Category B* profile should have the following parameters: height of 200 ft., speed of 45 kt, and descent rate of 600 ft. /min. Such profile should be maintained up to a height of 50 ft. at 45 kt, after which the helicopter would decelerate until hovering.

* Category B: The Category B procedure is an AEO procedure that requires a specified horizontal takeoff distance from HIGE to 50 ft. height and a specified horizontal landing distance from 50 ft. height to HIGE. Single engine stay-up-ability is not assured when operating at Category B weights (RFM Sikorsky, Model S76C, part 1, date of revision October 25, 2010, page 4-53).

- Throughout the final approach profile, the aircraft maintained a speed reduction due to the nose-up attitude, reaching positive pitch-angle values close to 16º, which resulted in increasingly lower speeds and steeper approach ramps (close to 42º). Excessive pitched up attitudes, may have led the pilot to lose visual contact with the platform for some time.

By means of information extracted from the aircraft's MPFR and PCMCIA, it was observed that the FD was uncoupled at a distance of 0.93 NM from the helideck and at an altitude of 554 ft. AGL.

Similarly, one observed that the aircraft even experienced a vertical speed of -3,920 ft. /min, with a zero-kt horizontal speed at the altitude of 264 ft. AGL (Figure 25).

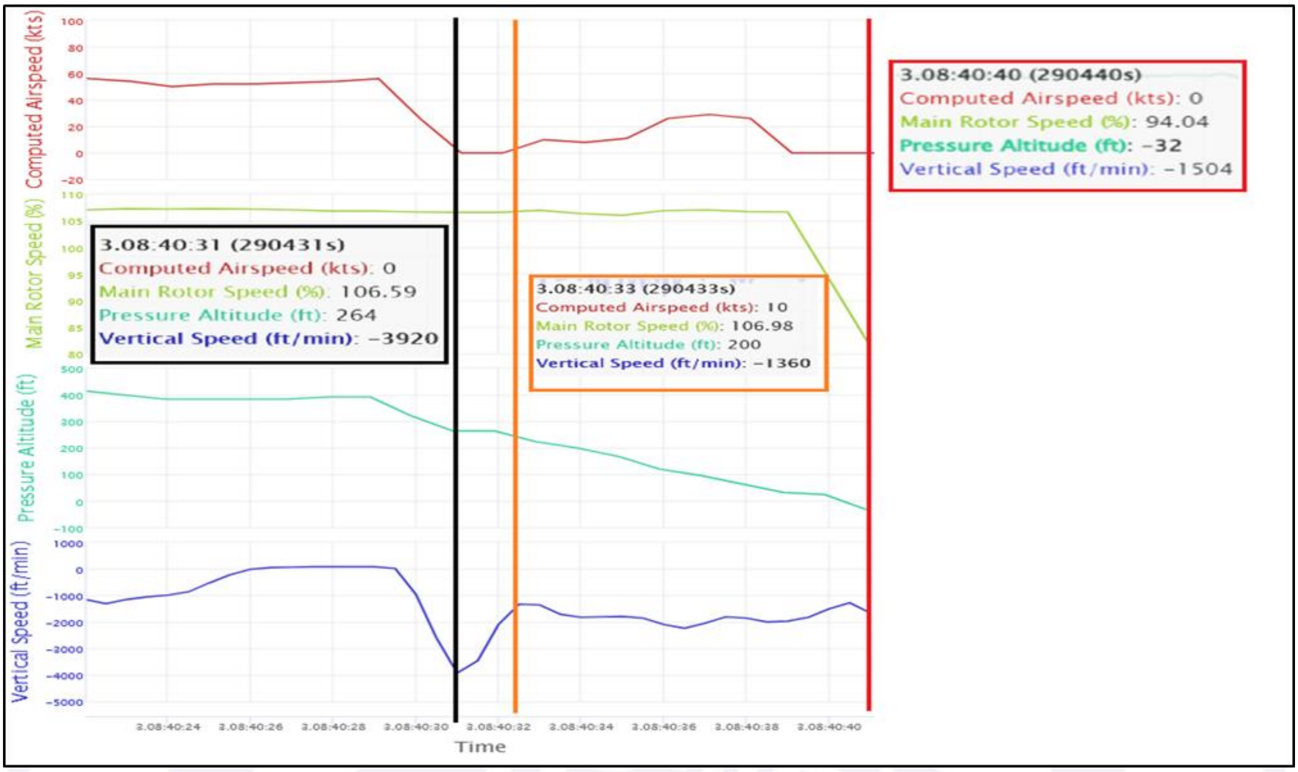


Figure 25 – Information extracted from the MPFR.

Subsequently, the aircraft entered an approach ramp, colliding with the surface of the sea at a distance of 0.63 NM from the helideck.

Considering that the height of the platform's helipad in relation to sea level was 27.9 m (91.53 ft.), the initial approach ramp adopted was 4.5°, and the average ramp effectively executed was 9.5°.

The aerodynamic phenomenon known as “Vortex Stall” or “Vortex Ring State” occurs when the rotor operates within its own turbulence wake, causing the following effects:

- sudden increase in the aircraft's rate of descent;
- random movements of the aircraft around the three axes - pitch, roll, and yaw - characterizing low frequency oscillation;
- also, low efficiency of cyclic and collective controls (ample control movements without effective response from the aircraft – aka “*mushing*”).

Figure 26 depicts Vortex Ring conditions:

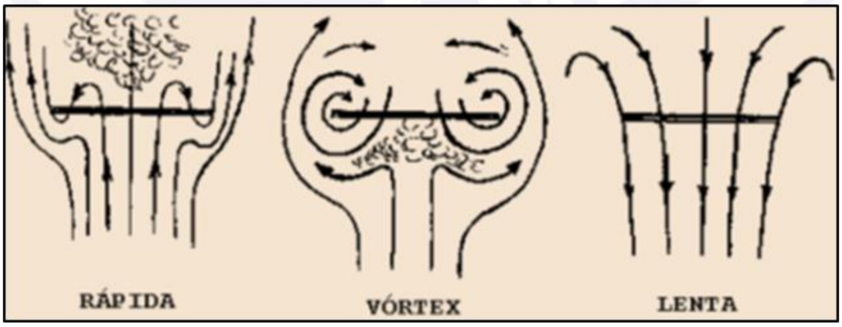


Figure 26 - Schematic drawing of the streamlines in the “vortex rings” condition.
Source: BRAZIL. Command of Aeronautics. Flight Testing and Research Institute.
DH01: Basic Notions - Theory. São José dos Campos, 2012.

The conventional technique employed to exit this flight condition involves lowering the collective control to reduce the load on the main rotor disc and, consequently, decrease the induction of vortex rings, thereby restoring the authority of the cyclic control.

Next, lower the nose of the aircraft to induce the tilt of the main rotor wake behind the aircraft and prevent the recirculation of vortices, that is, with forward speed, the wake is tilted backwards.

The second recognized technique for recovering from “Vortex Stall” is called *Vuichard Recovery*, in which one simultaneously uses the pedals and lateral displacement to allow the helicopter to exit such condition.

Figure 27 shows an example of a stabilized descending turn in autorotation and with power. One observes that, for the example aircraft, it is possible to perform a powered descent on aerodynamic ramps of up to 9º at any speed.

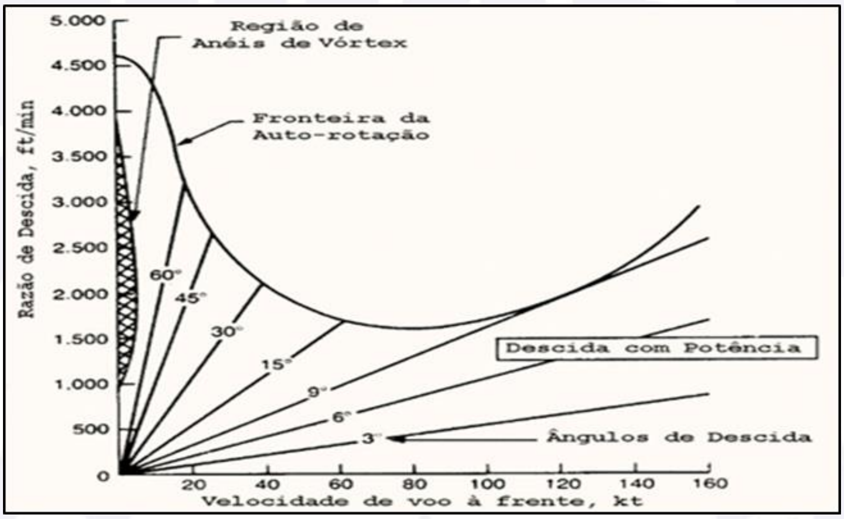


Figure 27 - Example of a stabilized descending turn in autorotation and with power using different ramps. Source: BRAZIL. Command of Aeronautics. Flight Testing and Research Institute. DH01: Basic Notions - Theory. São José dos Campos, 2012.

However, if it is necessary to descend on a steeper ramp, the allowable speed range is limited by the boundary of a stabilized autorotation. Above this curve, the rotor cannot convert energy quickly enough to maintain the autorotation profile, since it exceeds the expected rotation values.

The hatched part of Figure 27 also shows that intermediate descent rates, with very steep ramps (close to vertical descent) may facilitate the occurrence of vortex rings.

Thus, pilots have to be vigilant for this phenomenon. Descending vertically or with steep ramp angles require slow descent speeds.

The limit values for the approach ramp and descent speeds to avoid the vortex region are different for each type of helicopter. For a given a helicopter, these values vary with weight and altitude.

The lighter the weight and the lower the density-altitude, the greater the care required by the pilot, as vortex phenomena will occur at lower descent speeds.

According to the analysis of information from the aircraft's MPFR and PCMCIA, one observed that, after the PIC warned the SIC about to the low speed, there was an application of the collective control, resulting in a slight reduction in the rate of descent followed by a change in the attitude of the aircraft, when the cyclic control was applied to lower the nose of the helicopter. In this way, it is possible to affirm that there was control authority, but the correction was not sufficient to avoid the collision with the sea.

Thus, considering the authority of the cyclic and collective controls during the descent, the lack of perception of low-frequency oscillations in the aircraft's attitude, forward speed, and an aerodynamic ramp below 60º (in absolute values), there is no evidence to suggest the occurrence of a “Vortex Stall” phenomenon during the final approach to the 9PMM Platform.

Examination of the DECUs (Digital Engine Control Units)

The Investigation Committee took both DECUs of the PR-LCT aircraft to the facilities of the *Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile* (BEA), in France, for verification of the in-flight engine parameters. After analyzing the volatile memories of the aforementioned DECUs, the French Investigative Authority reported that it was not possible to obtain reliable data to substantiate the analysis.

Examination of the engines

The Arriel 2S2 engines (SN 42326TEC and SN 42370TEC) of the PR-LCT aircraft underwent examinations aimed at verifying the existence of any possible abnormal conditions.

During the initial inspection of the SN 42326TEC engine, it was verified that the connections of the lubricating oil and pneumatic pipes had an appropriate torque, and no abnormal oil leaks or air leaks were identified (Figure 28).

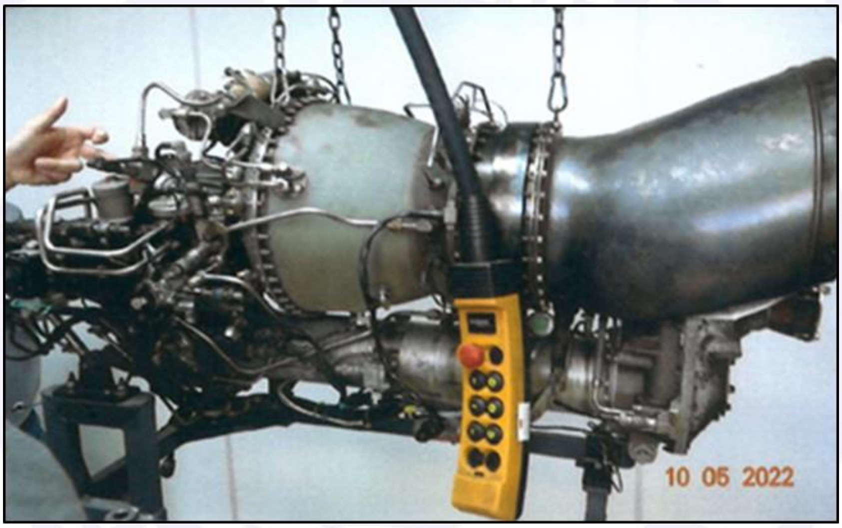


Figure 28 – Left-hand side view of the SN 42326TEC engine.

One found that there were no filings retained in the engine's magnetic plugs in the components of the lubrication system. The main oil filter pre-clogging indicator was in the normal working position, indicating that the main oil-filter bypass system did not have any clogging issues.

In the module 02, one observed that the axial compression stage was stuck due to oxidation and corrosion of the bearing.

One made the decision to conduct a boroscopic inspection and to photograph the module 03 internally. No signs of damage were found, such as loss of turbine blades, fractured or deformed blades.

In the module 04, there were no abnormalities that could compromise the development of engine power. All blades of the free turbine were intact and without evidence of degradation or impact marks.

Another evidence of normal engine operation was found in the module 05.

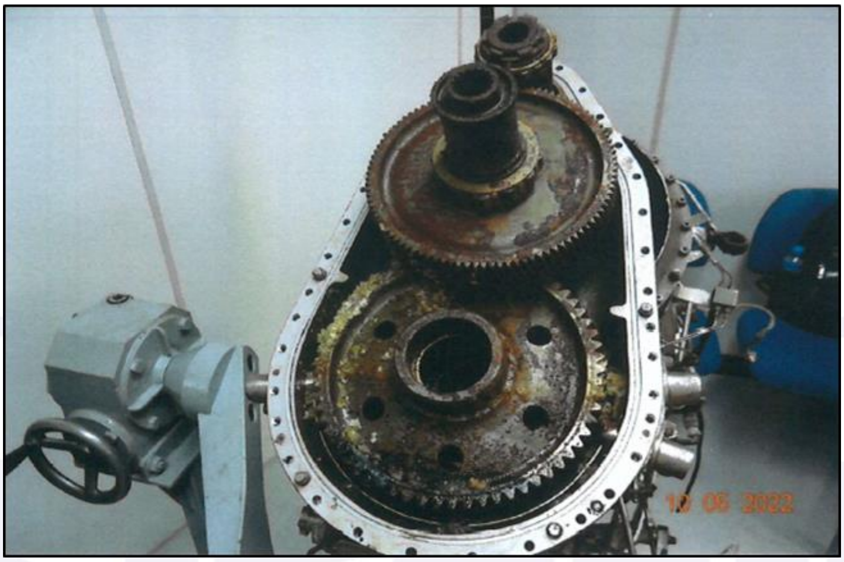


Figure 29 - General view of the reduction gears of the module 05 of the SN 42326TEC engine.

The misalignment observed in the marks on the input pinion and the splined nut of the module 05 indicated that the engine was running and that the systems in operation suffered an abrupt stop (Figure 30).

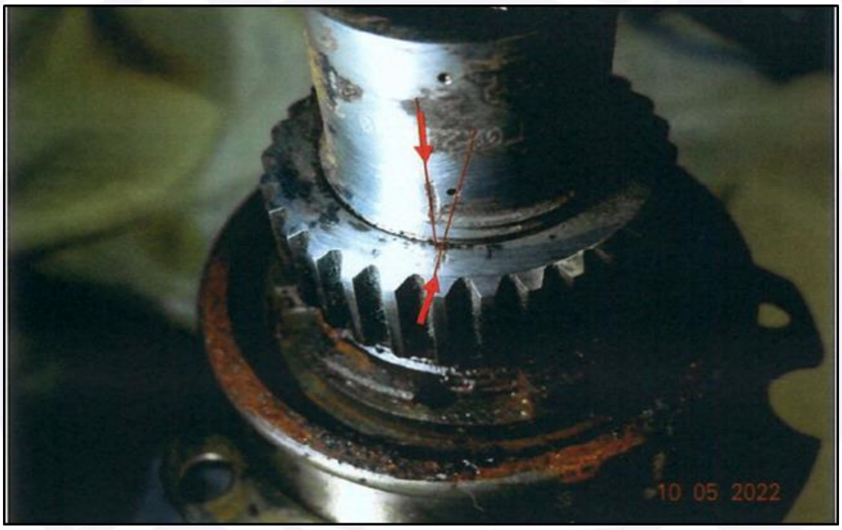


Figure 30 - View of the misalignment of the marks between the input pinion of the module 05 of the SN 42326TEC engine and the shaft.

The marks serve as references for the maintenance of the module. According to the engine manufacturer, for any movement to begin between the marks, at least twice the nominal torque specified for the nut assembly would be required.

Depending on the measured value, when misalignment occurs, the module should be sent for revision or disposal.

It is important to highlight that such marks only misalign during operation when the engine is functioning normally, developing power, and the assembly suffers a sudden stop. In the case of the engine in question, the misalignment was greater than 2 mm (Figure 31).

Figure 31 - Measurement of the 2.54 mm misalignment observed between marks.

Due to the similarity of the results from the investigation, the entire analysis of the SN 42326TEC Arriel 2S2 engine could be extended to the SN 42370TEC Arriel 2S2 engine.

To corroborate the results obtained from the exams, data extracted from the aircraft's MPFR revealed that both engines were functioning normally, developing power at the time of the crash, given that when power was demanded from the engines, there was an immediate increase in torque.

Other systems evaluated

No abnormalities were found in the operation of the PR-LCT's autopilot and flight director.

The EGPWS inspection, carried out on 09 March 2022, was still in its period of validity. It transmitted the "*two hundred*" and "*one hundred*" altitude callouts to the pilots as specified by the manufacturer, as soon as the helicopter passed 200 ft. and 100 ft. AGL based on the RADAR altimeter, moments before the collision with the sea.

1.17. Organizational and management information.

The aircraft operator was an air taxi company that utilized the AW139, B212, SK92, H135 and variants of the SK76 helicopter model, notably, to serve the offshore segment, according to the requirements established by the RBAC-135. The company had authorization to operate throughout the Brazilian national territory, including over large expanses of water and uninhabited terrain or jungle.

With respect to organizational and management issues, the MGO, in section 1, item 6, page 19, read that the system of manuals of the Helicopter Operating Unit (UOH) contemplated the following documents:

- General Operating Manual (MGO);
- General Maintenance Manual (MGM);
- Safety Management Manual (MGSO);
- Operational Training Program (PrTrnOp);
- Maintenance Training Program (PrTrnMnt);
- Aircraft Maintenance Program (PrMnt);
- Dangerous Goods Manual (MAP);
- Flight Attendant Manuals (MCmsV);
- Training manual on Team Resource Management (CRM);

- Air Operator Safety Program (PSOA);
- Standard Operating Procedures (SOP); and
- Risk prevention program associated with the misuse of psychoactive substances in civil aviation (PPSP).

As specified in its Operating Specifications (EO), the company operating the PR-LCT helicopter had authorization granted by the ANAC for the conduction of non-scheduled public air transport services, as an air taxi company, limited to passenger transport, cargo transport, as well as sick-passenger transport services. The referred authorization also covered operations in the cargo configuration and transport of dangerous goods.

The section 1, item 2.2, p. 19 of the PTO described, among other aspects, that the company's management, in its quality policy regarding the process of transporting passengers and cargo to offshore platforms by means of helicopters, determined compliance with the regulatory requirements of the Brazilian Association of Technical Standards (ABNT) NBR ISO 9001. The certification was obtained on 23 July 2001 and subject to periodical renewals ever since. Training within the UOH was also part of, and complied with, the procedures of the aforementioned management system.

As for the operational aspect, the MGO prescribed that the UOH flights would begin based on customer demand. The Coordination of Flights would issue a plan, designating an aircraft and the pertinent crew according to specific internal procedures. Completion of the flight would take place with the shutdown of the engines, after accomplishment of all the steps set out in the planning, and the filling out of all the forms inherent to the flight.

The operator also possessed an Operational Safety Management System (SMS) implemented by means of the Operational Safety Management Manual (SMM) - MSG LA-20 - revision 10, dated 03 May 2021, approved by the ANAC. The MGSO, on page 11, mentioned the company's commitment to operational safety, before the Brazilian Civil Aviation Authority:

> PART 1 - OF THE CERTIFICATE HOLDER
>
> *Líder Aviação Company*, as the holder of the certificate nº 1998-06-0CAP-02-05 for operation 135, holder of the certificates nº 6512-01 (Executive Maintenance Unit and Helicopter Operations Unit), nº 0101-01 (*Líder* Signature), and holder of the certificate nº 0012-01 (Composite Technology *do Brasil*) for organizations of aeronautical product maintenance 145, assumes, before the National Civil Aviation Agency (ANAC), the commitment to implement the operational safety policy defined in this document in accordance with the applicable regulations.

The MGSO, p. 20, described the operator's operating environment as follows:

> […]
>
> 2. DESCRIPTION OF THE OPERATIONAL ENVIRONMENT OF *LÍDER AVIAÇÃO*
>
> *Líder Aviação* provides charter flights for passenger and cargo, aircraft management services, regulated by the RBAC 135, operated according to the EO (Operation Specification) of the *UOH* (Helicopter Operations Unit) and *FGA*, as well as aircraft maintenance and composite material repairs regulated by the RBAC 145.
>
> In order to provide hangar-storage and towing support, *Líder Aviação* has an Airport Assistance Unit.
>
> Starting with the identification of the main threats in aviation relating to the organization, improvements are necessary to make companies more effective in managing their business activities. An Operational Safety Management System provides a process of continuous improvements in the organization, managing the associated risks and reducing accident costs, ensuring that identification and management of the organizational weaknesses take place before the occurrence of incidents.

The ultimate tool for risk control and accident prevention is predictive and preventative communication, which allows the identification of risks and their mitigation to a point of coherent acceptance for safe operation in all segments.

It must also comply with the specific legislations, which are applicable to the organization and to customers' contractual requirements.

2.1 ACTIVITIES DEVELOPED

This manual describes the structure of the Operational Safety Management System for the Passenger Transport process, Specialized Air Service, as well as Maintenance and Repair of Aircraft and Equipment on all respective operating bases of *Líder Aviação.*

2.2 INTERACTIONS OF THE SGSO WITH OTHER SYSTEMS

Líder Aviação's SGSO is fully cohesive with the Integrated Management System (SGI) and with all systems related to the operation of air transport and other administrative systems; as well as with Quality, Safety, Work Safety, Property Security, Environment, and Integrity.

This system provides methodologies for planning actions, developing goals, and measuring process management indicators, in order to ensure that safety and environmental risks are under management. Once implemented, QSMSI management becomes part of the employees' routine and, in other words, part of the company's culture.

Líder Aviação interacts with other SGSOs (such as: Airport Operators, other air taxi companies, offshore companies, Brazilian Aviation Operational Safety Group (BCAST), *HeliOffshore*, National Committee for the Prevention of Aeronautical Accidents (CNPAA), etc., where it shares safety information, participates in meetings, FOD moments, emergency drills, etc.

On the topic, one found that, on 27 July 2021, the ANAC conducted a remote audit of the aircraft operator's SGSO, which was considered satisfactory.

As for the frequency of flights, one found that in the period from 01 April 2021 to 28 February* 2022 (*the month preceding the accident), the SIC logged a total 36 hours and 40 minutes of flight and 22 offshore landings. Such numbers make up a monthly average of 3 hours and 20 minutes of flight, as well as two offshore landings. It is worth noting that, in ten months of the referred eleven-month period, the SIC was participated in the air-ambulance service schedule.

In this service, the pilots staffed the aircraft in accordance with the on-alert schedule established by the operator, awaiting a possible call, either to respond to emergencies in maritime units, or to conduct passenger transport flights.

The SIC recalled that, as he was not flying frequently due to the peculiarities of the air-ambulance schedule, he focused on his theoretical preparation and simulation of normal and emergency procedures, using, for this purpose, helicopters stored in hangars or parked in the flight line.

He also pointed out having noticed a similar practice being adopted by some S-76C++ pilots who were on air-ambulance shift work.

In March 2022 (the month of the accident), according to information provided by the operator, around 30% of the one-hundred-twenty-one S-76C++ pilots hired by the company were participating in air-ambulance shift work.

In the period of 90 days preceding the accident, the SIC logged a total of 4 hours of flight and two offshore landings. He did not recall performing an offshore landing, effectively operating the aircraft's flight controls during that period.

One could not identify, amid the operator's administrative documents, a control over the number of offshore landings of its pilots in effective operation of the aircraft's flight controls.

In the SIC's description of the planning for the flight of the accident, he said that no specific briefing was delivered by the PIC addressing the main aspects of helideck operations, such as approach and landing procedures, missed approach procedures, and takeoffs.

On the subject, the aircraft operator's PTO, revision 19, dated 12 April 2021, section 1, Item 1.6.3 - "*Methodology Applied to Instructions and to Theoretical and Practice Training*", read the following

> […]
>
> A briefing will precede all the training flights, for explanation of the objective and development of the mission, as well as of the execution of each planned maneuver.

By means of interviews of some of the company's crewmembers, it was possible to verify that holding specific briefings was not a recurrent practice on the part of flight instructors for these flights, as they were seen as routine offshore flights for the transport of passengers.

1.18. Operational information.

The forwarded flight notification defined that the PR-LCT helicopter would perform a VFR flight with duration of 20 minutes, Indicated Speed (IAS) of 140 kt, taking off from SBSV (*Deputado Luiz Eduardo Magalhães* Airport), bound for 9PMM (*Manati* Maritime Platform).

On the day of the accident, the two pilots arrived at the departure aerodrome hangar, and then went to the operations room to receive the documentation related to the flight and to check the weather.

In accordance with the MGO, section 11 - *Flight Procedure*, item 1.5, p. 153 - *Weather Information and Forecast*:

> Planning of the flight must be made considering meteorological information and forecasts related to the departure aerodrome, to the destination and alternate aerodromes, issued by the DECEA (METAR, TAF) or by other agencies approved or recognized by the DECEA.
>
> [...]
>
> If the flight is bound for a maritime unit not having meteorological information generated by an official organization, the planning must be made upon receipt of the meteorological conditions informed by the destination maritime unit (*Weather Report*).
>
> [...]
>
> Landing is authorized only if the crew is in possession of the unit's conditions and if the unit is within the limits recommended by *Líder Aviation* Company for (day- or night-time) landing in maritime units.

Thus, the aircraft operator, by means of the MGO, section 3, item 5.2, p. 59, would establish the meteorological minimums for operations at an aerodrome or helipad that did not have an instrument approach procedure, as follows:

> OPERATIONS AT AERODROMES OR HELIPOINTS WHICH DO NOT HAVE INSTRUMENT APPROACH PROCEDURES
>
> Aerodromes and helipads will be open for helicopter landing and takeoff operations, when the prevailing meteorological minimums are equal to or greater than the values listed in the table below:

Área	Período Diurno		Período Noturno	
	Teto (Feet)	Visibilidade (Metros)	Teto (Feet)	Visibilidade (Metros)
Macaé	600	1500	1000	3000
Campos	600	1500	1000	3000
São Tomé	600	1500	NA	NA
Cabo Frio	600	1500	1000	3000
Marlim	600	1500	NA	NA
Enchova	600	1500	NA	NA
Albacora	600	1500	NA	NA
Vitória	800	1000	1000	3000
Jacarepaguá	600	1500	1000	3000
Naveganetes	600	1500	1000	3000

*Tabela de Mínimos Meteorológicos VFR para área de operações UOH.

Within this context, one found that the meteorological minimums in the area of *Salvador*, *Bahia*, where the 9PMM maritime platform was located, were not described in the VFR Meteorological Minimum Table for the UOH operations area.

However, the Command of Aeronautics' ICA 100-4/2021, dealing with "*Special Air Traffic Rules and Procedures for Helicopters*", established the following criteria for visual flight rules:

> 3 VISUAL FLIGHT RULES
>
> 3.1 GENERAL CRITERIA
>
> 3.1.1 Within controlled airspace
>
> [...]
>
> 3.1.2 Outside controlled airspace, above 3,000 feet altitude or 1,000 feet above the ground, whichever the greater, the VFR flight of a helicopter will only take place when, simultaneously and continuously, the following requirements are met:
>
> a) one maintains flight visibility conditions equal to or greater than 3,000 m;
>
> b) one remains at least 1,500 m horizontally and 500 feet vertically from clouds or any other meteorological formation of equivalent opacity; and
>
> c) one maintains reference with ground or water, so that meteorological formations, below the flight level, do not obstruct more than half of the pilot's area of vision.
>
> 3.1.3 Outside controlled airspace, below 3,000 feet altitude or 1,000 feet above ground level, whichever is greater, VFR helicopter flight will only take place when, simultaneously and continuously, the following requirements are met:
>
> a) one maintains flight visibility conditions equal to or greater than 1,000 m, provided that the flight speed is sufficient to see and avoid traffic or any obstacle with sufficient time to prevent a collision; and
>
> b) one stays away from clouds and maintain reference with the ground or water.
>
> 3.2 MINIMUM HEIGHTS FOR VFR FLIGHTS
>
> 3.2.1 Except for landing and takeoff operations, or when authorized by the competent DECEA Regional Organization, the VFR flight by a helicopter will not take place over cities, towns, inhabited places or over a group of people outdoors, at a height of less than 500 feet above the highest obstacle within a radius of 600 m around the aircraft.
>
> 3.2.2 In locations not mentioned in 3.2.1, the flight will not take place at a height lower than the one that allows the aircraft, in the event of an emergency, to land safely and without danger to people or property on the surface.
>
> NOTE: Such height must be at least 200 feet.

At around 09:40 UTC, after ensuring that they had the information necessary for conducting the flight, the pilots went to the aircraft and waited for the passengers to arrive.

The aircraft was within the specified weight and balance limits, and presented, among other features, the ones listed below:

- empty weight: 7,766 lb.;

- maximum takeoff weight: 11,700 lb.; and
- takeoff weight on the accident flight: 11,413 lb.

On the occasion, the SIC occupied the right-hand pilot's seat, activated the battery, and started preparing the aircraft for the flight. In the meantime, the PIC welcomed the passengers and delivered the safety briefing outside the aircraft.

The SOP, section 1, p. 32, *Generalities*, defined the methodology for the use of the checklist by the company's helicopter pilots, as follows:

> *LÍDER UOH* uses three checklist methods:
>
> a) R/D - Read and Do;
>
> b) C/R - Challenge and Response; and
>
> c) M - Memory.
>
> The form of use will depend on the nature of the procedures required and on the phase of the flight, and may be R/D, C/R or M. In the *Líder* company's checklists, there are legends that determine which of the methods can be used.
>
> On a flight, whenever there is more than one option to perform a check, one should use the C/R method. If the PF chooses to use the R/D method, he must call out "Read and Do" after the title of the procedure. Ex.: "*After Take-off checklist Read and Do*"
>
> 12.2 C/R - CHALLENGE AND RESPONSE
>
> This method consists of the PF and PM working together through questions and answers, with the aim of increasing efficiency in the communication and understanding between crewmembers. For this reason, Challenge and Response is used when the degree of importance of the procedure is higher. This series of questions and answers reduces the likelihood of error during the execution of the procedure.
>
> Firstly, the crew must configure the aircraft according to memory, preferably following a flow or a script that is logical and easy to remember. After completing the sequence of actions, the checklist will be used to verify that all the items on the list have been worked.
>
> In order to ensure adequate reading and execution of the procedure, the following rules are to be followed:
>
> a) During the procedure, the crewmember being questioned (PF) must respond only after visually checking the condition of the item announced.
>
> b) The PM must confirm the PF's response with the action provided for in the procedure.
>
> c) If the answer is correct, the PM proceeds to the next item.
>
> d) If the answer is incorrect, the PM must inform the expected condition, correcting the action as necessary.
>
> Below is an example of the *Challenge and Response* execution of an item from the S-76 Before-Landing procedure:
>
> PF: Checks that the aircraft is at a speed compatible with the procedure (less than 130 KIAS) and requests "*Before Landing*";
>
> PM: Checks whether the aircraft speed is in accordance.
>
> PM: Silently performs the following actions from memory (*Scan Flow*)
>
> - Gear ....Down
>
> - Parking Brake............. Release
>
> - DECU Advisory.......... Check
>
> - Landing Light ....On
>
> PM: Reads the title of the procedure "*Before Landing Checklist*" aloud;

PM: Reads the item and waits for the PF's response;

PF: Responds after visually checking the current configuration of the item;

PM: Confirms the response with the action expected by the procedure.

Then, with the passengers on board, the crew worked the aircraft's checklist items, in accordance with the SOP prescriptions, started up the engines at 09:54 UTC, and taxied on the ground uneventfully.

At 10:06 UTC, the aircraft took off from SBSV bound for the 9PMM Platform (Figure 32). The weather conditions were VMC, and there was no rain at the aerodrome of departure.

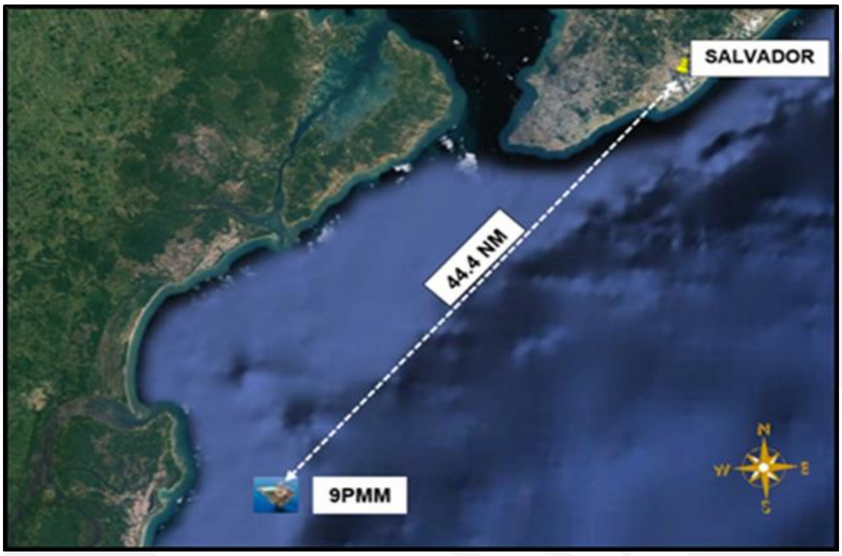


Figure 32 - Croquis of the route between SBSV and 9PMM in a straight line.

After performing the visual departure procedures from SBSV, the SIC leveled off the helicopter upon reaching 1,500 ft. AGL, and used the FD en route to assist in maintaining the altitude, speed, and heading parameters.

The MGO, section 11, p. 194, *Flight Procedure*, listed the following requirements for air operations on an unattended platform:

Normally Unattended Installations (NUI) have the purpose of operating as a *base* installation. When operating toward a NUI, the following additional requirements are in place:

(a) The unit must be certified for landings.

(b) Before start of the flight, the HLO-in-charge must be identified among the passengers. The procedures that will be followed after landing must be discussed with the HLO, and, in particular, it must be made clear that the aircraft door is only to be opened by one of the crewmembers;

(c) Confirmation must be obtained that the aircraft has landed safely - The *base* facility is responsible for monitoring unsafe conditions such as gas leaks. In some cases, confirmation of safe landing can be obtained by means of radio communication. In other cases, such safety information will be obtained through a green/red light;

(d) In addition to the flyover for identification of the platform, an additional orbit of the installation may be carried out at a lower altitude for inspection of the landing area. Special attention must be paid to the presence of birds and FOD since the unit is a NUI. Crewmembers must pay attention to the wind direction and possible exits on the helideck, thus allowing them to plan the position in which the helicopter will land on the helideck;

(e) After the landing and conduction of the pertinent checks, a crewmember must leave the cabin, put on the chocks, open the door, allow only the HLO to get out of the aircraft, and hand over to him/her the responsibility for disembarking the passengers;

(f) Only in emergency circumstances should an aircraft shut down its engines at a NUI;

(g) When everyone has boarded the aircraft, one of the crewmembers must remove the chocks, check that there is no luggage on the helipad and that the luggage compartment and doors are closed.

The SOP, section 9, p. 154, had the following considerations regarding offshore operations:

1. GENERAL

The offshore environment offers unique challenges to helicopter pilots. The demands of the operation, the nature of oil and gas production and exploration facilities, and the environment in which the flight takes place (weather, terrain, obstacles, traffic) demand special practices, techniques and procedures that are not found in other air operations.

This section describes techniques and practices that aim to increase pilots' situational awareness so that offshore operations can be carried out with the highest level of safety and standardization.

2. FACTORS TO BE CONSIDERED FOR TAKE-OFFS AND LANDINGS AT OFFSHORE HELIPADS

When taking into account all the variables associated with the environment in which offshore helipads are located, it may be necessary to use slightly different profiles for each takeoff and landing. Factors such as the weight of the aircraft, center of gravity, wind speed, turbulence, size, elevation and orientation of the helideck, obstacles, power margin, gases from the Maritime Units' exhausts (*hot plume*), etc., have an influence on takeoffs and landings. During the approach phase, additional considerations such as the need for a clear trajectory for the go-around, obstacles, visibility, height of the base of clouds, etc., should influence the selection of the profile to be used for landing. Profiles can be modified, taking into account the relevant factors mentioned above and the characteristics of each type of helicopter.

[...]

12. PRE-LANDING PROCEDURES

12.1 GENERAL

Some operational procedures are essential to ensure the safety and smooth running of the operation. Compliance with these procedures aims to improve coordination between crew members (CRM) and the level of situational awareness in the cabin, thus minimizing the possibility of errors that could result in a landing in the wrong maritime unit, or any other error that could cause an incident or accident.

12.2 COMMUNICATION WITH THE MARITIME UNIT (U.M.)

The crew is supposed to make initial contact with the U.M. at least 15 minutes before the estimated time for the overflight. This period of time is used for the unit to adjust to takeoff and landing operations.

At this initial call, the crew must inform the trip number, origin and destination of the aircraft, boarding and disembarking of passengers/cargo, the estimated landing time and, for mobile units, request the current coordinates and compare them with those entered in the GPS/FMS.

To request permission to land on the helideck, an additional call must be made approximately 5 minutes before the scheduled landing time. At this call, the crew will obtain the Maritime Unit conditions, as well as clearance to land.

[...]

12.3 FLYING OVER THE MARITIME UNIT

Before approaching for landing, the crew must fly over the maritime unit, in order to identify it and decide on the best approach trajectory, depending on the factors to be considered in takeoffs and landings at offshore helipads described in this section.

> For an appropriate identification of the U.M., one should fly over the U.M. and join the traffic circuit at a speed between 70 and 90 KIAS.
>
> The pilot in charge of identifying the U.M. will be handling the aircraft controls before the flyover. After identification, if necessary, the controls and the flight director will be transferred to the side of the pilot in charge of performing the landing.
>
> Turns of the aircraft in the traffic circuit should preferably be made to the side of the pilot responsible for landing.
>
> If the factors to be considered are not positively identified, a new flyover of the U.M. should be carried out.

From such perspective, it is worth noting that the conditions of the destination U.M. would be transmitted by the 9PMM Platform support vessel, with the aircraft crew being responsible for verifying the operational feasibility of landing in the referred U.M.

At a distance of approximately 15 NM from the 9PMM Platform, the crew of the support vessel, in response to a radio call made by the PR-LCT helicopter, reported the following meteorological conditions via VHF: wind direction 250º in the area close to the landing helipad, presence of clouds, precipitation of rain: not identified.

With the aircraft descending visually from 1,500 ft. to 500 ft. AGL on the approach to the destination (about 3 NM away from the 9PMM Platform), the pilots of the PR-LCT worked the *before-landing offshore* checklist.

The SOP, section 5, item 6, p. 95, *Normal Flight Procedures*, *Arrival*, *Pre-landing checks*, read:

> *Before Landing* is the procedure used to configure the aircraft for landing. For offshore operations, *Before Landing* is the first of two procedures used to configure the aircraft for landing.

In addition, in accordance with the SOP, section 12, item 2.14, *Cockpit Checklist*, p. 232, the following items were to be checked before landing offshore:

> *2.14 S76 - BEFORE LANDING OFFSHORE (start 3 NM before RIG)*
>
> *BEFORE LANDING C/R*
>
> *GEAR - DOWN/ 3 GREEN*
>
> *PARKING BRAKE - APPLIED*
>
> *RADAR - STBY*
>
> *AFDS - NO LIGHTS*
>
> *DECU ADVISORY - NO FAULTS*
>
> *EXTERNAL LIGHTS - A/R*
>
> *SX-5 SEARCH LIGHT RESCUE - Off*
>
> *CHOCKS - REQUEST*
>
> *RIG (OVERFLY) - IDENTIFY / CLEARED*
>
> *Objectively announce the 9P code displayed on the helideck, and confirm whether clearance for landing at the Maritime Unit has been received.*
>
> *[...]*

Afterwards, the helicopter flew over the maritime platform at a height of about 500 ft. AGL at an Indicated Air Speed of 80 kt, leaving the platform to the right-hand side, identifying it as 9PMM, and deciding that the traffic circuit and the landing would be performed by the SIC, due to wind direction. On the downwind leg of the visual traffic circuit (Figure 33), the SIC informed the PIC that he (SIC) would perform a standard landing profile for the helideck, performance class 2.

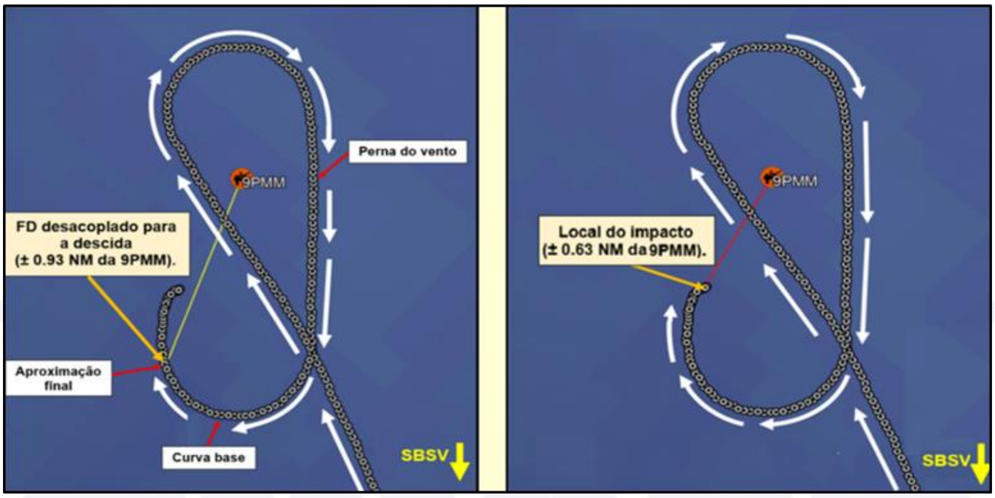
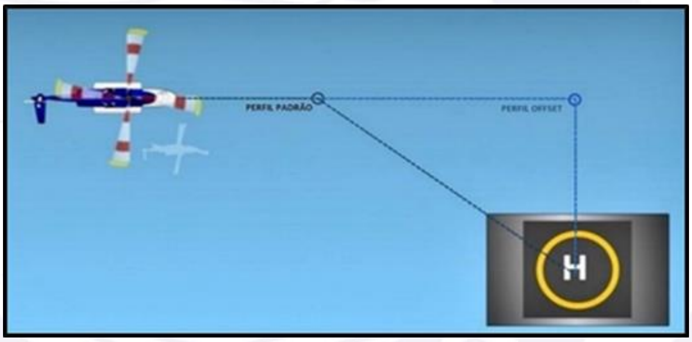


Figure 33 - Visual traffic profile performed by the PR-LCT helicopter for approach to the 9PMM Platform until the moment of impact.

In this regard, the SOP, section 9, items 12.10 and 13, p. 166, *Offshore Operations*, established the standard approach profile for landings, as well as the flight parameters and phraseology for class 2 helideck landings, as described below:

12.10 STANDARD LANDING PROFILE

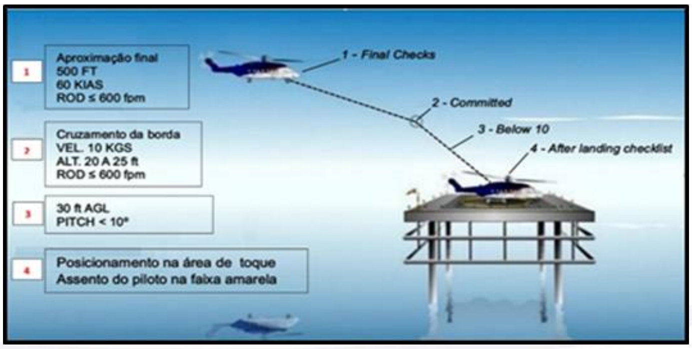
The approach must be initiated upwind to an imaginary point outside and above the helideck, forming an angle of 45° between the approach axis and the touchdown point. The separation of the tip of the main rotor blades from the edge of the helideck must be maintained until the aircraft approaches the decision point, ensuring that the go-around path is clear. From this point, the aircraft must be piloted so as to fly over the edge of the helideck, with approximately 10 kt of speed in relation to the ground and a small rate of descent until the transition to hovering in the landing area.



[...]

13. HELIDECK - CLASS 2 LANDING

EVENTO	PF	PM
Aeronave estabilizada na aproximação final a 500ft, 60kias, razão inferior a 600fpm	Solicita: ***"Final Checklist"***	Após armar os flutuadores e obter a re-identificação da U.M., anuncia ***"Final Checklist Complete"***
No ponto de decisão	Anuncia "**Committed**"	Monitora a atitude e a altura. Anuncia ***"Below 10"*** quando o pitch estiver estabilizado abaixo de 10°. Caso a aeronave esteja abaixo de 30ft, com *Pitch* superior a 10°, anuncia ***"Pitch"***.



[...]

The SOP, section 10, item 8, p. 195, *Class Performance*, defined Class 2 Performance, as follows:

> CLASS 2 PERFORMANCE
>
> GENERAL
>
> An aircraft operating in this Class Performance must be capable of continuing the flight safely in the event of a critical engine failure, except when the failure occurs at the beginning of the takeoff maneuver (*before DPATO*), or at the end of the landing maneuver (after DPBL), when a forced landing may be required.

The SOP, section 1, item 7, p. 25 - Generalities, defined the acronyms *DPATO* and *DPBL*, as follows:

> DPATO - *Defined Point at Take-off* - means a point during take-off and the initial phase of climb, before which the helicopter may not be able to continue the flight after a critical engine failure, and a safe forced landing may be necessary.
>
> DPBL - *Defined Point at Before Landing* - is a point which varies depending on the speed, rate of descent, and height above the deck, at which the aircraft, after passing, may not perform as expected to go around or continue a safe landing in the event of the loss of the critical engine. Therefore, a forced landing in water or on land may be necessary.

The SIC, at the end of the base turn, when aligning with the final approach of the traffic circuit, on the 250º magnetic heading, at a distance of approximately 0.93 NM from the helideck, informed the PIC that he (SIC) would uncouple the *flight director* (*altitude - FD_ALT OFF, heading - FD_HDG OFF and speed - FD_IAS OFF*) and begin the descent, assuming, from that moment on, the effective operation of the flight controls.

On that occasion, the data extracted from the MPFR indicated that the helicopter had the following parameters, as shown in Figure 34:

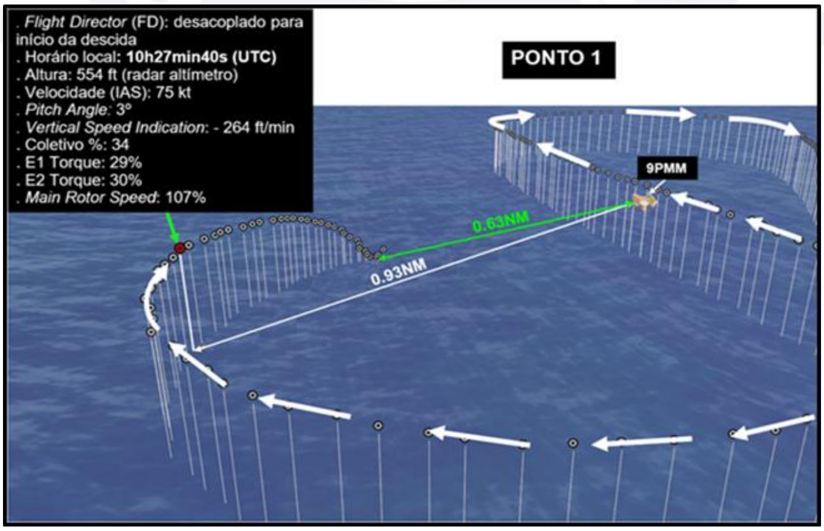


Figure 34 - PR-LCT's flight path on the final approach, highlighting the parameters at point 01.

The MGO, section 11, item 2.5.7, p. 158, defined *stabilized approach* as follows:

> Normally, when starting the final approach, the helicopter must already be stabilized on the approach and with the checks being completed.
>
> A stabilized approach is characterized by an approach trajectory of constant angle and constant rate of descent, ending near the touchdown point, where the landing maneuvers begin. A stabilized approach is the safest profile of all, except in special cases where another trajectory may be required due to non-visual conditions.
>
> The unstabilized approach criterion used for each aircraft model can be found in the respective Standardization Manual for each aircraft model.

The SOP, section 1, item 21, p. 43, established the VMC stabilized approach parameters for SK76 aircraft, as described below:

> STABILIZED APPROACH - VMC
>
> A stabilized approach is the one in which the pilot establishes and maintains a constant angle throughout the approach, with the aim of reducing workload and increasing the crew's situational awareness. During a visual approach, the aircraft should be stabilized at an altitude of no less than 300 feet from the landing surface. Otherwise, the missed approach procedure must be performed.
>
> - The parameters which define a stabilized approach in onshore and offshore visual conditions are described below:
>
> - The aircraft should be on the correct approach trajectory;
>
> - Only smooth and small changes in the lateral and vertical axes are necessary;
>
> - The aircraft should be in the correct configuration for landing;
>
> - The rate of descent should be less than 600 fpm;
>
> - The power of each engine should not be less than 15% of torque; and
>
> - Heading changes should not be more than 45° below 400 ft. AGL (*Off Shore* only).

One verified that, 5 seconds after the uncoupling the *flight director* and beginning of descent, the PIC informed the SIC that he (PIC) was waiting for the SIC to request the *final checklist*, at which point the data extracted from the MPFR indicated that the helicopter presented the following parameters , as shown in Figure 35.

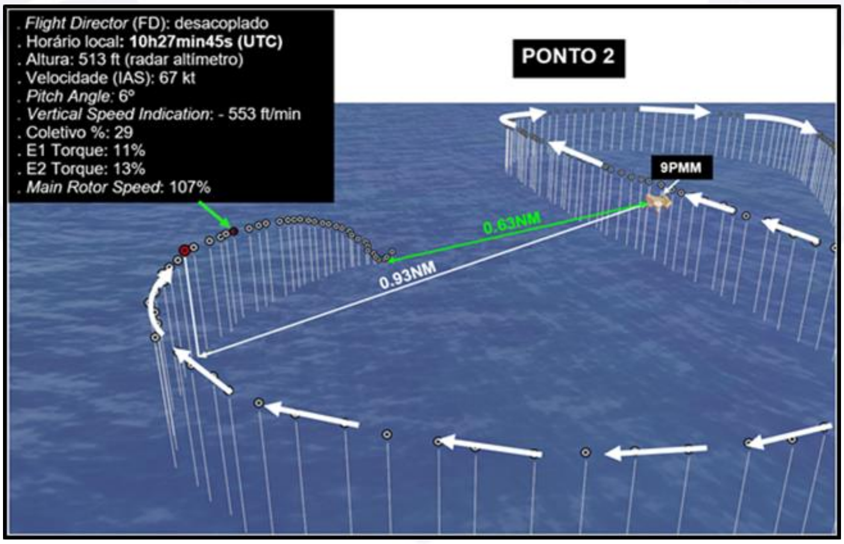


Figure 35 - PR-LCT’s flight path on the final approach, highlighting the parameters at point 02.

The SOP, section 5, item 7, p. 95, established the methodology for pilots to work the Final Checklist, as described below:

7. FINAL CHECKLIST

GENERAL

The *Final Checklist* complements the *Before Landing* in the aircraft configuration for offshore landings. This procedure is typically performed during periods of high workload, and thus can be performed from memory. The *Final Checklist* must be requested by the PF when the aircraft is stabilized on final and at a speed compatible with the use of floats. The PM must perform the procedure using the *scan flow* method, in silence, and then question the PF in order to obtain positive confirmation of the actions carried out.

Example:

PF: "Request Final Checklist"

PM: "Perform memory items"

PM: "Floats"

PF: "Armed"

PM: "Rig"

PF: "Identified 9PXX"

PM: "Checklist Completed"

In addition to the procedures established above, the SOP, in section 12, item 2.14, p. 232, described the items that should be performed by pilots in the *Final Checklist Offshore Helideck*:

FINAL C/R, R/D or M

IF AFDS CAUTION LIGHT IS ON, ISOLATE AFDS BEFORE ARMING FLOATS

Floats - Arm <75 kt

Rig - Confirm

Reconfirm and objectively announce the 9P code on the helideck as soon as it is viewed.

The SIC answered, "*okay*", but did not request the *Final Checklist* from the PIC. The PIC then informed the SIC that he (PIC) would arm the rafts, at which point the data extracted from the MPFR indicated that the helicopter had the following parameters, as shown in Figure 36.

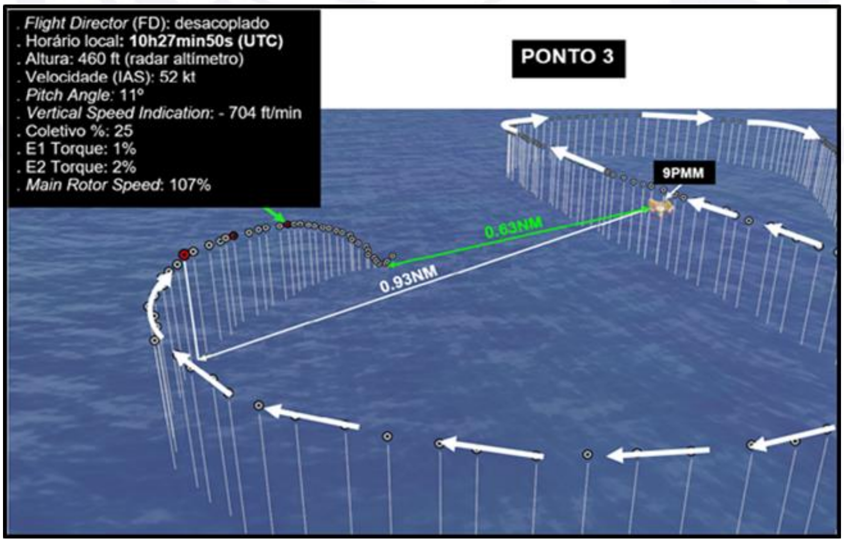


Figure 36 - PR-LCT's flight path on final approach,
highlighting the parameters at point 03.

The SIC answered with an "okay" to the PIC, and declared that if he (SIC) felt any discomfort with height and position, he would go around. It is noteworthy that, while transmitting such information via the intercom, the SIC maintained the helicopter's torque close to zero and, at the same time, continuously actuated on the cyclic command, in order to pitch up the aircraft.

Data extracted from the MPFR indicated that the helicopter presented the parameters described below (Figure 37), after the SIC finished his transmission relative to the conditions for a possible go-around.

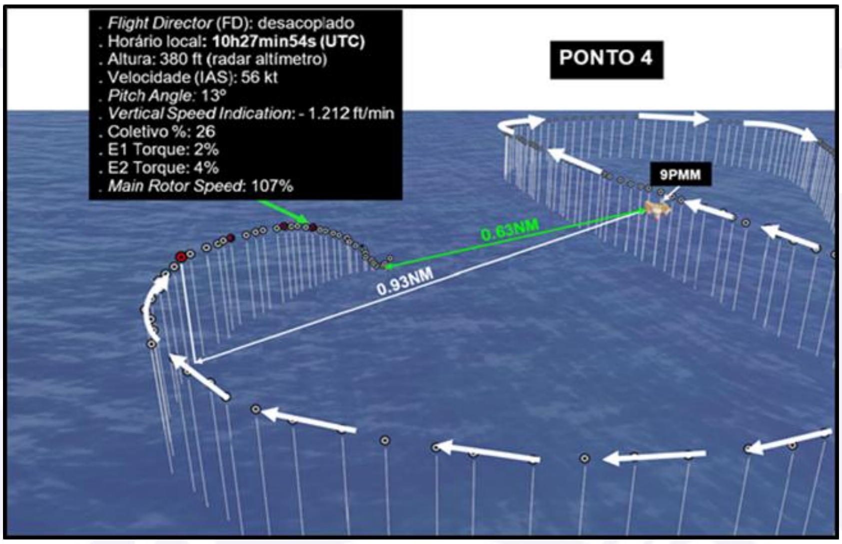


Figure 37 - PR-LCT’s flight path on final approach, highlighting the parameters at point 04.

Next, the PIC alerted the SIC that the descent rate was a little high, and the SIC confirmed that it was high. The data extracted from the MPFR at this point indicated that the helicopter had the following parameters, as shown in Figure 38.

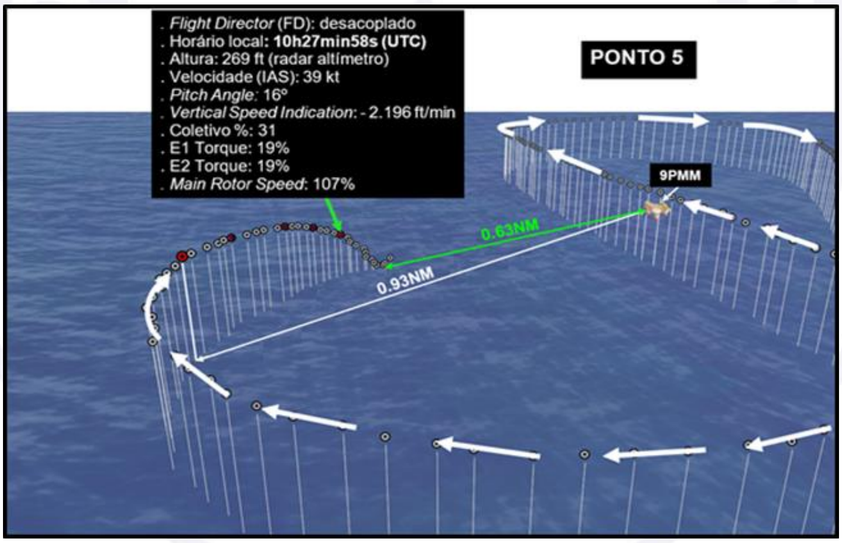


Figure 38 - PR-LCT’s flight path on final approach, highlighting the parameters at point 05.

The SOP, section 1, item 16, p. 44, established the *standard calls* to be used by pilots:

> STANDARD CALLS
>
> Standard Calls were established to minimize the possibility of interpretation errors on the part of crew members, and also to initiate corrective actions during the execution of tasks. Below, one will mention calls that have a comprehensive meaning or that are not found in other sections of this manual. Underlined terms will be defined in the “Definitions” title of this section. The calls related to information provided by

the ATC units will be presented in Portuguese so that they are in accordance with the control agency’s phraseology. The other standard calls will be made in English.

[...]

16.2 EXCESSIVE RATE OF DESCENT

When observing an excessive rate of descent:

PM: Announces “*Descent Rate*”.

PF: Responds “*Check, correcting*” and reduces rate of descent to suit operational standards.

If the excessive rate of descent is necessary to maintain flight safety, the PF must announce “I*ntentional*” and proceeds with the maneuver.

16.3 ABNORMAL SPEED

When observing an abnormal speed:

PM: Announces “*Airspeed*”.

PF: Responds “*Check, correcting*” and reduces speed to operational limits.

If the speed deviation is necessary to maintain flight safety, the PF must announce “*Intentional*” and proceeds with the maneuver.

The EGPWS issued the “*two hundred*” altitude callout as the aircraft passed 200 ft. AGL (RADAR altimeter), with a VSI (Vertical Speed Indication) of -1,836 ft. /min.

The PIC warned that the SIC was losing speed, and the SIC confirmed that he was high, while actuating on the collective command, continuously increasing the helicopter's torque. Data extracted from the MPFR indicated that, on the occasion, the helicopter had the following parameters, as shown in Figure 39.

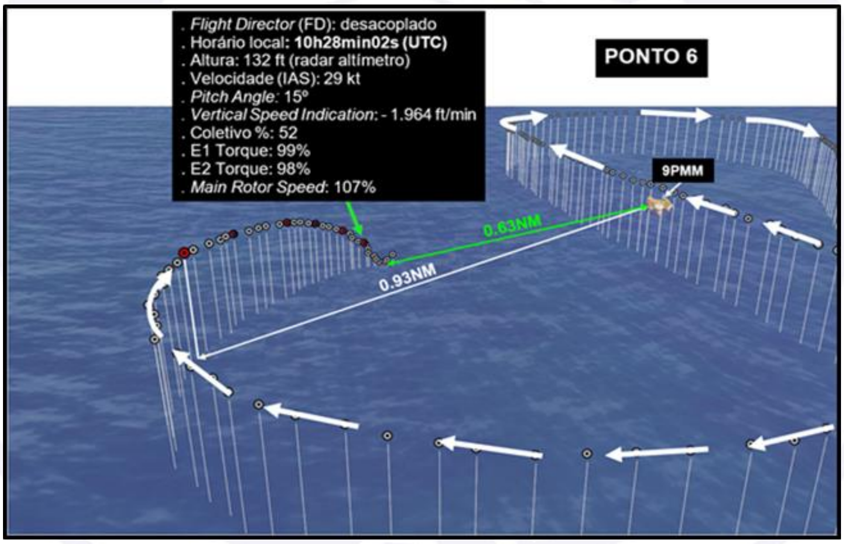


Figure 39 - PR-LCT’s flight path on final approach, highlighting the parameters at point 06.

The EGPWS issued the “*one hundred*” altitude callout as the aircraft passed 100 ft. AGL (RADAR altimeter), with a VSI of -1,839 ft. /min, moments before the collision with the surface of the sea.

From then on, the SIC actuated intensively in the cyclic command, varying the aircraft's longitudinal attitude from a pitch-up 16.0º to 0.0º in 1 second. At that moment, the application of collective command exceeded the torque transient limit specified by the manufacturer (115% for each engine).

The PIC warned the SIC, “*Speed! Speed!*”, and, at that moment, according to data later extracted from the MPFR, the helicopter had the following parameters, as shown in Figure 40.

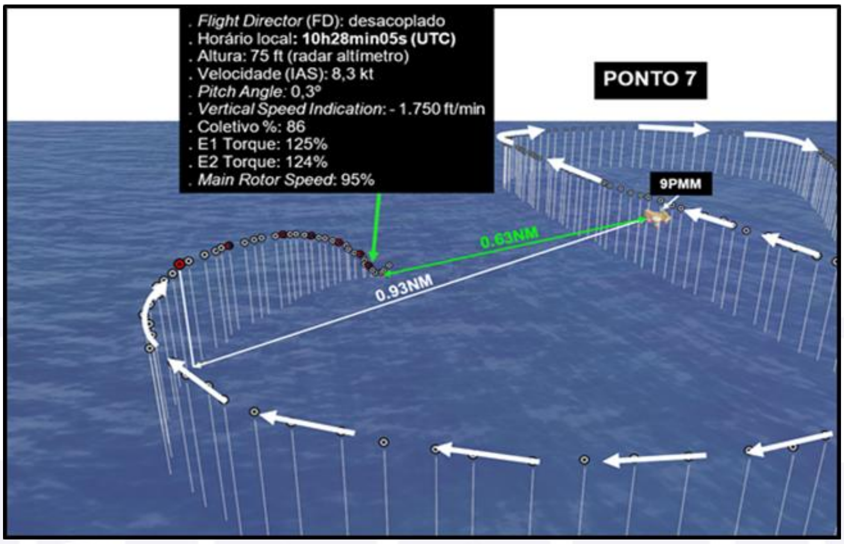


Figure 40 - PR-LCT's flight path on final approach,
highlighting the parameters at point 07.

The PIC alerted the SIC a last time before the crash, "*Speed!!!*" Data extracted from the MPFR indicated that, on the occasion, the helicopter had the following parameters, as shown in Figure 41.

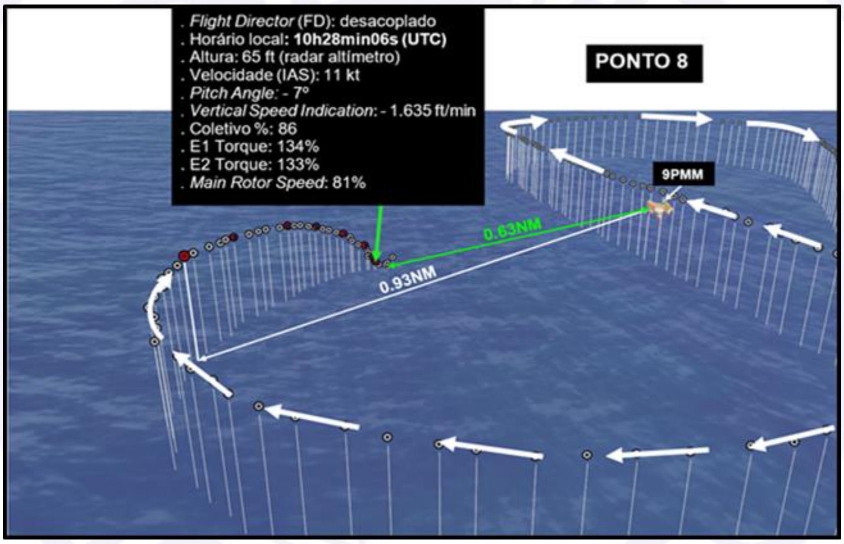


Figure 41 - PR-LCT's flight path on final approach, highlighting point 08.

The SOP, section 1, p. 32 - "*Generalities*", described policies and standard phraseology in the use of the checklist by the company's helicopter pilots, "*Human and Operational Factors Affecting Compliance with Standard Procedures*", as well as the importance of CRM:

> 12.3.1 POLICIES AND PHRASEOLOGY STANDARDS IN THE USE OF CHECKLISTS
>
> Whenever there is a checklist prepared by the Company, its use is mandatory, and one is not allowed to use a checklist created by another operator, person, or institution.
>
> The items and actions described in the procedure must be clearly announced.
>
> For the use of the checklist, the terms "Pilot" and "Copilot" are only used to specify which side of the cabin an action should be performed, with "Pilot" being the pilot who is sitting in the seat on the right.
>
> Ex.: Answer to a seat-belt question would be: "Pilot fastened", "Copilot fastened".

During the execution of the procedure, the PM is responsible for confirming whether the response to each item is in accordance with the action described:

a) Whenever the crew member starts reading a procedure, he must announce the title of the procedure before continuing to read the items;

b) When a procedure is completed, the pilot performing the reading must say his name followed by the word "Complete".

c) For the action that is described as *AS REQUIRED (A/R)*, the response must indicate the condition or position of the item. Example:

PM: "Parking Brake"

PF: "Apply" or "Release"

d) For the action described as *Check*, the response must indicate the condition of the system at the time of verification. Example:

PM: "*Transmission/ HYD Press/ Overspeed*"

PF: "*Transmission and Hydraulical Press, normal range. Overspeed Light, out*."

e) For the action described as *Set*, the response must include the adjustment or configuration of the item described in the procedure. Ex.:

PM: "*Altimeters*"

PF: "*Adjust 1013*"

f) For the action described as *Note*, the response must indicate the quantity of the item described in the procedure. Ex.:

PM: "*Fuel Quantity*"

PF: "*1560 Lbs*"

12.4 HUMAN AND OPERATIONAL FACTORS AFFECTING COMPLIANCE WITH NORMAL PROCEDURES

To ensure effective compliance with published standard procedures, it is important to understand why pilots sometimes omit a procedure from the checklist or simply do not perform all of the items described therein.

The omission of a procedure from the checklist is rarely intentional. It is more common for this type of deviation from the SOP to be the result of an interruption of activities in the cabin, due to operational circumstances.

The following are factors and conditions that are normally cited as the initial cause of non-compliance with a procedure:

a) Distractions caused by other activities in the flight cabin;

b) Interruptions (e.g.: communications between air traffic control and the pilot);

c) Work overload, including inadequate management of multiple tasks;

d) Inadequate management of priorities, generally caused by the lack of a model of conduct in cases of emergency;

e) Reduced attention (*tunnel vision*) normally associated with abnormal conditions and high workload;

f) Application of incorrect CRM techniques, including inefficient cross-check and ineffective coordination between crew members;

g) Excessive confidence in one's memory;

h) Inefficient construction of the checklist, including inadequate or incorrect content and poorly defined division of tasks.

i) Bad habits acquired from other equipment, in periodic training or as a result of inefficient evaluation-flights due to lack of emphasis on strict adherence to normal procedures.

[...]

14. COCKPIT COORDINATION (CRM)

The captain is responsible for the safety and success of the operation, which does not exempt the other crew members from the responsibility of ensuring that this takes place. During operations with more than one crew member, coordination between crew members is vital for the safe and effective performance of flights. A crew member's individual responsibility does not end with their job position description. On the contrary, it extends to any area of the operation with which the crew member comes into contact. During periods of high work demand or stress, it can be quite difficult to ensure that critical information has been properly assimilated and acted upon. Therefore, in order to share the cabin with other crew members, it is necessary to work as a team. It is the crew's responsibility to ensure that all critical information is passed on, understood, and put into practice according to the situation's demands.

1.19. Additional information.

Maritime Authority Norm - Video and voice recording system

The NORMAM 27/DPC established, among others, the following requirements for video and voice recording on helidecks:

0604 - VIDEO AND VOICE RECORDING SYSTEM

The helideck must have a video recording system, with continuous recording without the use of motion sensors, to record aerial operations (final approach, landing, and takeoff) with visualization according to the scheme in Annex 6A, and voice recording, to record communications between the aircraft and the radio operator. To improve the control and standardization of their operations, air companies may request recorded images from maritime units, which will share them.

The recordings of the video and voice recording system must be stored in accordance with the deadlines established in the Data Preservation Procedures contained in the Command of Aeronautics' Instruction (ICA) nº. 63-25, for the voice recording system.

If the helideck's voice and video recording system is inoperative, the person responsible for the maritime unit must immediately communicate the fact to the DPC, estimating the deadline for reestablishing the operational condition. At the discretion of the DPC, if the time to repair the system is considered excessive, palliative control measures or even operational restrictions may be applied.

The RPM must have a video monitor at the radio station for visualization of the helideck.

Such system constitutes a valuable tool for investigation in the event of an aeronautical accident and prevention of possible future occurrences.

The video recording system of the 9PMM Platform helideck was in operation, however, images of the accident were not recorded, since the camera was directed to the helideck, as recommended.

LUMAR 20 Support Vessel - Contractual requirements from the 9PMM operator

Below is an extract of the contractual instrument signed between the company operating the 9PMM Platform and *Agência Marítima e Transportes LUMAR LTDA.*, for the time-chartering of a type UT 750 vessel, which supported the operations of the 9PMM maritime platform (*emphasis added*):

Annex III - Vessel requirements:

[...]

1.2 The vessels must be delivered to PETROBRAS fitted with all the pieces of equipment and materials necessary for the performance of their functions.

[...]

1.4 Vessels must be fitted with all navigation, communication, and salvage equipment, including a fixed anemometer, two binoculars, and a barometer with annual measurement by a company accredited by DHN, and any other required by the Brazilian Maritime Authority and PETROBRAS in compliance with this contract.

According to information collected, the type UT 750 vessel, LUMAR 20, which supported the 9PMM Platform, was not fitted with a boat with rescue capabilities on board, at the time of the rescue of the PR-LCT's occupants.

Requirements – pilots' recent experience

The Brazilian Civil Aviation Regulation nº 61 (RBAC-61), amendment 13, "*Licenses, Ratings and Certificates for Pilots*", dated 20 March 2020, section 61.21, p. 13 - *Recent Experience*, in force at the time of the accident, defined the following:

> 61.21 Recent experience
>
> (a) Except for the deadlines established in section 61.19 of this Regulation, a pilot may only act as pilot-in-command of an aircraft if within the preceding 90 (ninety) days he has performed:
>
> (1) for daytime flight operations:
>
> [...]
>
> (ii) in the case of other aircraft, at least 3 (three) takeoffs and 3 (three) landings during day- or night-time, in which the controls of the aircraft of the same category and class/type have effectively been operated;
>
> [...]

On this topic, the IOGP 690-2, p. 52, recommended criteria with the aim of ensuring that pilots of commercial offshore transport flights carried out in helicopters performed their duties with adequate training, qualifications, knowledge, skill and experience, as highlighted below:

Table 11-2: Aircraft Commander and Co-pilot's qualifications.

QUALIFICATION	***EXPERIENCE***
Total hours previous 90 days (See note 1)	*50 hours of which at least 10 on type* (emphasis added)
Medical certificate appropriate for license	*Current*
Instrument rating	*Current; OPC at 6-monthly intervals*
Night offshore recency previous 90 days	*3 cycles (See notes 2 & 3) (grifo nosso)*
CRM or ADM, initial/refresher	*Annual*
Dangerous Goods awareness	*Every 2 years or in accordance with local regulatory requirements*
Offshore experience	*One year*
Helicopter Underwater Escape Training (HUET)	*Every 4 years*

Table 2 Notes:

1. If hours are not met, a line check (which maybe a normal revenue flight) is conducted by a Line Training Captain.

2. One-night cycle consists of a night take-off, approach and landing to an offshore location. A simulator of the same type or series being flown may be used to meet the night recency requirements, provided this is acceptable under national legislation, and it has the visual fidelity to replicate landing on an offshore facility.

3. Use of the simulator for night deck recency cannot be used for 2 consecutive 90-day periods, as a minimum simulator-based recency alternates with actual offshore recency activity.

Furthermore, it was possible to verify that a foreign company operating an oil and gas platform established, for aircraft operators contracted by them, the following requirements regarding the experience of helicopter pilots for the purpose of commercial passenger transport in offshore operations in Brazil:

- the pilot must have flown at least 50 hours in the 90 days preceding the flight, 10 hours of which in the same type of aircraft, including 3 landings and takeoffs at the maritime unit.

1.20. Useful or effective investigation techniques.

NIL.

2. ANALYSIS.

It was an offshore passenger-transport helicopter flight, with two pilots and eleven passengers on board.

The notification form presented indicated SBSV as the airport of departure. The aircraft would fly VFR at an altitude of 1,500 ft. AGL, bound for 9PMM (*Manati* Maritime Platform).

As for the prevailing meteorological conditions during the flight, as it was not possible to determine ceiling and visibility in the region of accident, one attempted to estimate the weather conditions based on other data available.

Initially, the presence of isolated Cumulonimbus and Towering-Cumulus formations was forecast due to local thermodynamics, with no synoptic features like ITCZ or cold front affecting the area where the accident occurred, in the between 06:00 and 12:00 UTC of 16 March 2022.

Corroborating the forecast abovementioned, the SIC reported having sighted isolated rain in some parts of the route, although during the final approach to the 9PMM Platform, he did not detect the presence of precipitation.

The image extracted from the camera installed on the 9PMM Platform showed that the “horizon line” around the platform was not well defined due to the existing cloudiness.

However, it was not possible to determine to what extent the prevailing meteorological conditions influenced the crew's performance during the final approach to the helideck.

At around 09:40 UTC, having completed their preparation for the flight in question, the pilots proceeded to the helicopter, after getting aware of the technical-operational conditions relative to the departure aerodrome, destination helideck, and their aircraft.

In the sequence, the SIC occupied the right-hand seat, activated the battery, and began preparing the aircraft for flight, while the PIC welcomed the passengers and held a safety briefing outside the aircraft.

As for this subject, the MGO prescribed that, during the safety briefing, the crewmember should verbally ask which passengers possessed HUET training, and place them close to the aircraft's emergency exits.

However, according to information collected, two passengers who did not possess the HUET training occupied seats close to the PR-LCT’s emergency exits.

Survivors reported that it was common practice for crews to ask the passengers whether they had received the HUET training, but, specifically in the case of the accident the question was not made.

It was not possible to confirm whether the evacuation of passengers from the aircraft was compromised due to this fact. However, it is known that the optimization of the escape actions, among other aspects, is also conditioned on faithful compliance with the procedures established in the HUET.

On this subject, the IOGP’s Report 690-3, “*Support Operations*”, recommended that passengers undergo full HUET training at least every four years, as well as carry PLB-type personal protective equipment.

Once the passengers had embarked, the PIC occupied the left-hand pilot's seat as Pilot Monitoring, concomitantly with the role of Flight Instructor.

The SIC flew the aircraft as the Pilot Flying, for being in the process of operational upgrade, in the enroute-experience phase, with the aim of being promoted to captain.

Upon completion of the procedures for joining the traffic circuit, the crew decided that, due to the direction of the wind, the landing would be carried out by the SIC.

The traffic circuit was flown uneventfully until the aircraft joined the final approach segment. The SOP prescribed that the final approach should start at a height of 500 ft., speed of 60 kt., and descent rate of less than 600 ft. /min.

At the end of the base turn, with the aircraft aligning with the final approach of the traffic circuit on a magnetic heading of 250º, the *flight director* was uncoupled at a distance of approximately 0.93 NM from the helideck, and the descent was started manually.

The flight was uneventful until that moment, with the aircraft flying within the parameters of height, speed, and rate of descent recommended by the SOP.

Five seconds after uncoupling the *flight director*, the PIC informed the SIC that he (the PIC) was waiting for the final checklist request. The SIC said, "*okay*", but did not request the final checklist from the PIC.

According to the SOP, the final checklist complemented the *before-landing* checklist with the aircraft configured for offshore landings, being normally worked during periods of high workload and, therefore, could be accomplished from memory.

The final checklist was to be requested by the PF (SIC) with the aircraft stabilized on the final approach at a speed compatible with the use of floats.

According to the SOP, *standard calls* were established with the objective of minimizing the possibility of interpretation errors among crew members, and initiating corrective actions during the execution of tasks.

The *calls* related to information provided by the control units, would be presented in Portuguese so that they would be in accordance with the air traffic control phraseology. Other *standard calls* were to be made in English.

That said, the Pilot Monitoring (the PIC, in this case) was supposed to run the *final checklist* using the *scan-flow method* in silence, and then question the Pilot Flying (the SIC) by means of calls in English, aiming to obtain positive confirmation of the actions performed.

Thus, in contrast with the prescriptions of the SOP, the PIC used Portuguese to make the calls prescribed for the final checklist, informing the SIC about the 9PMM code, and that the life rafts were "*okay*". The SIC, in turn, did not confirm the actions performed by the PIC.

Such fact may indicate that the SIC did not fulfill the calls prescribed for the final checklist because his attention was distracted by other stimuli, such as maintaining visual references with the horizon line while trying to keep the platform in sight.

On the other hand, the inappropriate use of calls may have compromised the management of tasks assigned to the pilots and, consequently, their situational awareness.

In this way, it is possible that any lapse in the working of the checklist procedures was the result of an interruption in cabin activities caused by operational circumstances, such as those described in item 12.4, of the SOP, "*Human and Operational Factors that Affect Compliance with Normal Procedures*", notably, with regard to the application of incorrect CRM techniques, including inefficient cross-check and ineffective coordination between crew members.

It should be noted that, 14 seconds after uncoupling the FD, the SIC informed the PIC that he (the SIC) would perform a go-around in the air if he felt any discomfort in relation to the height and position of the helicopter on the final approach segment.

It is also noteworthy that, while transmitting the aforementioned information to the PIC via intercom, the SIC maintained the helicopter's torque close to zero and, at the same time, continuously actuated on the cyclic control in order to pitch up the aircraft, to the point of reaching a positive angle of 13º.

Following that, the PIC warned the SIC that the rate of descent was “a little high”. It is worth noting that, during the final approach, the MPFR records indicated that the PR-LCT helicopter reached a descent rate of -3,920 ft. /min.

Taking into account the instructions listed in the SOP, the VSI parameter that defined a stabilized approach in VMC for the SK76 helicopter was significantly exceeded, and a missed approach procedure should have been performed when the descent rate of -600 ft. /min was surpassed.

Therefore, it was possible to observe the presence of inadequate assessment and a less-than-assertive attitude of the crew in relation to the exceedance of the VSI parameter established by the SOP, both in relation to the stabilized approach and the lack of actions capable of leading the crew to a timely correction.

According to the SOP, the call to be used by the PIC to alert the SIC about the excessive rate of descent should have been “*descent rate*”.

The SIC should have replied “*check, correcting*” to the PIC, if he was going to reduce the descent rate to adapt to operational standards, or “i*ntentional*”, if the excessive descent rate was necessary to maintain flight safety.

According to the RFM of the Model S76C Sikorsky helicopter, a controlled approach, in Category B, was to be established with the following parameters: 200 ft. AGL, speed of 45 kt, VSI of - 600 ft. /min. Such profile should be maintained until a height of 50 ft. and speed of 45 kt, after which the aircraft would be decelerated until hovering.

However, the investigation committee found that, throughout the final approach profile, the aircraft maintained an attitude of speed reduction on account of a pitch-up attitude, reaching pitch-up angle values close to 16º, which resulted in increasingly lower speeds and in steeper approach ramps, close to 42º. It is possible that, with such excessively steep attitudes, the pilot momentarily lost visual contact with the platform.

Twenty-two seconds after the uncoupling of the FD, the PIC alerted the SIC that the helicopter was losing speed, and the SIC replied that he was high, when the aircraft was passing 132 ft. AGL, at a speed of 29 kt. (IAS) and a VSI of -1,495 ft./ min.

Furthermore, according to the SOP, the call to be used by the PIC to alert the SIC about abnormal speed should be “*airspeed*”. The SIC, in turn, should have replied “*check, correcting*” if he was going to adjust the speed to adapt to operational standards, or “i*ntentional*” if considered that the speed deviation was necessary to maintain flight safety.

Shortly thereafter, the EGPWS issued the “*one hundred*” altitude alert, as the aircraft passed 100 ft. AGL (RADAR altimeter), with a VSI of -1,839 ft. /min, moments before the collision with the sea.

From then on, there was effective actuation on the cyclic control, changing the aircraft’s longitudinal attitude from the 16.0º nose-up to 0.0º in 1 second. At that moment, the inputs on the collective control contributed to exceeding the aircraft's transient torque limit. However, it was not possible to determine whether the action on the flight controls was performed by the SIC or if there was intervention by the PIC.

Then, the PIC warned the SIC of the low speed for the last time, and the aircraft collided with the sea.

From the analysis of the information extracted from the MPFR, one observed that, after the PIC alerted the SIC with regard to the low speed, the collective control was applied, resulting in a slight reduction in the rate of descent and, subsequently, a change in the attitude of the aircraft, consistent with a cyclic control input "to lower the nose of the aircraft". Therefore, it can be said that there was command authority, but the correction was not sufficient to reestablish control of the aircraft.

Hereupon, and in view of the authority of the cyclic and collective commands throughout the descent, characterized by the recovery of the rate of descent, forward speed, height, and aerodynamic ramp below 60º in absolute values, no evidence was identified to confirm the occurrence of a "Vortex Stall" phenomenon during the final approach to the 9PMM Platform.

Tests performed on the PR-LCT's engines enabled one to affirm that both of them were functioning normally and developing power at the time of the crash.

Within the scope of human factors and risk management, the investigation committee studied the aspects that contributed, or supposedly contributed, to the occurrence of the accident. Some of the aspects of this offshore flight are highlighted below:

- it was the first flight of the fortnight working period for both pilots;
- it was the first enroute flight for the SIC, under the supervision of a flight instructor, in the phase of en-route operational-experience training in preparation for his promotion to aircraft captain;
- it was the first time that the SIC flew the helicopter sitting in the pilot's right-hand seat, since he was hired by the aircraft operator; and
- it was the first time that the SIC would perform an approach and landing at the 9PMM platform.

In addition, during the 90 days preceding the accident, the SIC carried out a total of 4 hours of flight time and 2 offshore landings. He did not remember having performed any offshore landings effectively operating the aircraft's flight controls during the referred period.

Thus, after expanding the time range, one identified that, in the period from 01 April 2021 to 28 February* 2022 (*the month preceding the accident), the SIC logged 36 hours and 40 minutes of total flight time and 22 offshore landings, numbers that make up a monthly average of 3 hours and 20 minutes of flight and 2 offshore landings.

It should be noted that the SIC, during that eleven-month period, served in the air ambulance schedule for ten of those months, during which flight frequency was reduced.

One also identified that, within the scope of the aircraft operator, there was no requirement specifying a minimum number of offshore takeoffs and landings carried out by pilots in effective operation of the aircraft's flight controls in a given period.

In this regard, defining such minimum requirement within the scope of the aircraft operator could act preventively in the case of the flight in question, by not allowing the SIC, who was being evaluated for a prospective command position and under those circumstances, to make the approach to the 9PMM Platform.

These aspects refer to the possibility of inadequacy in the planning performed by the organization's management staff, especially as far as the allocation of human resources for the execution of operational activities were concerned, as a result of a failure in supervision.

However, it is worth highlighting that, in relation to the pilots' recent experience, the aircraft operator, for the purpose of operating commercial transport of passengers offshore by helicopter, was compliant with the requirements established by RBAC 61, amendment nº 13, item 61.21 - "Licenses, Qualifications and Certificates for Pilots", dated 20 March 2020.

In this occurrence, however, it is possible to infer that such requirements were not adequate to meet the minimum level of safety, since a pilot could be compliant with the aforementioned RBAC-61's requirement by performing three vertical takeoffs and three subsequent landings, without necessarily having conducted a taxi or even a complete visual traffic in a maritime unit effectively at the controls of the aircraft.

On this subject, the International Association of Oil & Gas Producers (IOGP), an association in which the 9PMM Platform's operator was a member, by means of the Report 690, version 1.1, of February 2021 - *Offshore Helicopter Recommended Practices (OHRP)*, established recommended practices aimed ensuring that pilots of offshore commercial transport flights conducted by helicopters performed their duties with the proper qualifications and experience, in accordance with the requirements contained in Table 11-2: "*Aircraft Commander and Co-pilot qualifications*".

In this respect, it was identified that a foreign company active in the oil and gas exploration sector established minimum requirements for the experience of helicopter pilots hired by its aircraft operators for the commercial transportation of passengers in offshore operations in Brazil, as follows:

- the pilot should have flown at least 50 hours in the 90 days prior to the flight, including 10 hours in the same type of aircraft, and this should include three landings and takeoffs at the Maritime Unit.

It is worth noting that these minimum requirements exceeded those required by the RBAC-61, as, in addition to the 3 takeoffs and 3 landings, they also included total flight hours, hours in the type of aircraft, and number of takeoffs and landings at Maritime Units.

The SIC's description of the accident, highlights that the PIC did not conduct a specific briefing addressing relevant aspects of the operational conditions en route, physical characteristics of the helideck, type of approach, and emergency procedures, as outlined in the company's PTO.

The SIC also added that he and the PIC had served together as crew members on several occasions. The first time was at the beginning of the SIC's aviation activities with the company in February 2021. Another time was in periodic training in the flight simulator, four months before the occurrence, and the last on the flight of this accident.

During the critical moments of the final approach for landing on the helideck, although with little assertiveness, the PIC did alert the SIC about the excessive rate of descent and the speed, which was below the values recommended by the SOP for those circumstances. The SIC's lack of immediate reaction to adjust the aircraft's speed, demonstrated that communication between the pilots was not adequate.

The complacent attitude of the PIC, combined with the SIC's personality profile, which was more prone to following orders and performing tasks during periods of higher tension, compromised the interaction between the pilots, hindering the implementation of the necessary corrective measures to execute a go-around following an unstable approach.

In the SIC's description of the event, it is worth noting that during the final approach, he focused his attention on maintaining the platform in sight, something which may have reduced his situational awareness, leading him to develop a selective perception or "tunnel vision", as he was exclusively concentrated on the platform, without noticing the significant changes in other crucial variables, such as speed, rate of descent, height, and the torque applied.

That being said, it was found that the SIC did not efficiently perform the cross-check of height, speed, rate of descent, and distance from the helideck, thus inappropriately using his sensory perception and the information available on the aircraft's instruments. It is possible that he shifted his focus outside the aircraft in an attempt to seek external references, to the detriment of monitoring the appropriate flight parameters to keep the aircraft under control.

Based on the investigation data, it was observed that the SIC possibly lost visual contact with the helideck for some time during the final approach to the 9PMM Platform. Thus, by focusing his attention solely on the platform, the SIC likely failed to properly identify the flight parameters, which could have helped reverse his loss of situational awareness.

The PIC, in turn, as the Pilot Monitoring and Flight Instructor, was unable to intervene and prevent the accident. Given the circumstances, it is possible that the SIC's trust in the PIC may have enhanced increased his sense of safety in conducting the flight.

Thus, one inferred that the SIC believed that the PIC was, in fact, adequately monitoring the aircraft's instruments and, at the same time, the approach parameters. This may have compromised the SIC's ability to assess the unstable profile utilized on the final approach, as well as its likely consequences for the safety of the operation.

The pilots' difficulty perceiving and analyzing the variables present on the final approach may have compromised their ability to respond to adverse situations, thus denoting their inability to make a decision capable of preventing loss of control of the helicopter.

With respect to the survival and evacuation equipment of the aircraft, it is worth to highlight that, at the time of the accident, the PR-LCT helicopter, its crew and passengers, had the emergency equipment listed as mandatory both in RBAC-135 and in the S- 76C++ MGO issued by the aircraft operator.

In this sense, it should be noted that the pilots' life jackets were fitted with individual PLBs. However, the RBAC-135, amendment nº 9, dated 01 March 2021, did not require the use of PLBs in life jackets of passengers transported in offshore helicopter operations, while the IOGP recommended the use of PLB by passengers transported in helicopters on offshore commercial flights.

The utilization of PLBs on passengers' life jackets would contribute to their spotting by search and rescue services, in the event of an accident at sea, should the helicopter's life raft have a failure, with a consequent dispersion of the survivors.

In addition, it is worth mentioning that, in accordance with the provisions of the RBAC-135, section 135.167, the use of life jackets equipped with the Compressed-Air Emergency Breathing System (CA EBS) was not listed as mandatory emergency equipment for crew and passengers in offshore helicopter operations, in contrast with the recommendation made by the IOGP.

Still on this subject, in 2020, the CAA UK, by means of the CAP 1877, annex "A", item A10, established as mandatory the use of the CA EBS for helicopters' crew and passengers in offshore operations.

Considering that the autopsy report issued by the Secretariat of Public Security of the State of *Bahia* concluded that the PIC's cause of death was mechanical asphyxiation due to the immersion of the airways in a liquid medium, one inferred that the efficient use of an compressed-air emergency breathing system (CA EBS) by the PIC, could have increased the probability of the pilot to escape from the submerged aircraft.

Relatively to the procedures of search and rescue of the PR-LCT's crew and passengers after the crash, the ARCC-RE received the signals of the aircraft's ELT and of the pilots' PLBs, via the MEOSAR system, and immediately started the coordination aimed at locating the aircraft, as recommended by the legislation in force.

According to the aircraft operator, the flight coordination attempted to communicate with the PR-LCT helicopter at 10:50 UTC, and received contact of the referred aircraft via the flight tracking system of the company at 10:53 UTC, approximately 25 minutes after the crash.

With respect to the supervision procedures for flights conducted by the aircraft operator, the MGO, item 3.4, p. 52, prescribed that, in the event of the aircraft becoming inactive in *Flight Following*, the designated flight coordinator should immediately attempt to communicate with the aircraft via VOIP or satellite telephone, and that failure in this attempt would initiate the response plan to the emergency.

Therefore, it was verified that improvement of the flight monitoring requirements by the aircraft operator could reduce the time needed to locate the PR-LCT, as well as the time required to activate the company's plan of response to the emergency.

The survivors were rescued from the sea by the 9PMM Platform's UT 750 support vessel, call sign LUMAR 20, which did not have a lifeboat with rescue capabilities on board.

One hour and thirty minutes after the rescue, the pilots and three passengers were transferred from the LUMAR 20 support vessel to a motor boat, in order to reduce the travel time to a hospital of *Valença*, State of *Bahia*.

It was found that resources for emergency response available in the city of *Valença* were not included in the aircraft operator's emergency-response plan, a fact that may have made it difficult to summon the medical units in that city.

3. CONCLUSIONS.

3.1. Findings.

a) the pilots held valid CMAs (Aeronautical Medical Certificates);

b) the pilots held valid SK76 aircraft type and IFRH ratings;

c) the pilots were qualified and had experience in the type of flight;

d) the aircraft had a valid CVA (Airworthiness-Verification Certificate);

e) the aircraft was within the prescribed weight and balance limits;

f) the records of the airframe and engine logbooks were up to date;

g) the PIC occupied the left-hand seat, performing the roles of Pilot Monitoring and Flight Instructor;

h) the SIC operated the aircraft as the Pilot Flying, as he was in the process of level-up training for co-pilots, in the phase of enroute operational experience acquisition, with the objective of being promoted to aircraft captain;

i) it was the pilots' first flight in the fortnight flying-period, and it was the SIC's first flight in the process of evaluation for promotion to S-76C++ aircraft captain;

j) it was the first time that the SIC made an offshore approach for landing, occupying the right-hand pilot's seat at the aircraft-operating company;

k) it was the first time that the SIC was making an approach for landing on the PMNT-1 *Manati* Platform (9PMM);

l) the SIC, at the end of the base turn, when aligning for the final approach to 9PMM, uncoupled the *flight director* and commenced descent, taking over the effective operation of the flight controls from that moment on;

m) on the final approach, an inflight loss of control occurred, and the helicopter crashed into the sea, before making it to the platform;

n) data extracted from the MPFR indicated that, at 264 ft. AGL, the helicopter speed reached 0 kt (IAS) and -3,920 ft./min (VSI);

o) the EGPWS issued the “one hundred” altitude callout, as the aircraft passed 100 ft. AGL (RADAR altimeter), with a VSI of -1,839 ft./min;

p) tests of the engines confirmed that they were functioning normally and developing power at the time of the crash;

q) after the crash, the floats kept the helicopter on the sea surface in an upside down attitude, and, upon manual activation of the life raft located on the right-hand side of the helicopter, the eleven passengers boarded;

r) the SIC rescued the unconscious PIC from the cockpit through the left front door of the aircraft, and took him to the life raft;

s) the pilots and passengers were rescued from the sea by the 9PMM’s support vessel and transported to the city of *Valença*, State of *Bahia*;

t) the aircraft sustained substantial damage;

u) the SIC and the eleven passengers suffered minor injuries; and

v) the PIC suffered fatal injuries.

3.2. Contributing factors.

Attention – undetermined.

When focusing his attention on the 9PMM Platform, the SIC is likely to have failed to adequately identify the flight parameters indicative of a destabilized approach, reducing the possibility of a quick and accurate response for correcting such condition. As a result, relevant information made available by the aircraft's instruments may not have been duly observed, hindering one’s selective attention and generating dysfunction of one’s warning system.

Adverse meteorological conditions – undetermined.

The image captured by the 9PMM Platform’s video camera shows the presence of clouds in the region of the accident. However, it was not possible to determine to what extent did the existing meteorological conditions influence the crew's performance during the final approach to the helideck.

Crew Resource Management – a contributor.

The inadequate use of standard call-outs compromised the management of tasks assigned to the pilots. Furthermore, the loss of control of the aircraft was associated with the application of incorrect CRM techniques, including inefficient crosschecking and ineffective coordination.

Work-group culture – undetermined.

One verified that the practice of flight instructors in relation to holding specific briefings was not recurrent for this type of flight, as it was an offshore routine flight for the transport of passengers. Yet, it is possible to infer that holding a specific briefing would have contributed to the mitigation of the risks associated with the operation, when one considers that the flight in question was the first flight of the scheduled fortnight working period for both pilots. Besides, it was the SIC's first flight en route under supervision by a flight instructor. In addition, it was the first time the SIC was occupying the right-hand seat. Finally, it was the first time the SIC would be performing an approach for a landing on the helideck of the 9PMM *Manati* Platform.

Handling of aircraft flight controls – a contributor.

Exceedance of the rate of descent to values above 600 feet/min on the final approach for the intended landing on the 9PMM *Manati* Platform, being rate of descent one of the parameters defined in the aircraft operator's SOP for a stabilized VFR approach with SK76 helicopters, evidenced an inappropriate handling of the aircraft's flight controls.

Perception – undetermined.

It is likely that, on the final approach, the exceedance of the parameters recommended for a stabilized approach may have resulted from impairment of the SIC's ability to recognize, organize, understand, and project sensations arising from internal and external stimuli to the aircraft's operating environment, leading to degraded situational awareness, stimulus overload, delayed perception, and "tunnel vision".

Management planning – a contributor.

The organizational processes adopted within the scope of the operator's SMS were not enough for identifying the dangers posed by the circumstances of that flight. Such dangers were, namely, the fact that it was the first flight of the fortnight working-period for both pilots; the fact that it was the first enroute flight of the SIC being evaluated by a flight instructor; and, the fact that it was first time the SIC was occupying the right-hand seat after being hired by the aircraft operator.

Support systems – undetermined.

It is possible that the requirements established by the RBAC-61, addressing the subject of pilots' recent experience, have not proven adequate to meeting the minimum level of safety in offshore commercial passenger transport operations with helicopters.

Managerial oversight – undetermined.

The failure to conduct a specific briefing for a flight under the supervision of a flight instructor during the operational experience training phase en route to a Maritime Unit, where the SIC would for the first time make a landing in the right-hand seat as Pilot Flying, indicates that it was a recurring practice among flight instructors not to conduct specific briefings for this type of flight. This reveals a flaw in the company's managerial supervision, which may have contributed to the deviations observed on the final approach for landing.

Other (survival equipment) – undetermined.

It is possible that the efficient use of an emergency compressed-air breathing system by the PIC would have increased the likelihood of his escaping the submerged aircraft.

4. SAFETY RECOMMENDATIONS

A proposal of an accident investigation authority based on information derived from an investigation, made with the intention of preventing accidents or incidents and which in no case has the purpose of creating a presumption of blame or liability for an accident or incident.

In consonance with the Law n°7565/1986, recommendations are made solely for the benefit of safety, and shall be treated as established in the NSCA 3-13 "Protocols for the Investigation of Civil Aviation Aeronautical Occurrences conducted by the Brazilian State".

To Brazil's National Civil Aviation Agency (ANAC):

A-033/CENIPA/2022 - 01 Issued on 08/05/2024

Evaluate the relevance of adopting the best practices outlined in Report 690 of the International Association of Oil & Gas Producer, especially in regard to the implementation of the HUET (Helicopter Underwater Escape Training), the use of a compressed air emergency breathing system (type CA EBS), and the use of Personal Locator Beacons by crews and passengers on commercial offshore helicopter flights.

A-033/CENIPA/2022 - 02 Issued on 08/05/2024

Disseminate the lessons learned from this investigation, among the operators governed by the RBAC-135 involved in offshore operations, with the purpose of alerting helicopter pilots to strict adherence to the application of Crew Resourse Management techniques, including cross-checks and effective coordination, especially during the final VMC approach for landing in helidecks.

A-033/CENIPA/2022 - 03 Issued on 08/05/2024

Ensure the adoption of strategies on the part of *Líder Táxi Aéreo S.A. Air Brasil*, focusing on improving its managerial oversight mechanisms, aimed at pilots' strict compliance with the standard callouts and briefings prescribed for all training flights, as established in the respective SOPs and PTO of the referred company.

A-033/CENIPA/2022 - 04 Issued on 08/05/2024

Evaluate the relevance of implementing a specific RBAC for offshore operations, taking into account the peculiarities pertaining to this type of air activity.

5. CORRECTIVE OR PREVENTATIVE ACTIONS ALREADY TAKEN.

By the ANAC (National Civil Aviation Agency):

- on 05 April 2022, the ANAC initiated a remote inspection process on the operational safety management system of *Líder Táxi Aéreo S.A. Air Brasil*, with the purpose of evaluating the compliance and level of effectiveness of that system;
- the assessment was conducted through analysis of evidence submitted by the company, as well as through an interview with the Operational Safety Manager; and
- on 29 August 2022, the ANAC closed the inspection without pointing out any non-conformities or recommendations.

By the Brazilian Navy:

In the course of this investigation, the Brazilian Navy published the Revision nº 3 of the NORMAM 27/DPC, which, by means of changes in the wording of some of the topics of the article 0706, established the following requirements concerning air operations in helidecks located on an unattended fixed platforms:

- the helideck is to be used for landings in up to a maximum three air journeys per week and in VMC conditions;
- it must have a sensor indicating wind direction and strength (anemometer);
- it must have a portable anemometer;
- it must have an external temperature sensor; and

- the use of a support vessel fitted with a rescue boat will be compulsory. This support vessel must transmit wind and temperature conditions in the area of the platform to the aircraft before the first landing.

By PETROBRAS:

- conduction of a simulated exercise, with the scenario of a forced landing at sea close to the 9PMM platform, updating the corporate standards that guide the response to this type of emergency;
- offshore aviation companies are contractually required that their crews make a radiotelephony call to vessels that support helicopter flight operations on an unattended platform, 5 minutes before landing, and that they abort the landing if they do not receive, in response, the information that the vessel is ready;
- required, for the case in which a vessel is scheduled to support helicopter flight operations on an unattended platform, that the commander or designated crewmember maintain visual contact with the aircraft from the first before-landing call, until the landing takes place, in addition to ensuring by radiotelephony that the flight was safely completed in the event the aircraft is not in sight;
- contractually established for offshore operating companies that seats near the emergency exits be occupied primarily by passengers with a valid HUET;
- the transition to the use of compressed-air emergency-breathing devices for passengers and crew has begun, with establishment of the requirement to new contracts, conditioned by the addition of old contracts, still to be negotiated;
- requirement of usage of a PLB by each passenger, in new contracts, with the possibility of addition to current contracts; and
- restriction of scheduled flights for unattended platforms to which the respective weather report has not been sent in advance.

By *Líder Táxi Aéreo S.A. Air Brasil*:

- updating of crisis-management checklists of emergency-response plans, based on the lessons learned from the accident in question;
- updating of emergency-response plans for helicopter operational bases;
- updating of internal procedures regarding the filling out of flightcrew-evaluation forms;
- incorporation of additional factors for a detailed psychological analysis of every pilot’s profile in the company;
- conduction of psychological reassessment applied to all of the company's flight instructors;
- updating of the procedures related to instruction flights, in which the initial flight of the scheduled fortnight working period, conducted either by the aircraft captain or by the co-pilot, is not to be considered as an instruction flight;
- face-to-face CRM training implementation process, with the help of internal and external facilitators, and continued support from an outsourced company for distance training, when applicable;

- inclusion of a company’s aviation psychologist for participation in simulator sessions with flight-crew members, with the aim of assessing the pilots' profile and assisting in CRM practice, aimed to improve crew coordination and communication; and
- holding of a seminar for flight instructors focusing on technical, operational, and human factor aspects for all flight-instructor captains.

On August 5th, 2024.