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Aircraft Accident Investigation Bureau AAIB

Final Report No. 1995 by the Aircraft Accident Investigation Bureau

concerning the accident

to the Kamov KA-32A12 helicopter, registration HB-XKE

on 26 March 2002

“Ufem Schoren” municipality of Neuenegg/BE

approx. 15 km west of Berne-Belp airport

Ursachen

Der Unfall ist auf den nahezu gleichzeitigen Ausfall beider Triebwerke aufgrund einer Verwechslung eines Schalters zurückzuführen. Nach der Autorotation kippte der Helikopter nach der Landung auf die rechte Seite.

Zum Unfall beigetragen hat:

- Kombination eines Typenberechtigungsfluges mit einem technischen Flug
- Nicht angepasste Ergonomie der Schalter *free turbine overspeed test* und *gas generator test*
- Fehlende technische Sicherheitsnetze

General information on this report

This report contains the AAIB's conclusions on the circumstances and causes of the accident which is the subject of the investigation.

In accordance with Annex 13 of the Convention on International Civil Aviation of 7 December 1944 and article 24 of the Federal Air Navigation Law, the sole purpose of the investigation of an aircraft accident or serious incident is to prevent future accidents or serious incidents. The legal assessment of accident/incident causes and circumstances is expressly no concern of the accident investigation. It is therefore not the purpose of this investigation to determine blame or clarify questions of liability.

If this report is used for purposes other than accident prevention, due consideration shall be given to this circumstance.

The definitive version of this report is the original in the German language.

All times in this report unless otherwise indicated, are indicated in the standard time applicable to the area of Switzerland (local time – LT), corresponding at the time of the accident to Central European Time (CET). The relationship between LT, CET and coordinated universal time (UTC) is: $LT = CET = UTC + 1 \text{ h}$.

For reasons of protection of privacy, the masculine form is used in this report for all natural persons, regardless of their gender.

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Final Report

Owner	Heliswiss AG, 3123 Belp, Switzerland
Operator	Heliswiss AG, 3123 Belp, Switzerland
Aircraft type	Kamov KA-32A12
Country of registration	Switzerland
Registration	HB-XKE
Location	"Ufem Schoren" municipality of Neueneegg/BE
Date and time	26 March 2002 at approximately 16:12

Synopsis

The accident was reported to the Russian investigating authority, the IAC Air Accident Investigation Commission, and the manufacturer by means of ACCID.

According to Annexe 13 of the Convention on International Civil Aviation (ICAO Annex 13), the state of manufacture of the aircraft has the option of sending authorised representatives to the investigation. This option was exercised. The representatives of the IAC arrived in Belp on 28.03.02 and accompanied the investigation.

Summary

On the afternoon of 26 March 2002 the twin-engine Kamov KA-32A12 helicopter, registration HB-XKE, took off from Berne-Belp aerodrome on a type rating flight. On the return flight, the flying instructor carried out a technical engine test. When he did so, both engines cut out, almost simultaneous. The pilot then initiated an autorotation and landed in a field. On touchdown, the helicopter tipped onto its right side. The aircraft was severely damaged. The occupants were unharmed.

Investigation

The notification was received at the Aircraft Accident Investigation Bureau (AAIB) at approximately 16:20. The investigation was opened at the site at approximately 18:45 by the AAIB in cooperation with the Berne cantonal police.

The accident is attributable to the almost simultaneous failure of both engines because of confusion over a switch. After the autorotation, the helicopter tipped over on its right side after landing.

The following factors contributed to the accident:

- the combination of a type rating flight with a technical flight
- inappropriate ergonomics of the free turbine overspeed test and gas generator test switches
- a lack of technical safeguards

Within the framework of the investigation, one safety recommendation was made.

1 Factual information

1.1 Flight preparation and history of the flight

1.1.1 General

For the description of the flight preparation and history of the flight, the recordings of the cockpit voice recorder and the statements of the crew members were used.

The flight took place under visual flight rules.

1.1.2 Flight preparation

On 25 March 2002, i.e. one day before the accident, a 100-hour check was carried out on helicopter HB-XKE, on the airframe and the engines. During the technical check flight it was established that the engine limiters were functioning, but not the associated warning lamps. The helicopter was cleared for flying operations.

The appropriate adjustments were made on the ground after the flight, on the basis of the measured data.

A type rating examination flight was scheduled for the afternoon of 26 March 2002. In order to provide the pilot with a further training opportunity, a flight was made on the morning of 26 March 2002. During the flight the engine parameters were checked and it was found that the engine limiter of the right engine was continuing to reduce power without the warning lamp lighting up. The settings were subsequently corrected once more.

1.1.3 History of the flight

At 15:22 on 26 March 2002, the twin-engine Kamov KA-32A12 helicopter took off from Berne-Belp aerodrome on the type rating examination flight. On board were the examination candidate, in the left-hand seat, the flying instructor in the right hand seat and the examiner from the Federal Office of Civil Aviation in the observer's seat.

The flight progressed from the Heliswiss AG base in the direction of departure waypoint "HW". During the climb, the crew once again tested the engine power limiters. This took place after prior consultation with the examiner.

In the Schwarzenburg – Laupen – Grosses Moos area, the manoeuvres required for the examination were flown. At approximately 16:06 the examiner asked for a dual engine failure to be simulated. The pilot immediately initiated an autorotation, which took place successfully. The candidate was then requested to carry out a quick stop at 2500 ft QNH near the Gümmenenbrücke bridge. This ended the examination programme.

At approximately 16:09 the pilot reported on the aerodrome control (Berne Tower) frequency "*Berne from helicopter HB-XKE, Laupen, 3000 ft, Information U, for landing Heliswiss*". He received clearance from the aerodrome controller to fly into the aerodrome traffic zone and was requested to report at approach waypoint "HW".

At approximately 16:11 the helicopter was in the Oberwangen area at 1000 m/AMSL. The flying instructor, in his capacity as test pilot, carried out preliminary operations for an engine test, during which various audio warnings sounded immediately. Both engines cut out almost simultaneous. The pilot then initiated an autorotation. The crew mentioned the tailwind. On final approach, the speed was a little over 100 km/h. The helicopter touched down on a field ap-

proximately 40 seconds after the dual engine failure at a forward speed of approximately 15 km/h. On landing, the aircraft tipped onto its right side. The helicopter was severely damaged. The occupants were unharmed.

The pilot was PF throughout the flight.

1.2 Injuries to persons

Injuries	Crew	Passengers	Total number of occupants	Others
Fatal	---	---	---	---
Serious	---	---	---	---
Minor	---	---	---	---
None	3	---	3	---
Total	3	---	3	---

1.3 Damage to aircraft

The helicopter was severely damaged.

1.4 Other damage

There was damage to agricultural land caused by the impact and salvaging of the helicopter and by leaking kerosene.

The site of the accident has since been renatured.

1.5 Personnel information

1.5.1 Flying instructor

Person	Swiss citizen, born 1953
Licence	Commercial Pilot Licence, helicopter CPL (H), issued by the FOCA, valid till 19.11.2000 Private Pilot Licence, helicopter PPL (H), issued by the FOCA, valid till 19.05.2002
Ratings	Flying instructor FI(H), valid till 05.06.2004 Radiotelephony RTI Night flying, helicopter NIT(H) Mountain landings MOU (H)
Rated helicopter types	A 109, AL II, AL III, AS 350 Types, AS 355, B 171 SYCAMORE, B 205, B 206 / 206L, B 212 PIC, B 214 PIC, B 407, B 47 SOLOY, B 47 Types, Bell 204, BH06/ST/LT, BK117, BO 105, Hughes 300, Hughes 500, KAMOV KA 32, R 22, SA 315
Medical fitness certificate	Class 2, without restrictions
Last medical examination	19.05.2000

1.5.1.1	Flying experience	
	Total	3773:06 hours
	on the accident type	167:47 hours
	during the last 90 days	24:25 hours
	of which on the accident type	13:32 hours
	during the last 24 hours	1:48 hours
	of which on the accident type	1:48 hours
	Landings, total	29 015
1.5.2	Pilot	
	Person	Swiss citizen, born 1954
	Licence	Commercial Pilot Licence, helicopter CPL (H), issued by the FOCA, valid till 06.07.2002 Private Pilot Licence, helicopter PPL (H), issued by the FOCA, valid till 06.01.2004
	Ratings	Flying instructor FI(H), valid till 19.06.03 Radiotelephony RTI Night flying, helicopter NIT(H) Mountain landings MOU (H)
	Rated helicopter types	AL II, AL III, AS 350 Types, B 206 / 206L, B 214, B 407, B 47 Types, Hughes 300, Hughes 500, SA 315
	Medical fitness certificate	Class 1, without restrictions
	Last medical examination	18.12.2001
1.5.2.1	Flying experience	
	Total	10 180:05 hours
	on the accident type	12:01 hours
	during the last 90 days	22:16 hours
	of which on the accident type	12:01 hours
	during the last 24 hours	2:10 hours
	of which on the accident type	2:10 hours
	Landings, total	90 069
1.5.3	Examiner	
	Person	Swiss citizen, born 1942
	Licence	Commercial Pilot Licence, helicopter CPL (H), issued by the FOCA, valid till 10.06.2002

	Ratings	Flying instructor FI(H) Examiner TRE(H) Radiotelephony RTI Night flying, helicopter NIT(H) Mountain landings MOU (H)
	Rated helicopter types	A 109 E, AL II, AL III, AS 350 Types, B 206 / 206L, MD900/902, SA318/SE313, SA 315, SA 365
	Medical fitness certificate	Class 1, without restrictions
	Last medical examination	10.12.2001
1.5.3.1	Flying experience	
	Total	Approx. 3850 hours
	on the accident type	None
	On board in his capacity as Federal Office of Civil Aviation examiner.	
1.6	Aircraft information	
1.6.1	General	
	Registration	HB-XKE
	Aircraft type	KA-32A12
	Characteristics	Twin-engine transport helicopter with co-axial, counter-rotating rotor system
	Manufacturer	Kamov Company, Moscow, Russia
	Year of construction	1992
	Serial number	8709/02 (31587)
	Owner	Heliswiss AG, 3123 Belp, Switzerland
	Operator	Heliswiss AG, 3123 Belp, Switzerland
	Engine	2 Klimov TV3-117VMA
	Auxiliary Power Unit (APU)	Type AI-9
	Operating hours, airframe	2606:04 hours
	Airframe, number of landings	7372
	Max. permitted take-off mass	11 t
	Mass and centre of gravity	The mass of the aircraft at the time of the accident was approximately 8595 kg. Both the mass and centre of gravity were within the permitted limits according to the AFM.
	Maintenance	Swiss Helicopter Maintenance AG (SHM AG), Berne Airport, 3123 Belp, Switzerland The last 100-hour check on the airframe and engines was carried out and certificated by SHM AG on 25.03.2002.

Technical limitations	The following points were entered in the logbook on 26.03.02: <i>"a) Limiter test flight (24'). RH Eng. not ok.</i> <i>b) Training conversion examination (56')"</i>
Fuel grade	JET A1 kerosene The fuel sample contained very few solid particles. Otherwise, the sample complied with the tested points of the requisite specification.
Fuel reserves	At the time of the accident there were about 1275 kg of fuel on board.
Registration certificate	Issued by the FOCA on 12.06.1996 / No. 1
Airworthiness certificate	Special category / Restricted. Issued by the FOCA on 17.06.1996, valid till revoked.
Certification in non-commercial use	VFR day & night only; Aerial work with internal or external load; Crew training & proficiency flights; Technical & positioning flights; No transport of passengers for remuneration or hire; Transport of passengers limited to persons directly involved with aerial work
Certification in commercial use	VFR day & night only The validation conditions apply to these types of use.
Last airworthiness inspection	Carried out by the FOCA on 10.08.2001.
1.6.2 Engine number 1	
Serial number	7087853703620
Year of construction	Unknown
Installation location on HB-XKE	Left side in October 1999 at:
- Operating time since manufacture	575:00 hours
- Flying cycles since manufacture	No information
- Operating time, helicopter	1652:58 hours
Operating time since manufacture	1528:06 hours
Flight cycles since overhaul	1310
Operating time since installation in HB-XKE	953:06 hours

1.6.3	Engine number 2	
	Serial number	7087893000316
	Year of construction	Unknown
	Installation location on HB-XKE	Right side in October 1999 at:
	- Operating time since manufacture	1052:16 hours
	- Flying cycles since manufacture	No information
	- Operating time, helicopter	1652:58 hours
	Operating time since manufacture	2005:22 hours
	Flight cycles since overhaul	1310
	Operating time since installation in HB-XKE	953:06 hours

1.6.4 Design characteristics and certification basis of helicopter KA-32A12

Helicopter KA-32 was developed by the Kamov company as a civil transport helicopter based on the KA-27 submarine hunter helicopter and features the design characteristics typical of Kamov: a compact fuselage of very robust construction with a co-axial rotor system.

The helicopter with registration RA-31587 was imported into Switzerland as KA-32A. After extensive conversion work and validation by the Federal Office of Civil Aviation, it received registration mark HB-XKE and was now designated KA-32A12.

The type KA-32A12 helicopter was certificated as follows, according to information in the rotorcraft flight manual (RFM), Section 1 Limitations:

"This helicopter is certified under NLG 32.29 and FAR Part 29, Category A and B. Note: NLG 32.29 requirements in their structure and contents are equivalent to FAR Part 29, Amendment 29-1 to 29-24."

The Federal Aviation Regulations (FAR) PART 29 - AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY ROTORCRAFT require, among other things:

"§ 29.777 Cockpit controls.

Cockpit controls must be—

(a) Located to provide convenient operation and to prevent confusion and inadvertent operation; and.....

§ 29.903 Engines.

(b) Category A: engine isolation. For each category A rotorcraft, the powerplants must be arranged and isolated from each other to allow operation, in at least one configuration, so that the failure or malfunction of any engine, or the failure of any system that can affect any engine, will not—

(1) Prevent the continued safe operation of the remaining engines; or

(2) Require immediate action, other than normal pilot action with primary flight controls, by any crewmember to maintain safe operation.

§ 29.1353 *Electrical equipment and installations.*

(a) Electrical equipment, controls, and wiring must be installed so that operation of any one unit or system of units will not adversely affect the simultaneous operation of any other electrical unit or system essential to safe operation."

1.6.5 Cockpit and seating positions

Helicopter HB-XKE has conventional cockpit equipment. The instruments display metric scales. On the right-hand side of the instrument panel there is a panel of warning lamps (annunciator panel), which is coupled with an audio warning system. The light blue colour of the panels is distinctive. The left seat is for the pilot flying. The dual controls were installed on the right-hand side.

The relevant controls can be operated from either side.



Fig. 1: Cockpit Layout – Instrument panel and upper part of the centre console

1.6.6 Regulation of rotor and engine speed

The two engines are each fitted with a speed regulation system. This system consists of a hydromechanical controller (fuel flow control unit – FCU) and an electronic regulator (engine electronic governor – EEG). This unit is designated the engine power conditioning limiting system. Its function is described as follows in the engine maintenance manual:

"The engine power conditioning limiting system is intended to limit the gas generator rotor rotational speed versus engine inlet air temperature and pressure with an improved accuracy."

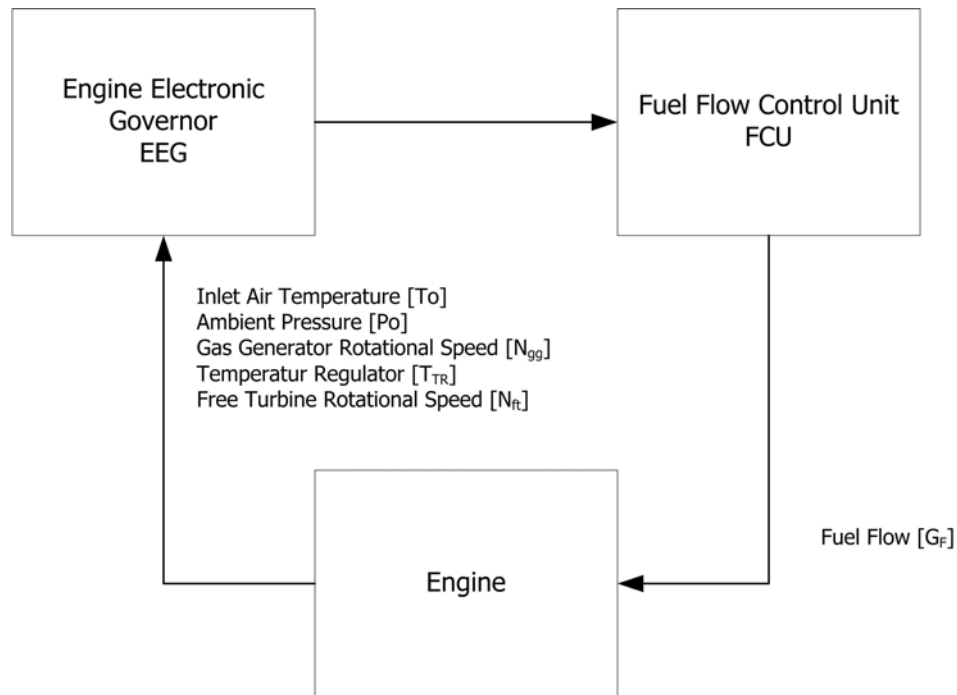


Fig. 2: Block diagram of an engine conditioning limiting system

The nominal rotor speed (N_R) of the KA-32A12 when cruising is 90%; this corresponds to 272.2 rpm.

1.6.6.1 Hydromechanical Controller– system description

The hydromechanical controller (fuel control unit - FCU) regulates the fuel flow to the engine under all operating conditions including startup and shutdown. In addition, the FCU controls the engine's variable guide vanes (VGV). The helicopter's fuel serves as the operating medium. The FCU is mounted laterally on each engine's external gearbox.

The fuel flow to the engine combustion chamber is cut off by means of the engine shutdown actuator.

1.6.6.2 Engine electronic governor EEG – system description

The engine electronic governor EEG is part of the engine conditioning limiting system and acts on the fuel flow control unit actuator and the engine shutdown actuator.

The EEG is responsible for the following functions, among other things:

- limits the gas generator speed (N_{gg}) at maximum take-off power as a function of T_0 and P_0 .
- limits N_{gg} at the 2.5 minute power in the event of an engine failure (OEI) as a function of T_0 and P_0 .
- gas generator speed can be reduced by 4% by means of the turbo compressor switch.
- in the event of a free turbine overspeed, generates a signal which acts on the engine shutdown actuator and the L (R) ENG FT OVERSPEED annunciators.

The EEG consists of the following functional components:

- Electrical power supply (+27 V DC)
- Free turbine overspeed prevention unit (FTOPU)
- Gas generator rotational speed limiting circuit (CC circuit)

1.6.6.3 Free turbine overspeed prevention unit

The free turbine overspeed prevention unit (FTOPU) consists of two identical channels and one test circuit.

In Section 073.15.04 of the engine maintenance manual, this function is described as follows:

"When the rotational speed of the free turbine reaches $118 \pm 2\%$ ¹ the two channels of the FTOPU operate and a command is applied through a power amplifier to the FTOPA actuator (to shut down the engine) and to the L (R) ENG FT OVERSPEED annunciator. Whenever only one of the FTOPU channels operates, the signal is not generated to go to the FT_{OPA}: a command with a self interlock is instead applied to the L (R) ENG FT OVERSPEED annunciator of the channel that has operated.

If the second channel fails to operate in 0.2 s the test circuit generates a command to reset both channels, i.e. to bring them to the initial state. The L (R) ENG FT OVERSPEED signal is therewith removed.

FTOPU Test Mode:

The FTOPU may be tested channel-by-channel or integrally. In testing the FTOPU channel-by-channel TEST 1² or TEST 2 signal is applied to the FTOPU (depending on the number of channels which is intended to be tested). In response to this signal the boundaries of the FTOPU operation range become reduced to $N_{ft} 96 \pm 2\%$ ³: the maximum limit speed in the test mode ($N_{ft\ test}$) is thus lower than $N_{ft\ lim}$.

This makes it possible to check the correctness of operation of the channel in operating the EEG without gaining the $N_{ft\ im}$ speed.

When the FTOPU test selector switch is turned to TEST 1 or TEST 2 position the operation of one of the channels is checked and a signal is applied to the L (R) ENG FT OVERSPEED annunciator. The channel under test becomes therewith self-interlocked. The channel interlock in the TEST mode is removed on elapse of 0.2 s after the selector switch is placed to the OPERATION⁴ position. The FTOPU with FT_{opa} operation and interlock may be tested by placing the selector switch from TEST 1 to TEST 2 position without holding it in the OPERATION position for 0.2 s. The self interlock is in this case removed by de-energizing the engine electronic governor."

¹ On the KA-32A12, a power turbine speed of 118% corresponds to a power turbine speed of 106.2 %.

² TEST 1 and TEST 2 correspond to the designations CIRC 1 and CIRC 2 of the free turbine overspeed test switch on the centre console.

³ On the KA-32A12, a power turbine speed of 96 % corresponds to a power turbine speed of 86.4 %.

⁴ OPERATION corresponds to the OPER designation of the free turbine overspeed test switch on the centre console.

1.6.6.4 Integration in the helicopter

The switches for operation of the EEG are located in the centre console. The hinged flaps are light blue and exhibit no special identification or safeguards. In the closed position, the switches are in the normal position.

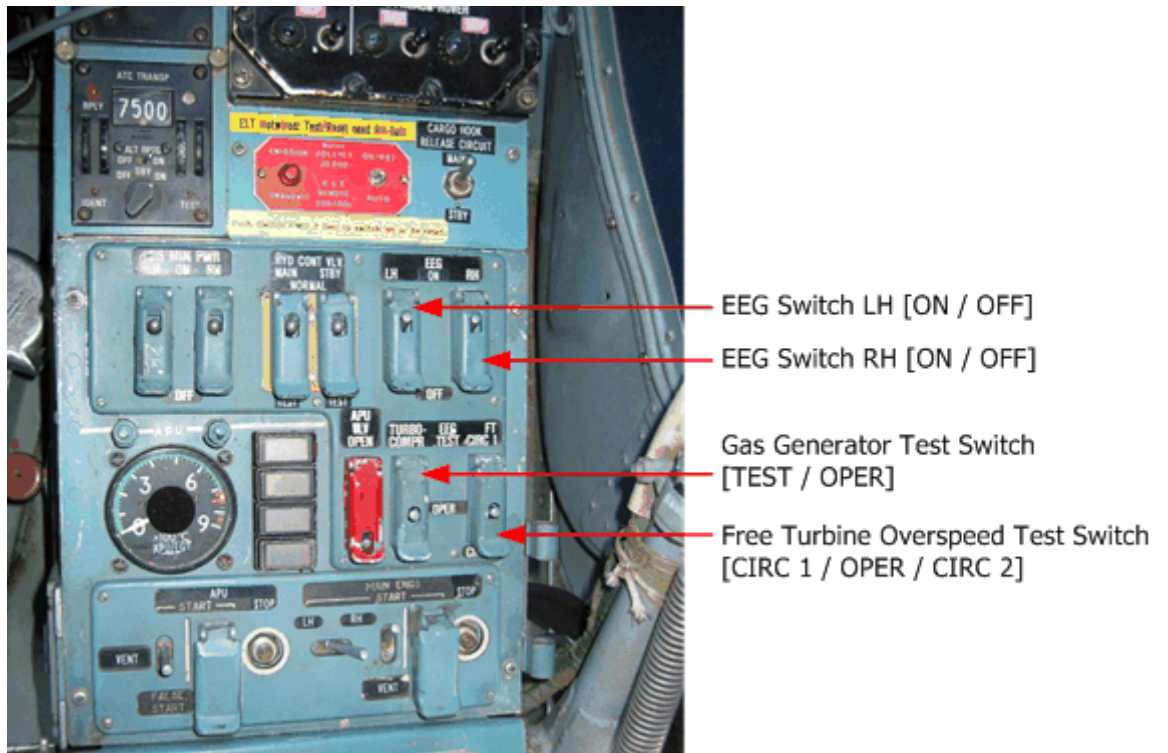
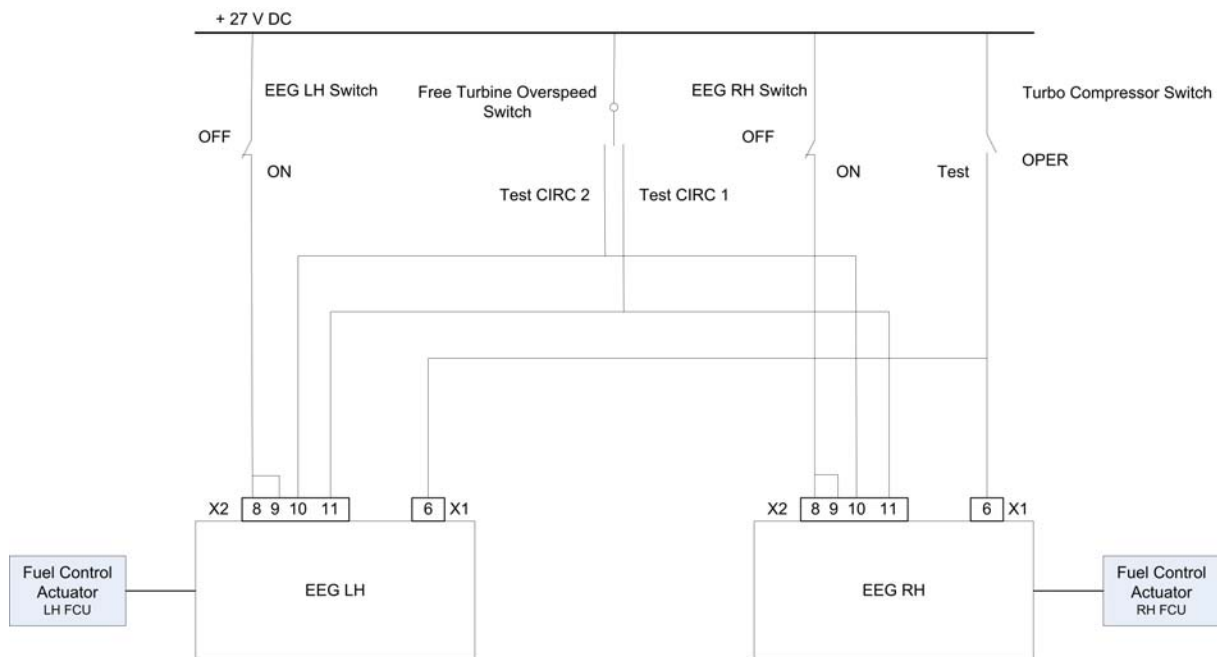


Fig. 3: Lower section of the centre console – layout of switches and their identification

The two engines each have an FCU and an EEG. The free turbine overspeed test switch acts simultaneously on both EEGs.

A simplified electrical schematic of installation of the two EEGs in helicopter HB-XKE is given below:



1.6.6.5 Maintenance regulations

The maintenance instructions (Maintenance Manual 005.20.20) for the Klimov TV3-117VMA engine require the following points, among others, to be checked after a 100-hour inspection:

- Main rotor RPM regulator adjustment
- GG EEG circuit check
- Free turbine circuit check
- Check of the gas generator RPM at take-off and contingency ratings (with GG EEG circuit on)

1.6.7 Engine adjustment procedure

In order to determine the parameters of the hydromechanical controller, the corresponding engine's EEG must be switched off by means of the EEG LH or EEG RH switch. This de-activates the electronic part of the regulation circuit.

Testing of the free turbine overspeed prevention unit takes place on the ground with the engines running. Activation of the test sequence in the air is possible, i.e. it is not prevented by technical means.

1.7 Meteorological information

1.7.1 General

The information in sections 1.7.2 to 1.7.5 was provided by MeteoSwiss.

1.7.2 General weather situation

"A ridge of high pressure extended from the British Isles to the Baltic. A weak 'bise' airflow prevailed on the northern side of the Alps, at the southern edge of this high-pressure area."

1.7.3 Meteorological conditions at the time and location of the accident

The following information on the meteorological conditions at the time and location of the accident is based on a spatial and chronological interpolation of the observations of different weather stations.

Weather/cloud	1-2/8, base at 5500 ft AMSL	
Visibility	about 12 km	
Wind	030°, 8 kt, gusting to 15 kt	
Temperature/dewpoint	+7 °C / -4 °C	
Atmospheric pressure	QNH LSZB 1022 hPa QNH LSZH 1024 hPa	
Hazards	-	

1.7.4 Natural light conditions

Position of the sun	Azimuth: 243°	Elevation: 26°
---------------------	---------------	----------------

Natural light conditions	Daylight
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1.7.5 Aerodrome weather reports

*METAR Berne-Belp (LSZB) aerodrome, 15:20 UTC:
07007 8000 FEW035 08/M03 Q1022 NOSIG =*

1.8 Aids to navigation

Not applicable.

1.9 Communications

Radio communication between the crew and the Berne-Belp aerodrome air traffic controller took place normally and without any difficulties up to the time of the accident.

1.10 Aerodrome information

Not applicable.

1.11 Flight recorders

A BUR-1 flight data recorder (FDR) and a MARS-BM cockpit voice recorder were installed in the tailboom of helicopter HB-XKE.

After the accident, both devices were in their installed position and were externally intact.

1.11.1 Flight data recorder

Type	BUR-1
Parameters	Various analogue and discrete parameters
Recording medium	Analogue, tape loop
Duration of recording	50 ±10 hours

1.11.2 Cockpit voice recorder

Type	MARS-BM
Parameters	Four voice channels
Recording medium	Analogue, tape loop
Duration of recording	Min. 30 minutes

1.11.3 Flight data recorder read-out

The Russian investigating authorities were charged with downloading the data from the flight data recorder and the CVR. Both devices were in good condition.

- The recordings from the flight data recorder could not be analysed because of a device malfunction of which the owner was aware.
- Comprehensibility of the CVR recordings was good and the recordings were complete.

1.11.4 Installation regulations for flight data recorders in Switzerland

The installation of FDR and CVR was not prescribed at the time of the accident.

1.12 Wreckage and impact information

1.12.1 Wreckage

A visual inspection of the wreckage provided no indications of pre-existing defects.

1.12.2 Impact



Fig. 4: HB-XKE in its final position



Fig. 5: Initial traces of contact of the rear landing gear with the terrain

During the landing after autorotation, the helicopter initially came into contact with the terrain with its rear landing gear. Just before it came to a halt, the helicopter tipped to the right and came to rest on its side. The rotor blades hit the ground with high kinetic energy and were destroyed. Externally, the airframe remained largely intact. The front right landing gear was displaced.

1.12.3 Accident site

The accident site was approximately 1 km north-west of Thörishaus on a partially wooded hillside. The terrain sloped slightly and the subsoil in the area of the accident was soft.

Accident location	"Ufem Schoren" municipality of Neuenegg/canton of Berne
Swiss coordinates	592 600 / 194 500
Geographical latitude	N 46° 54' 06"
Geographical longitude	E 007° 20' 29"
Elevation	660 m AMSL 2165 ft AMSL
Location	Approx. 15 km west of Berne-Belp airport
National map of Switzerland	Sheet no. 1166, sheet: Berne, scale 1:25 000

1.13 Medical and pathological information

All three occupants were unharmed.

There are no indications of the crew suffering any health problems.

1.14 Fire

Fire did not break out. The rescue services were able to pump approximately 900 l of fuel out of the tanks.

1.15 Survival aspects

1.15.1 General

The lap and shoulder belts were being worn and withstood the deceleration forces.

The accident was survivable.

The helicopter's very compact construction protected the occupants well.

1.15.2 Emergency transmitter

The helicopter was equipped with a Joliet JE 290-95-00 emergency transmitter (emergency location beacon aircraft – ELBA). The device was installed and was not triggered.

1.16 Tests and research

Not applicable.

1.17 Organisational and management information

1.17.1 Heliswiss AG air operator

The Heliswiss AG company, based in Belp, was founded in 1953 and is active in the passenger and external cargo transport sector. Furthermore, Heliswiss operates a flying school.

A KA-32 has been in operation since 1990. A pilot was available to operate the helicopter. This pilot was on holiday till 7 April 2002. No pilot had yet been assigned for missions from 27.03.2002.

1.17.2 Swiss Helicopter Maintenance AG maintenance organisation

The Swiss Helicopter Maintenance AG (SHM) company was founded in 2001. At the time, among other things, the maintenance organisation of the Heliswiss AG company were integrated into the new company. From this time, maintenance on Heliswiss AG helicopters was carried out by SHM.

1.18 Additional information

1.18.1 Speed limits according to the flight manual

In the flight manual for HB-XKE, the minimum indicated air speed during an autorotation is defined as 100 km/h.

1.18.2 Emergency procedures according to the flight manual

The following procedural instructions in the event of a dual engine failure are defined in the flight manual:

“...

COLLECTIVE - FULL DOWN immediately

Establish autorotative glide at airspeed 100...130 km/h IAS

Turn to the direction of the nearest landing site

Accomplish autorotative landing

If time permits before landing shutdown engines as follows:

Fuel shut-off levers - CLOSE

Fuel shut-off valves - OFF”

The following procedural instructions in the event of an autorotative landing are defined in the flight manual:

“Proceed as follows:

Approach - upwind (if possible)

Establish airspeed 100 km/h IAS at 50 meters altitude

At 50 meters altitude and down to landing perform descent with continuous visual check of height

Landing without running

Accomplish flareout at 50...30 meters altitude depending on the approach speed as follows:

CYCLIC –pitch angle of up to 25 degrees

COLLECTIVE – UP to 2/3 of full travel

Maintain pitch angle up to complete deceleration at up to 3 meters height

At 3 meters height CYCLIC apply forward to achieve landing attitude

NOTE

Pitch angle is limited for landing 10 degrees maximum

Pitch angle is limited for ditching 15 degrees maximum

Simultaneously COLLECTIVE – UP to the upper stop

Accomplish landing on the main wheels with minimum forward speed and rate of descent

.....

Running landing

Accomplish flareout at 50...30 meters

CYCLIC smoothly nose up to achieve landing attitude (pitch 8...10 degrees) at 1...1,5 meters height

At 1...1,5 meters height COLLECTIVE – FULL UP, if required to land smoothly on the main wheels with minimum forward speed and rate of descent

During running at speed 40 km/h

COLLECTIVE – move smoothly to the lower stop

....”

1.18.3 Time requirement for re-starting an engine

Extensive manipulations have to be carried out to start an engine after a dual engine failure. Among other things, it is essential to start the auxiliary power unit (APU) beforehand. This process takes about 13 seconds. The APU should then be established for one minute. The engine start is then initiated. The engine start is concluded after approximately 36 seconds.

If the engine power lever is moved in 1 – 2 seconds from the idle position to the start (FT) position, acceleration times of approximately 8 seconds result. The power build-up which is possible from this moment requires an additional few seconds.

The time required for the entire sequence is therefore at least one minute, this under the condition, that the APU will not be stabilised for the duration of one minute.

1.19 Useful or effective investigation techniques

Not applicable.

2 Analysis

2.1 Technical aspects

2.1.1 General

The helicopter made its first flight after the 100-hour check on 25.03.2002. No release for test flight was generated for this flight. The only outstanding point was the adjustment of the engine limiter for the right engine.

The two step release-procedure with

a) *Release for testflight only*

b) *Release to service*

was not yet introduced by SHM at the time of the accident.

The helicopter was released for flight operations on the same day with the release to service.

Checking of engine adjustment for this helicopter is specified in the manufacturer's maintenance manual. Since the adjustments are made iteratively, the number of technical flights required varies.

Apart from the area of the engine speed regulation system, there are no indications of any pre-existing technical faults which might have caused the accident.

2.1.2 Availability of FDR and CVR

An FDR and CVR were installed in the helicopter. There were no FOCA regulations in this regard. It was possible to analyse the CVR without any problems and this provided very useful information. Unfortunately, analysis of the FDR was not possible for technical reasons. The AAIB considers it inappropriate that such systems are not maintained in operating condition.

2.1.3 Availability of the engine speed regulator during the flight involved in the accident

Both the hydromechanical and electronic engine speed controllers were available for both engines.

2.1.4 Technical explanation of the dual engine failure

In order to be able to test the right engine hydromechanical controller, the flight instructor intended to operate the EEG RH switch, thereby switching off the electronic controller. Because of confusion, the free turbine overspeed test switch, which is located in the same column of switches but one row further back, was operated.



The photo shows the intended operation of the EEG RH switch.



The photo shows the operation of the free turbine overspeed test switch which was actually carried out.

It could not be established whether the switch was initially brought to the CIRC 1 or CIRC 2 position. By analogy, as this position corresponds to the OFF position on the EEG RH switch, it can be assumed that the test sequence for CIRC 2 was activated first. When this was done, the test logic reduced the threshold for the power turbine speed N_{tttest} to 86.4 % on channel 2. At this time, the helicopter was cruising at a rotor speed, or power turbine speed respectively, of approxi-

mately 90%. Thus the condition for a power turbine overspeed was fulfilled for channel 2. The L ENG FT OVERSPEED and R ENG FT OVERSPEED warning lamps and the associated audio warning were activated. The effective rotor speed was not yet changing at this point in time.

Evidently the audio warning and warning lamps alarmed the flying instructor upon which, as an immediate reaction, he brought the free turbine overspeed test switch to the CIRC 1 position via the OPER position. This procedure took less than 0.2 seconds. Subsequently, the automatic test logic reduced the threshold for the power turbine speed N_{fttest} to 86.4 % on channel 1. At this moment, on both channels of the right and left EEG, the conditions for an assumed power turbine overspeed were met and the corresponding signals were generated to the engine shutdown actuator of the left and right engines. Both engines cut out immediately.

2.2 Human and operational aspects

Both the statements of the crew and the content of the CVR indicate that the examination flight was taking place in a calm and pleasant atmosphere.

The combination of the type rating examination flight and the technical engine test was unfavourable.

Having completed the type rating examination flight, time remaining to approach waypoint "HW" was short. The necessary manipulations for the engine controller test were carried out by the flight instructor under pressure of time. He normally carries out these flights and manipulations from the left-hand seat. An essential safeguard was not present by the absence of identification and protection of this very sensitive switch. In addition, there was no technical suppression of this test function to activate it only during ground runs.

An attempt to re-start the engines in flight was not possible. In addition the crew had correctly themselves concentrated on carrying out the autorotation.

The autorotation was carried out on the final approach at somewhat over 100 km/h. The AFM envisages two variants for landing. On the one hand a running landing and on the other a landing at a slow forward speed. The terrain did not provide any opportunity to make a running landing. The landing therefore had to take place after a flare at a low forward speed. In the process, because of its aerodynamic configuration, the helicopter loses control authority around the vertical axis. In the autorotative state, control of the helicopter about the vertical axis using differential torque is not possible. As long as there is sufficient forward speed, control is effected using the rudder. The 'bise' wind and above all the weak soil contributed to the helicopter tipping over to the right after the first touch down. Despite the material damage, the autorotation can be described as successful.

It was a fortunate coincidence that during the test the pilot had carried out an autorotation with subsequent go-around some six minutes previously, especially in view of the fact that training on autorotations on twin-engined helicopters is provided only rarely.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- The helicopter was licensed for day/night VFR operation, special category „restricted“.
- Both the mass and centre of gravity of the helicopter were within the permitted limits at the time of the accident according to the AFM.
- Apart from the engine speed regulation system, there are no indications of any pre-existing technical faults which might have caused or influenced the accident.
- The last 100-hour check on airframe and engines was certificated on 25.03.2002 and the helicopter was released for flying operations.
- The last airworthiness inspection by the FOCA took place on 10.08.2001.

3.1.2 Crew

- The pilots were in possession of the necessary licences for the flight.
- There were no indications of the pilots suffering any health problems during the flight involved in the accident.

3.1.3 History of the flight

- At 15:22 on 26 March 2002, the twin-engine Kamov KA-32A12 helicopter took off from Berne-Belp aerodrome on a type rating flight. On board were the pilot, in the left-hand seat, the flying instructor in the right hand seat and the examiner from the Federal Office of Civil Aviation in the observer's seat.
- On the return flight, at approximately 16:11, the flying instructor carried out preparatory manipulations for a technical engine test. When he did so, both engines cut out almost simultaneous.
- The free turbine overspeed test switch was erroneously operated instead of the EEG RH switch. The two switches are located in the same column of switches, one row apart. The switches were not secured or specially marked.
- The pilot then initiated an autorotation and landed in a field. On landing, the helicopter tipped onto its right side. The aircraft was severely damaged. The occupants were unharmed.

3.1.4 General conditions

- The flight was carried out as a combined type rating examination and flight test flight.
- Vital switches in the cockpit are not marked and secured.
- Activation of the free turbine overspeed prevention unit test sequence is possible in the air, i.e. it is not prevented by technical means.

3.2 Causes

The accident is attributable to the almost simultaneous shutdown of both engines because of confusion over a switch. After the autorotation, the helicopter tipped over on its right side after landing.

The following factors contributed to the accident:

- the combination of a type rating flight with a technical flight
- inappropriate ergonomics of the free turbine overspeed test switch and the gas generator test switch
- a lack of technical safeguards

4 Safety recommendations and measures taken since the incident

4.1 Safety recommendations

4.1.1 Safety deficit

On the afternoon of 26 March 2002 the twin-engine Kamov KA-32A12 helicopter HB-XKE took off from Berne-Belp aerodrome on a type rating examination flight. On the return flight, the flight instructor carried out a technical engine test. When he did so, both engines cut out, almost simultaneous. The pilot then initiated an autorotation and landed in a field. On touchdown, the helicopter tipped onto its right side. The aircraft was severely damaged. The occupants were unharmed.

The free turbine overspeed test switch was erroneously operated instead of the EEG RH switch. The two switches are located in the same column of switches, one row aft. The switches were not secured or specially marked. Activation of the free turbine overspeed prevention unit test sequence is possible in the air, i.e. it is not prevented by technical means. There is a lack of technical safeguards.

4.1.2 Safety recommendation no. 256 (previous 46) with interim report dated 2 May 2002

The following safety recommendation was transmitted to the FOCA in a letter on 2 May 2002:

We recommend to the FOCA:

that the N2 overspeed protection device switch (overspeed test switch) and the compressor test switch (N1 limiter test switch) be examined with regard to their function, risk assessment, safeguarding and coloration and that the necessary measures be taken.

4.1.3 FOCA comment dated 17 May 2002

“Upon examination of the relevant requirements according to FAR 29, in particular: 29.777, 29.901, 29.903, 29.927 and 29.1353 we consider the immediate measures according to the method of resolution proposed by the Heliswiss company to be acceptable as an interim solution.

Electrical de-activation of the test circuit in flight operation, as is currently being discussed with the manufacturer – according to the statement by Mr X – is accepted by the FOCA as a mid-term solution.

The protective arrangement for the N2 overspeed test switch and the N1 limiter test switch had already been discussed after the accident with Mr X by the FOCA inspectors for airworthiness and registers (LT).

Apparently there had already been such proposals internally at Heliswiss before the accident, but unfortunately they were not implemented.

Prior to commissioning of the helicopter after repair, the switches must be identified with red paint and guarded.”

4.1.4 Safety recommendation no. 256 to the European Aviation Safety Authority EASA

The Swiss AAIB makes the application, that the free turbine overspeed test switch and the gas generator test switch in relation to their function, risk analysis, safety device and colouring have to be verified and the necessary measures have to be taken.

In particular it has to be guaranteed technically, that an unintentional activation of these test sequences is not possible during flight.

4.2 Measures taken since the accident

4.2.1 Interim modifications of the switches by Heliswiss AG

To date, the helicopter manufacturer has only, by means of a drawing, recommended to mark the test switches in yellow-black colour. Further measures have not been made.

The keeper has marked and protected the gas generator test switch and the free turbine overspeed test switch (see Annex 2).

Berne, 9 September 2008

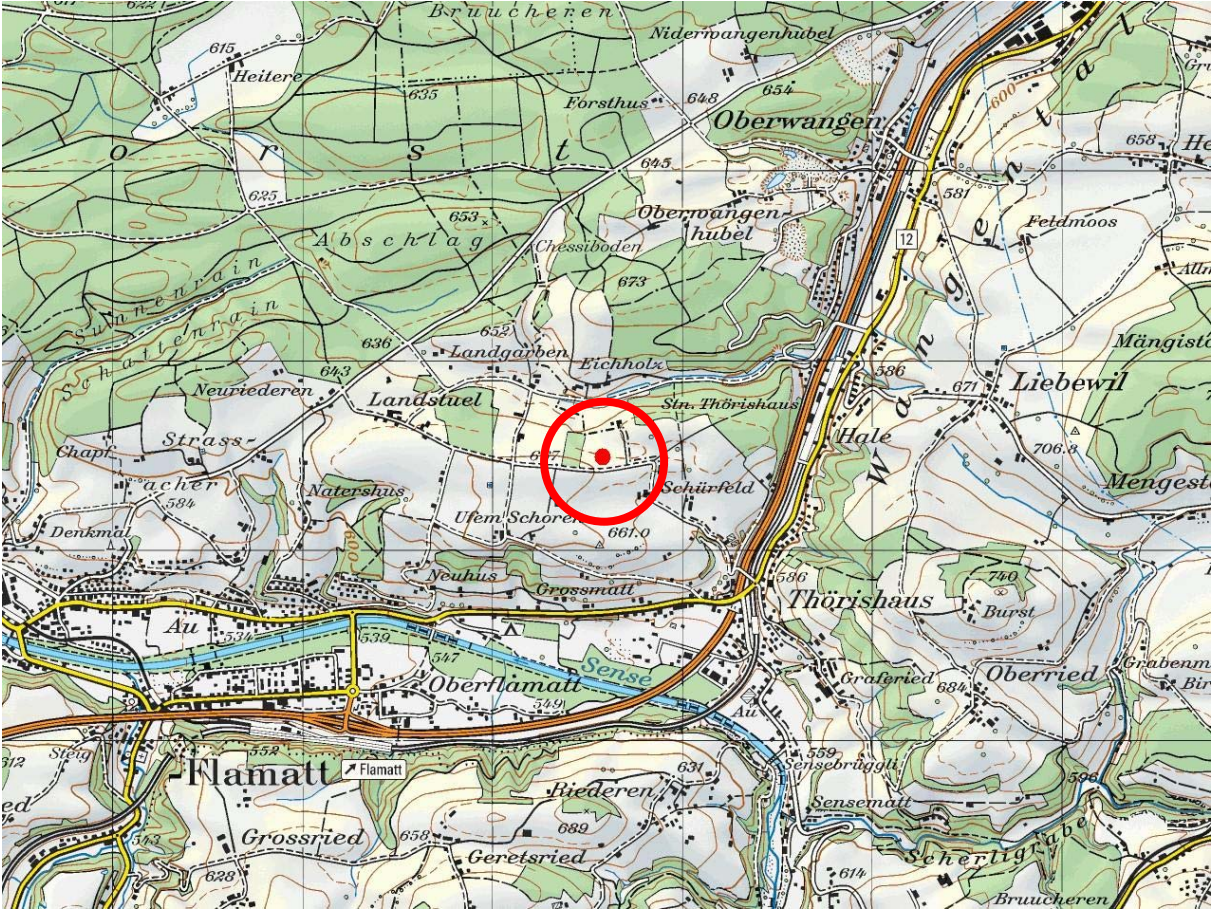
Aircraft Accident Investigation Bureau

This report contains the AAIB's conclusions on the circumstances and causes of the accident which is the subject of the investigation.

In accordance with Annex 13 of the Convention on International Civil Aviation of 7 December 1944 and article 24 of the Federal Air Navigation Law, the sole purpose of the investigation of an aircraft accident or serious incident is to prevent future accidents or serious incidents. The legal assessment of accident/incident causes and circumstances is expressly no concern of the accident investigation. It is therefore not the purpose of this investigation to determine blame or clarify questions of liability.

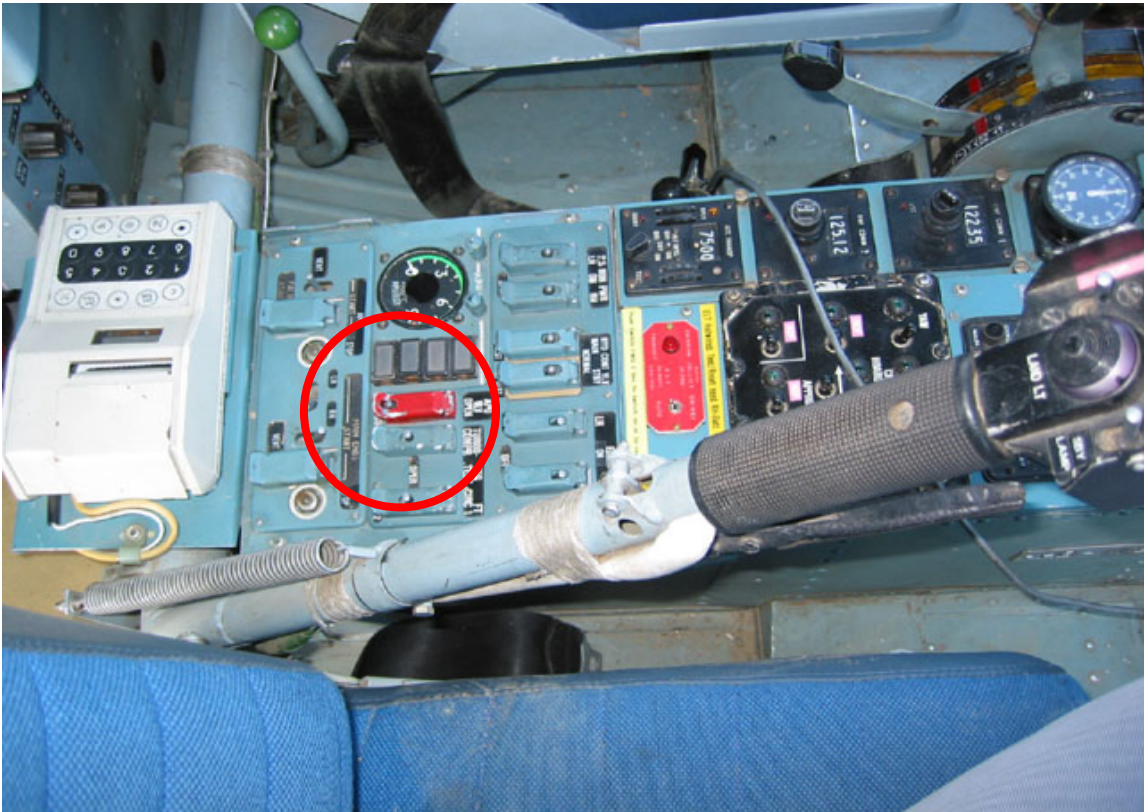
If this report is used for purposes other than accident prevention, due consideration shall be given to this circumstance.

Annex 1



Accident location "Ufem Schoren"

Annex 2



Centre console before the modification from the viewpoint of the pilot in the right-hand seat.



Centre console after the modification from the viewpoint of the pilot in the right-hand seat. The enlarged extract shows the detail of the modification.