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Aircraft accident investigation bureau AAIB

Final Report No. 1921 by the Aircraft Accident Investigation Bureau

concerning the accident

involving helicopter K-1200 K-MAX, HB-ZEH

on 29 July 2003

"Trute", municipality of Frutigen/BE, approx. 45 km SSE of Berne

Bundeshaus Nord, CH-3003 Berne

Ursachen

Der Unfall ist mit grösster Wahrscheinlichkeit auf eine unkontrollierte Öffnung der unteren Lastenklinke aufgrund deren mangelhaften Auslegung zurück zu führen. Dadurch fiel die Last zu Boden und verletzte eine Drittperson tödlich.

Zum Unfall haben beigetragen:

- Der Zertifizierungsprozess der Lastenklinke war den Anforderungen im Flugbetrieb nicht angepasst.
- Der Abladeplatz war mit einem betriebseigenen Flughelfer personell unterbesetzt.
- Die Organisation auf dem Abladeplatz wurde durch externe Helfer für den Flughelfer erschwert und unübersichtlich.
- Die Kommunikation war mangels Funkausrüstung der Dritthelfer erschwert.

General Information on this Report

This report contains conclusions by the AAIB 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/serious incident causes and circumstances is expressly no concern of the 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.

Unless otherwise indicated, all times in this report are indicated in Swiss local time (LT), corresponding at the time of the accident to Central European Summer Time (CEST). The relationship between LT, CEST and universal time co-ordinated (UTC) is as follows: LT = CEST = UTC + 2 h.

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

Final Report

Owner	Kaman Aerospace Corp., US-CT 06002 Bloomfield, USA
Keeper	Eagle Helicopter AG, 3770 Zweisimmen
Aircraft type	K-1200
Country of manufacture	USA
Country of registration	Switzerland
Registration	HB-ZEH
Location	"Trute", municipality of Frutigen/BE, approx. 45 km SSE of Berne
Date and time	29.07.2003, 08:42

General

Brief description

On Tuesday, 29 July 2003, a helicopter company was engaged in logging operations in the Frutigen area. Tree trunks were being flown out of the forest by helicopter and deposited on the drop zone of the landing area. On the approach to the landing area shortly before 08:45, the cargo hook opened. A third party was fatally injured by a falling trunk.

Investigation

The investigation was opened on the day of the accident together with the Berne cantonal police.

The accident is with a very high degree of probability attributable to an uncontrolled opening of the lower cargo hook because of its defective design. As a result, the load fell to the ground and fatally injured a third party.

The following factors contributed to the accident:

- The cargo hook certification process was not suitable for the flight operation requirements.
- The landing area was undermanned, with one flight assistant from the company.
- Organisation on the landing area was made more difficult, and impossible to oversee, for the flight assistant because of external helpers.
- Communication was made difficult for the external assistants because of the lack of radio equipment.

1 Factual Information

1.1 Pre-flight history and history of flight

1.1.1 Pre-flight history

Flying operations had already been carried out on 8 July 2003 for the same customer at the same location (logging). This task was carried out by the Eagle Helicopter AG company; on this occasion the pilot involved in the accident was also working with HB-ZEH.

1.1.2 History of flight

On the morning of 29 July 2003, the Eagle Helicopter AG company was engaged in logging operations on the "Trute" near Frutigen. Tree trunks were being flown out of the wood by helicopter and deposited on the drop zone of a central landing area. As a result of a break in an electric cable, the longline was changed after the third round trip. The lower cargo hook continued in use. The subsequent round trip was uneventful.

At approximately 08:42, the pilot was making his fifth approach to the landing area. A turn of two tree trunks were suspended vertically with chokers from the lower cargo hook and its longline respectively. The flight assistant gave the pilot height information over the radio. He warned the pilot over the radio: "Look out, fence, pull left". As the two trunks impacted forcefully on the ground, they gouged approximately 30 cm into the terrain and broke in two. The lower cargo hook opened in an uncontrolled manner. The two trunk sections still suspended in the hook then fell to the ground. As they did so, an assistant was struck so hard by a tree trunk section that he later died from his injuries.

The fatally injured assistant did not belong to the helicopter company or the forestry company and was not wearing a safety helmet. The persons present on the landing area were the company's own flight assistant, a forest ranger as loader[1] operator, and other persons.

The pilot asserted that he had not operated the catch.

1.2 Injuries to persons

	Crew	Passengers	Third parties
Fatally injured	---	---	1
Seriously injured	---	---	---
Slightly injured or uninjured	1	---	

1.3 Damage to aircraft

The helicopter was not damaged.

[1] Excavator-type machine with a gripper arm for handling trunk wood

1.4 Other damage

Minor damage to cultivated land.

1.5 Personnel information

1.5.1 Pilot

Person	Swiss citizen, born 1963
Licences	Commercial pilot's licence for helicopter, issued by the Federal Office for Civil Aviation FOCA on 10.08.1989, validity: 04.03.2004
Ratings	Radiotelephony VFR Night flying, helicopter Mountain landing
Registered aircraft classes	Helicopter
Registered aircraft types	ALIII, AS350 types, K-1200, R22, SA315
Medical fitness certificate	Class 1
Last medical examination	14.07.2003 Findings: fit to fly

1.5.1.1 Flying experience

Total	6651:45	hours
on K-1200	246:38	hours
during the last 90 days	203:35	hours all on K-1200

1.5.2 Assistant involved in the accident

Swiss citizen, born 1980

No flying experience

1.6 Aircraft information

Type	Kaman K-1200 / K-MAX
Characteristics	Single-seater transport helicopter
Year / serial No.:	1994 / A94-0014
Turbine	Textron Lycoming Div. T5317A-1; S/N LE07768C
Rotor	Intermesher. The K-1200 has two rotors each consisting of two rotor blades, which are mounted laterally on separate masts and with a phase difference of 90°. Seen from above, the rotors turn in opposite directions. Both rotors are mounted on individual shafts and driven by a common transmission. Since the rotors turning in opposite direction cancel their torques, this helicopter does not require a tail rotor.
Equipment	Belly cargo hook with weighing system. The mass of the last load flown was 4975 lbs (2257 kg). Cargo hook: Canam C60, serial number 6097, mounted on a longline approx. 50 m long.
Certification	Commercial use VFR by day, issued by the FOCA on 04:11:02.
Operating hours	Airframe: 5957 hours Engine: 6102 hours
Mass and centre of gravity	Were within the prescribed limits.
Airworthiness certificate	Issued by the FOCA on 12.09.2002.
Maintenance	Last 50 hour check carried out on 21.07.2003 at 5906.2 hours. According to the aircraft log, the LTA 99-643 and a pre-flight check were carried out on the day of the accident.
Fuel	No fuel sample was analysed.
Flight time reserve	Approx. 30 minutes

1.6.1 Brief description of the Canam C60 cargo hook

The product in question is a lower or remote cargo hook manufactured by Canam Aerospace Inc. in Canada. The Canam C60 type cargo hook was designed for use on the longline and was designed for loads up to 6000 lbs (2721 kg). The cargo hook can be released manually or electrically by means of a solenoid. The cargo hook was equipped with a protective cage (wrap around).

Figure: Lower cargo hook with two suspended “choker cables”

1.6.1.1 Method of operation of the Canam C60 cargo hook

The cargo hook is equipped with an interlock. This has the following main elements:

- interlocking mechanism (hinged closure)
- safety catch with tension spring
- load beam with locking mechanism

“Closed” mode	“Open” mode
In this mode the load beam is locked in position by the safety catch. This in turn is locked by the hinged closure and secured by the leg spring.	By manually rotating the red knob on the catch housing or by means of electrical control of the solenoid, the release is rotated and the hinged closure is unlocked; as a result, the safety catch releases the load beam.
	

1.6.2 Certification of the Canam C60 / No. 6097 / 6000LBS cargo hook

According to information from the manufacturer, the cargo hook was subject to the US Federal Aviation Regulations (FAR). The FAR § 27.865ff external loads regulation was applied and the cargo hook was tested in relation to the criteria required therein.

Regulation FAR 27.865ff essentially places the safety of the helicopter in the foreground as the highest priority: in extreme situations, in which a helicopter may be in danger, it must be possible to jettison, or rather release, the load.

The cargo hook was accepted by Canam Aerospace Inc. on 29.11.01 in accordance with FAR 27.865ff. In the process, the following inspections were carried out:

- inspection of the assembly of the cargo hook
- inspection of the electrical connection and all components
- a static load check
- "100 cycle test": guaranteed opening of the cargo hook (electrical control) under various loads
- vibration test (not further specified)

According to the test records, these tests were passed and the load catch was approved in accordance with FAR 27.86ff.

1.6.3 Approval criteria in Switzerland

1.6.3.1 STEG, STEV and machinery directive

The STEG (Bundesgesetz über die Sicherheit von technischen Einrichtungen und Geräten – Federal Law relating to the Safety of Equipment and Appliances) is the federal law concerning the safety of technical equipment and devices. Among other things, it regulates the placing on the market of technical equipment and devices.

In relation to the STEG, there is a decree on the safety of technical equipment and devices (STEV). For lifting gear, this refers to the EC machinery directive 89/392/EEC.

1.6.3.2 Competencies

The cargo hook was classified among load-bearing devices and load-bearing means. Competency is regulated as follows in the flight assistant syllabus (para. 3.2.1):

load-bearing equipment and means of lifting persons for transport of persons and personal safety devices are subject to the STEG.

An accredited certification agency can issue type approvals or type certificates.

Comment by the FOCA on the certification of cargo hooks:

*„**1. Gesetzliche Anforderungen (Luftrecht/STEG) für den Einsatz von ‚External load attaching means, (Lastenklinken etc.)***

Gemäss Art. 3 der Verordnung über das Luftfahrzeug-Unterhaltspersonal (VUP; SR 748.127.2) werden abwerfbare Aussenlasten, die ausschliesslich dem Materialtransport dienen, nicht als Luftfahrzeugteile definiert. Daher werden diese Komponenten (z.B. Remote-Sekundär Lasthaken an der Longline für „logging"), welche am Primär-Lasthaken angehängt werden auch nicht durch das BAZL zertifiziert.

Sämtliche Lastaufnahmemittel für den Personentransport (Rettungs- & Arbeitseinsätze) müssen hingegen durch das BAZL zertifiziert bzw. durch ein Zulassungsverfahren bezüglich Sicherheit geprüft werden (TM 50.605-20 Draft Ausgabe 3).

Geräte wie z.B. Remote Lasthaken werden allerdings vom Geltungsbereich des Bundesgesetzes über die Sicherheit Technischer Einrichtungen und Geräte (STEG; SR 819.1) erfasst. Gemäss Art. 2 der Verordnung über die Sicherheit Technischer Einrichtungen (STEV, SR 819.11), welche auf EG Maschinen Richtlinien (98/37) Anhang 4 verweist, sind Helikopter Lasthaken nicht prüfpflichtig (werden also nicht durch eine akkreditierte Stelle geprüft). Jedoch muss der Hersteller die grundlegenden Sicherheits- und Gesundheitsanforderungen gemäss Anhang I erfüllen. Er muss somit eine technische Dokumentation erstellen (Risikoanalyse, Festigkeits-Berechnungen, Zeichnungen, Betriebs- und Wartungsanleitung).

Europäische Normen (EG-Richtlinie) enthalten als „Regeln der Technik" Lösungsvorschläge, sie haben jedoch nach der Maschinenrichtlinie, welche den „Stand der Technik" fordert, nur unverbindlichen Vermutungscharakter.

Trotzdem sollte nicht unbeachtet bleiben, dass bei einem Vorfall Rückschlüsse auf eventuelle Verantwortlichkeiten des Operators/Herstellers gemacht werden können, sofern diese Richtlinien nicht eingehalten werden. Aus diesem Grunde ist die Empfehlung zweckmässig, dass der Operator bei der Beschaffung solcher Komponenten (Lastenklinken etc.) darauf achtet, vom Herstller eine entsprechende Konformitätserklärung zu fordern.

2. Zertifizierung der Lastenklinken

Lasthaken („primary hook" direkt am Heli) sind zulassungspflichtig und werden normalerweise durch den TC Holder zusammen mit dem Helikopter Typ oder auch als STC zertifiziert. Für Neuzulassungen sind die heutigen Anforderungen (CS 27 & 29 sowie FAA AC 27-1B & AC 29-2C) massgebend (insbesondere ist eine eingehende FMEA Analyse verlangt).

Wenn ein („primary") Lasthaken als „remote-hook" an der „longline" z.B. für „logging" eingesetzt wird, entspricht der Einsatz (Lasten durch Schläge, die im Betrieb auftreten) nicht mehr dem Einsatzspektrum, für welches der Haken ursprünglich zertifiziert wurde.

Ausserdem ist davon auszugehen, dass die heute im Einsatz verwendeten „remote"-Lasthaken damals nicht durch eine Behörde zugelassen wurden."

Translation:

1. Legal requirements (Air Law/STEG) for the use of 'external load attaching means' (cargo hooks, etc.)

According to Art. 3 of the Decree relating to aircraft maintenance personnel (VUP; SR 748.127.2) external loads which can be dropped, serving exclusively the transport of material, are not defined as parts of an aircraft. Consequently, these components (e.g. remote secondary cargo hooks on the longline for logging), which are hooked to the primary cargo hook are not subject to certification by the FOCA.

All load-attaching means for the transport of persons (rescue missions and work applications), however, must be certificated by the FOCA respectively tested for safety by an approval procedure (TM 50.605-20 Draft Issue 3).

Devices such as remote cargo hooks are nonetheless included in the scope of the Federal Law relating to the Safety of Technical Equipment and Appliances (STEG; SR 819.1). According to Art. 2 of the Decree relating to the Safety of Technical Equipment (STEV, SR 819.11), which refers to the EC Machinery Directive (98/37) Annexe 4, helicopter cargo hooks are not subject to testing (and are therefore not tested by an accredited agency). However, the manufacturer must fulfil the basic health and safety requirements as per Annexe 1. He must therefore provide technical documentation (risk analysis, strength calculations, drawings, operating and maintenance instructions).

European standards (EC directives) include as "Engineering Rules" proposals for solutions; however, according to the Machinery Directive, which demands the "state of the art", they have only the non-binding character of a presumption.

However, it should not be disregarded that in the event of an incident inferences may be drawn regarding possible liabilities of the operator/manufacturer, in so far as these regulations are not complied with. For this reason it is appropriate, that the operator, on acquiring such components (cargo hooks, etc.), should ensure that he requests a corresponding declaration from the manufacturer.

2. Certification of cargo hooks

Cargo hooks ("primary hook" directly on the helicopter) are subject to approval and are normally certificated by the TC holder together with the helicopter type or are certificated as STC. For new approvals, the current requirements (CS 27 & 29 plus FAA AC 27-1B & AC 29-2C) apply (in particular, a detailed FMEA analysis is required).

When a (primary) cargo hook is used as a remote hook on the longline, e.g. for logging, the application (loads subject to impacts which occur in use) no longer corresponds to the spectrum of use for which the hook was originally certificated.

Furthermore, it must be assumed that the "remote" cargo hooks currently in use were not approved at the time by any authority.

1.7 Meteorological information

1.7.1 General weather situation according information from MeteoSwiss

A high-pressure area extended as far as eastern Switzerland and determined the weather. On the ground, there was a light northerly 'bise' wind.

1.7.2 Weather at the time and location of the accident

The following information on the weather at the time and location of the accident is based on a spatial and chronological interpolation of the observations of different weather stations. These interpolations were carried out by MeteoSchweiz.

Weather/cloud	3-5/8, base approx. 7500 ft AMSL	
Visibility	about 30 km	
Wind	north wind at 1-2 kt, gusting to 5 kt	
Temperature/dewpoint	+ 13 °C / + 9 °C	
Atmospheric pressure	QNH 1026 hPa	
Hazards	None	
Position of the sun	Azimuth: 77°	Elevation: 14°

1.7.3 Measured values by the Adelboden weather station

Adelboden weather station 1320 masl

Time:	06:40
Temperature:	12 °C
Dew point:	9 °C
Wind direction	153°
Wind speed:	1 kt
Peak wind speeds:	3 kt

1.8 Aids to navigation

Not applicable.

1.9 Communication

Radio communication between the pilot and his flight assistants from the helicopter company took place normally and were not recorded. The assistant involved in the accident was not equipped with a radio.

1.10 Aerodrome information

Not applicable.

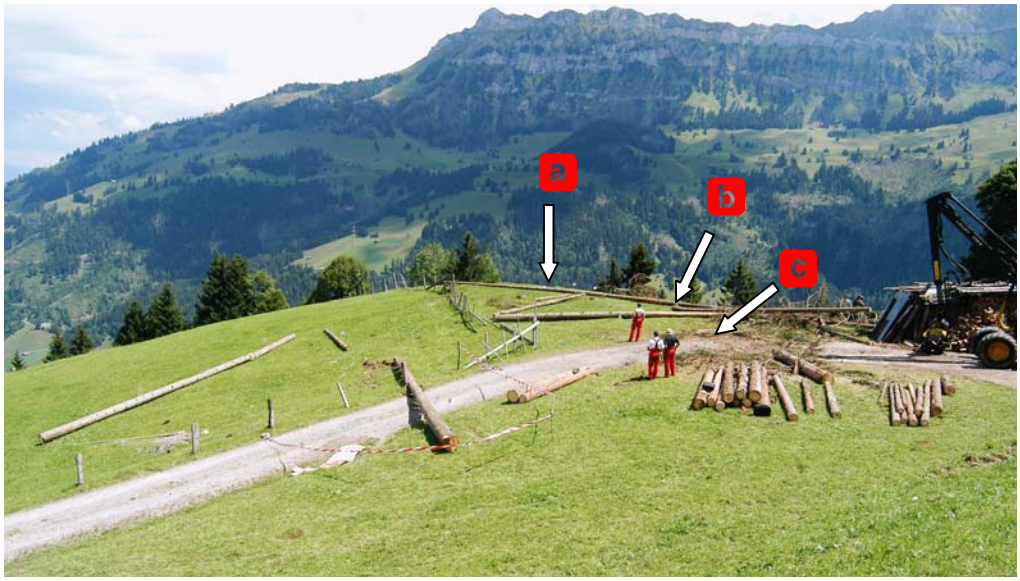
1.11 Flight recorders

Not applicable.

1.12 Wreckage and impact information

1.12.1 The site of the accident

The site of the accident was on a knoll in the vicinity of a farmhouse. The timber was being placed at the side of an access road.



General view of the site of the accident

a) Contact points of the trees
b) Flight assistant
c) Assistant (location of victim)

Coordinates: 615 907 / 156 759

Elevation of the site of the accident: 1236 masl

Sheet No. 1247 of the national map of Switzerland 1:25 000 Adelboden

1.12.2 Wreckage

The helicopter was not damaged.

1.13 Medical and pathological information

There are no indications of the pilot suffering any health problems during the flight involved in the accident.

The assistant who was fatally injured was examined in an institute for forensic medicine.

Results of the chemical/toxicological analysis:

- blood alcohol concentration at the time of the event: negative
- no concrete indications of the consumption of centrally effective drugs or of misuse of medicines.

The assistant died as a result of the injuries he had suffered.

1.14 Fire

Fire did not break out.

1.15 Survival aspects

With the exception of the group leader, the assistants were not wearing helmets.

According to the forensic examination, the internal injuries of the person involved were so serious that even the wearing of a helmet would not have been able to prevent death.

1.16 Tests and research

1.16.1 Initial examination of the lower cargo hook / longline / helicopter

The examinations carried out on the longline and the choker cables showed that both the longline and the choker cables were in a satisfactory condition.

The investigations which were carried out in connection with the electric cargo hook control operated from the helicopter showed that the cargo hook controls in the helicopter and the values measured in the electrical system were in a satisfactory condition or were within the tolerances laid down in the manual Moreover, the operation of mobile telephones and radios, or rather their electromagnetic radiation in the immediate vicinity of the catch solenoid, did not cause the cargo hook to open independently.

Blows from a sledgehammer, applied from above and from the side to the protective cage including the cargo hook did not open the cargo hook.

Dismantling the cargo hook and visual examinations showed that mechanical changes (traces) such as notches, fractures, cracks, dents, deformation, displaced springs, etc. could not be found. Nor could any distinctive marks be found on the catch solenoid, which was disassembled as far as was possible.

The end of the tension spring was shortened by the appropriate mechanic on the occasion of a check on the hook, in order to prevent slippage from the related lug on the safety lever.

The slightly increased spring tension due to the repair of the tension spring can be discounted as it has no effect on uncontrolled independent opening of the cargo hook.

Other scenarios, such as operation of the rotary knob of the catch due to branches penetrating the gaps in the protective cage or the cargo hook not being closed correctly initially, are out of the question.

In summary, the investigations which were carried out indicated that the material being used was in a satisfactory condition and that no malfunctions and/or defects could be found on the longline concerned.

1.16.2 Theoretical considerations

In normal operation, the catch is statically loaded predominantly in the vertical or near vertical direction. In addition to this load, dynamic loads apply:

- when the load is lifted
- during flight (oscillating load)
- when the load is deposited

These dynamic loads – as well as impacts and blows – are of unknown magnitude and may act in different directions. It is conceivable that during the depositing of two or more tree trunks the choker cable of one trunk stresses the cargo hook in a direction which deviates considerably from the vertical.

This might occur if, for example, two suspended tree trunks collide when they are deposited and the choker cable which has become loose hits the cargo hook in an oblique direction (like a whiplash). This powerful blow would generate a high dynamic load on the cargo hook for a relatively short duration.

An investigation was carried out as to how the locking mechanism of the cargo hook reacts to different dynamic loads which are possible in practical use. In particular, it was examined whether the catch is opened as a result of any blows or impacts on the cargo hook or as a result of lateral and/or rotational acceleration of the hook.

On the basis of the calculations made in the preceding hypothesis, it can be assumed with a high degree of probability that as a result of a sudden impact force acting at a specific angle, the catch can become unstable and open.

1.16.3 Laboratory test

For the test, the Canam C60 cargo hook was suspended from a weak spring. A 16.5 m long steel cable 8 mm in diameter was suspended from the hook and a dead stop was situated at the bottom end of the freely hanging cable. A drop-weight with a mass of 19 kg could be lifted from the dead stop and released to strike the dead stop with greater or lesser force, depending on the drop height; in the process:

- the cable was stretched
- the drop-weight was decelerated
- the cargo hook was accelerated downwards

If the suspension point and the centre of gravity of the cargo hook were in line with the cable, in the test the cargo hook was accelerated straight down.

When the cargo hook was rotated through approx. 50° for the test – this was accomplished by means of a thin cord – a parallel axis resulted between the line of the cable and the line of the suspension point/centre of gravity of the cargo hook.

When the drop-weight impacted on the dead stop, the cargo hook was accelerated both downward and rotationally. The cord broke in the initial phase of the test sequence.

Since it was not possible to determine the total moment of inertia of the cargo hook and the parallel axis distance, the calculations are lacking for this case.

In the test, the opening of the cargo hook took place as a result of the rotational and translational acceleration of the cargo hook (see Annexe 1).

The drop height above which the cargo hook opens could not be determined either theoretically or practically for the same test arrangement.

600 kg of sand absorbed the impact of the falling masses. Since the cargo hook opened during the test, the drop-weight and the cable fell into the sand.

The catch again opened when the test was repeated.

1.17 Organisational and management information

At the landing area, a company flight assistant was responsible for the procedures related to flying operations. He was supported by a forest ranger, who was operating the loader.

Without discussion with the flight assistant, the forest ranger and loader operator previously allowed participants in occupational therapy to assist in the landing area. The assistance was limited to rolling up the choker cables.

Shortly before work began, the flight assistant was made aware that the group would be assisting during flying operations. By means of a short briefing, the flight assistant tried to inform the members of the group of the dangers of flying operations.

Quote:

"*Ja, sie sollen, wenn der Helikopter kommt „uf zite ga", das habe ich ihnen mehrmals gesagt. Der Mann, der getroffen wurde, sagte zu mir, so schlimm kann das nicht sein, er habe ja schon gestern geholfen* (in einem anderen Flugbetrieb). *Ich habe ihm dann erklärt, was daran gefährlich ist, und er trage auch keinen Helm. Nach diesen Worten wich er dann zurück."*

Translation: "Yes, when the helicopter comes you must move "off to the side"; I told them that several times. The man involved told me it couldn't be that bad, he'd already helped yesterday (in a different aviation company). I then explained to him what the dangers were – and he was not wearing a helmet. After these words, he then withdrew."

Another member of the occupational group was helping to prepare the loads at the loading area in the wood.

A mechanic was responsible for maintaining the materials for flight operations.

In the flight operations manual (FOM), the task of logging was not described. Thus the most common area of operations for this type of helicopter in this company was not defined in terms of responsibilities and procedures.

1.18 Additional information

1.18.1 Other documented uncontrolled openings of the Canam C60 catch

Within the framework of the flight operations of Eagle Helicopter AG, other uncontrolled openings occurred before and after the fatal accident with the same type of helicopter and catch.

- In April 2003 during lifting of a double load, which began to swing violently about 25 m above ground.
- On 09.08.2003, when lifting a double load, the catch collided with a standing tree at a height of about 10 m.

1.19 Useful or effective investigation techniques

Not applicable.

2 Analysis

2.1 Human and operational aspects

A summary of the customary safety measures at the cargo landing area is listed below.

An appropriate form of organisation is essential for smooth and safe working. Every employee of the companies concerned must be aware of his position, his tasks, duties and competencies as well as his responsibility – and act accordingly.

- Utilising sufficient and suitable personnel at the cargo landing area. Never working alone, although too many people increase the accident risk.
- Excluding mutual risks by coordinated cooperation and reciprocal contact. Looking out for each other, understanding each other. The team leader must lead and coordinate the work.
- Ensuring efficient communication (radio, instructions, signs, signals). Supervision of the work by the team leader.
- When the helicopter approaches with a cargo and whilst the load is being deposited, no-one must be in the hazard area of the landing area. Personnel must remain to the side of the direction of flight and unloading, in the predefined safety zone.
- During the approach, landing and departure, work on the area must be suspended. This phase of the transport operation must be observed from a safe location until the danger is past.

The area in use had ideal characteristics for a timber download area. The approach to this knoll-like area was relatively simple. Despite the possible approach routine – the pilot had previously flown timber to this area before – it was necessary to take into account normal errors of estimation regarding angles and speed for this location.

The tracks of tree trunks in the terrain, which were approximately 30 cm deep, indicate that the load was deposited at a high rate of descent. This high rate of descent and the resulting impact of the tree trunks caused breakages and led the trunks to collide subsequently, allowing the cargo hook to open.

Independently of the features of the unloading site, judgement, flying skills or routines, irregularities in depositing the cargo can never be excluded. Thus unexpected breakages of trunks, catapulting branches, misjudgements, performance problems or technical problems with the helicopter may occur at any time. Too little account was paid to this circumstance with regard to the presence of assistants in the hazard area. A thorough briefing would have improved awareness of the possible plethora of hazards and might have changed people's behaviour. If a danger was perceived, given the noise of machinery, only a radio integrated in the safety helmet would have enabled correction of inappropriate behaviour or the alarm to be raised.

2.2 Technical aspects

2.2.1 General

The pilot did not claim that there were any technical deficiencies which might have contributed to the accident.

2.2.2 Conclusion regarding the technical examination of the Canam C60 cargo hook

Under the extreme operating conditions encountered in logging, for example, the cargo hook is clearly subjected to dynamic loads which were not required to be tested under the FAR 27.865ff regulations, but which are required by the current machinery directives.

The partial risk analysis which was produced indicated the weaknesses of the design. A practical series of tests confirmed the hypothesis that the cargo hook opened “inadvertently” in all the tests. The tests also indicated a possible inspection procedure.

If the design solution of a “hinged joint closure with deflection” is retained, it is imperative to incorporate a mechanical safeguard which prevents the deflection from being overridden in the event of momentum due to the force of an impact. This means that the interlock mechanism must be additionally mechanically blocked to prevent rotation.

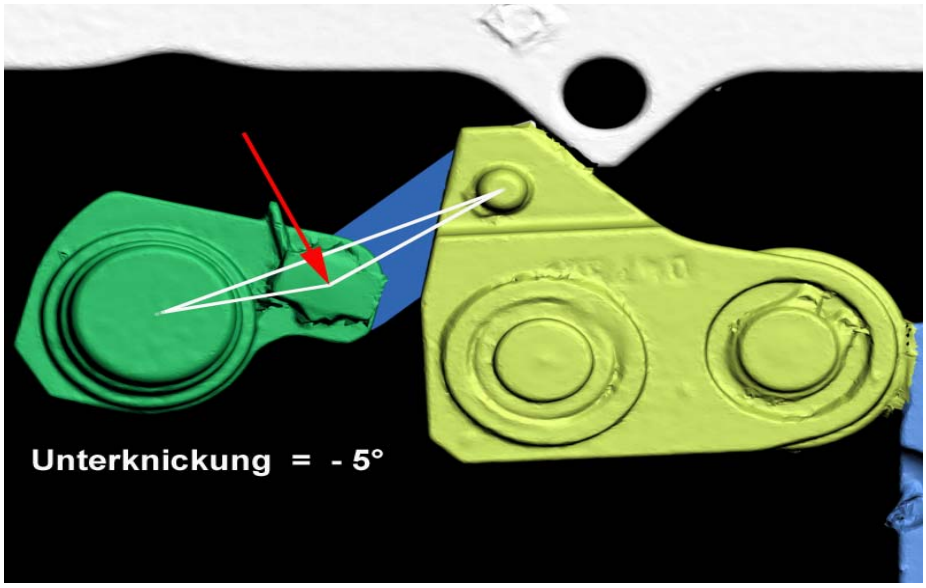


Figure: Hinged joint closure with deflection
Deflection = -5°

Limiting the maximum load of 6000 lbs to a distinctly lower load, e.g. 1000 lbs, does not prevent the uncontrolled opening of the cargo hook, as the load has no direct effect on the relevant impact force for opening the catch. This is mainly dependent on the mass of the cargo hook and its speed or on any rotational acceleration and the mass moment of inertia of the locking mechanism.

The available documentation for placing the cargo hook on the market does not comply with the requirements laid down by the STEG (federal law concerning the safety of technical equipment and devices):

- No declaration of conformity in accordance with EC machinery directives exists.
- No CE mark is applied.

3 Conclusions

3.1 Findings

- The pilot was in possession of a commercial pilot's licence, (cat. helicopter).
- There are no indications of the pilot having any health problems.
- The mass and centre of gravity were within the prescribed limits.
- The mass of the last load flown was 4975 lbs (2257 kg).
- The tree trunks were marked on the bark at regular intervals using a power saw.
- The pilot did not claim that there were any technical defects which might have contributed to the accident.
- According to his information, the cargo hook was not opened by the pilot himself.
- Present on the landing area were a flight assistant from the same company, a forest ranger as loader operator and a group of other people.
- The flight assistant was only informed shortly before commencement of work that other persons would be assisting.
- In the FOM, the task of logging was not described. The working procedures were therefore not defined.
- Uncontrolled openings occurred with the same type of helicopter and catch type before and after the accident.
- The analytical considerations of the behaviour of the Canam C60 cargo hook could be confirmed in a test. The catch always opened when the test was repeated.
- The available documentation for placing the cargo hook on the market does not comply with the requirements laid down by the STEG (federal law concerning the safety of technical equipment and devices).
- The manufacturer's "FAR declaration of conformity" does not suffice in this specific case.
- The weather conditions had no influence on the occurrence of the accident.

3.2 Causes

The accident is with a very high degree of probability attributable to an uncontrolled opening of the lower cargo hook because of its defective design. As a result, the load fell to the ground and fatally injured a third party.

The following factors contributed to the accident:

- The cargo hook certification process was not suitable for the flight operation requirements.
- The landing area was undermanned, with one flight assistant from the company.
- Organisation on the landing area was made more difficult, and impossible to oversee, for the flight assistant because of external helpers.
- Communication was made difficult for the external assistants because of the lack of radio equipment.

4 Safety recommendations

4.1 Safety recommendations of 8 September 2003

AAIB letter dated 8 September 2003 to the Federal Office for Civil Aviation – safety recommendations based on the initial results of the investigation.

No. 278 (formerly No. 79):

We recommend that the FOCA inform companies of the special procedures and dangers of logging with helicopters. The following points in particular must be addressed:

- organisation at the loading area
- organisation at the landing area
- aeronautical conduct

No. 279 (formerly No. 80):

We recommend that the FOCA inform companies to cease logging operations by helicopter with the Canam C60 cargo hook until further notice.

Moreover, we request that the FOCA conduct a survey among companies relating to cargo hook problems (especially inadvertent opening) in longline operation. We are particularly interested in the following information:

- cargo hook type
- description of the incident (lifting, depositing, etc.)
- the frequency of the incidents

No negative consequences should devolve in relation to the information from the companies.

No. 280 (formerly No. 81):

We recommend that the FOCA notify companies that inadvertent openings of cargo hooks are to be reported as flight operations incidents.

4.2 FOCA comment of 19 December 2003

Before the end of January 2004, the FOCA will send a directive to all aviation companies which are permitted to carry out cargo flights. This letter will be drawn up on the basis of the details below in relation to safety recommendations SE79, SE 80 and SE81. You will receive a copy once it has been sent.

On recommendation SE 79:

We are basically in agreement with this safety recommendation and will implement it as follows:

Companies are requested to subject procedures for logging, as described in the respective FOM, to close inspection. In particular, it is necessary to check whether the procedures in the FOM are described correctly and completely, whether they correspond to current practice and current safety requirements, whether they contain an adequate description of the organisation of the loading and unloading site and whether the aeronautical procedures (e.g. type of cargo loading and unloading, choice of flight path, etc.) are appropriate. The FOCA must receive written confirmation by 30.04.2004 to the effect that such an inspection has taken place and, if it has been established by this inspection that amendments must be made to the FOM, these must also be submitted to the FOCA by 30.04.2004 for approval.

On recommendation SE 80:

This procedure was discussed with the AAIB and the FOCA on 4 September 03. Since it is currently the case that this type of cargo hook is being used not only with longlines by large helicopters but in some cases also with longlines by small helicopters, but in such cases such "self-releases" are not known to date, the FOCA has decided to slightly modify the procedure relating to implementation of SE 80. The following text will be integrated in the above-mentioned letter:

"According to current knowledge and various clarifications it has been found that the CANAM C60 type cargo hook can open by itself under heavy loads (>1500 kg) and dynamic influences, such as those which occur in the case of logging. Further investigations are necessary; the cargo hook can probably open by itself under dynamic impacts. It is being investigated whether opening is possible subject to the effects of rotational or translational acceleration on the locking mechanism (release 'over the dead centre')".

Until the results of this investigation are available, the FOCA urgently recommends:

In view of the danger of impacts, load slippage, etc., the type Canam C60 cargo hook must not be used for loads which are greater than 1500 kg in critical operation in the case of logging.

In addition, all aviation companies making helicopter flights with external loads must submit a report to the FOCA by 31.04.2004 on incidents in which loads have been unintentionally lost. This report must include all incidents since 01.01.2001 and provide information on the following parameters:

Date

- *Helicopter registration*
- *Cargo hook type*
- *Type of use (e.g. logging, transport by net, concrete, etc.)*
- *Description of the incident (load pick-up, depositing of the load, etc.)*
- *Analysis of the problem (if carried out)*
- *Measures taken (technical, operational, e.g. instruction in the FOM)*
- *Information provided (in-house, to the FOCA, to others)*

All incidents must be listed, even if they have already been reported to the FOCA and even if the information can no longer be fully documented at the present point in time.

This information is used exclusively to promote aviation safety. To this end a report will be published on conclusion of the study. The FOCA does not intend to use the data which have been obtained to uncover any unlawful behaviour.

On recommendation SE 81:

The FOCA has already published a directive on 02.03.1993 concerning the obligation to report incidents in operation: TM-M No. 65.020-20. We will specially remind companies in a reminder letter that inadvertent opening of cargo hooks must be reported as incidents in flight operations.

4.3 New safety recommendation

4.3.1 Safety deficit

On 29 July 2003, a helicopter company was engaged in logging operations in the Frutigen area. Tree trunks were being flown out of the forest by helicopter and deposited on the drop zone of a central landing area. On the approach to the landing area, the cargo hook opened. A third party was fatally injured by a falling trunk.

In tests it was possible to prove that the Canam C60 cargo hook has a faulty design.

The available documentation for placing the cargo hook on the market does not comply with the requirements laid down by the STEG (federal law concerning the safety of technical equipment and devices):

- No declaration of conformity in accordance with EC machinery directives exists.
- No CE mark is applied.

4.3.2 Safety recommendation No. 382

The Federal Office for Civil Aviation should define and implement appropriate approval criteria for secondary cargo hooks corresponding to the conditions of use. Moreover, the legal basis should be adapted.

Load-attaching means which are already in use should be checked for their suitability as an immediate measure.

At international level, the Federal Office for Civil Aviation should make an effort to prevent the use of the Canam C60 hook, on the basis of the exposed shortcomings.

Berne, 10 November 2006 Aircraft Accident Investigation Bureau

Annexe 1

Photographs of the test using a high-speed camera

Frame 56 - 62	Frame 64 - 70	Frame 72 - 78	Frame 80 - 88