



ARAIB

ARAIB/AIR1002

AIRCRAFT INCIDENT REPORT

HELICOPTER DAMAGE FOUND AFTER EMERGENCY LANDING
HELIKOREA CO. LTD.

KA-32A, HL9406

BUK-RI, GIRIN-MYEON, INJE-GUN, GANGWON-DO

MAY 8, 2010



28 MARCH 2012

AVIATION AND RAILWAY ACCIDENT INVESTIGATION BOARD
MINISTRY OF LAND, TRANSPORT AND MARITIME AFFAIRS
REPUBLIC OF KOREA

According to the provisions of the Article 30 of the Aviation and Railway Accident Investigation Act of the Republic of Korea, it is stipulated;

The accident investigation shall be conducted separately from any judicial, administrative disposition or administrative lawsuit proceedings associated with civil or criminal liability.

And in the Annex 13 to the Convention on International Civil Aviation, Paragraphs 3.1 and 5.4.1, it is stipulated as follows;

The sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of the activity to apportion blame or liability. Any investigation conducted in accordance with the provision of this Annex shall be separate from any judicial or administrative proceedings to apportion blame or liability.

Thus, this investigation report issued as the result of the investigation on the basis of the Aviation and Railway Accident Investigation Act of the Republic of Korea and the Annex 13 to the Convention on International Civil Aviation, shall not be used for any other purpose than to improve aviation safety.

In case of divergent interpretation of this report between the Korean and English languages, the Korean text shall prevail.

AIRCRAFT INCIDENT REPORT

The Korea Aviation and Railway Accident Investigation Board. Helicopter Damage Found After Emergency Landing, HeliKorea Co. Ltd., KA-32A Helicopter, HL9406, Buk-ri, Girin-myeon, Inje-gun, Gangwon-do, May 8, 2010. Aircraft Incident Report ARAIB/AIR1002. Seoul, Republic of Korea.

The Aviation and Railway Accident Investigation Board (ARAIB), Republic of Korea, is a government organization established for independent investigation of aviation and railway accident, and the ARAIB conducts accident investigation in accordance with the provisions of the Aviation and Railway Accident Investigation Act of the Republic of Korea and Annex 13 to the Convention on International Civil Aviation.

The objective of the investigation by the ARAIB is not to apportion blame or liability but to prevent accidents and incidents.

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Helicopter Damage Found after Emergency Landing

- Operator: The HeliKorea Co. Ltd.
- Manufacturer: The KumApe Company
- Type: KA-32A (rotorcraft)
- Registration Mark: HL9406
- Place: Buk-ri, Girin-myeon, Inje-gun, Gangwon-do
(Latitude: N38° 0 ' 22.55 " , Longitude: E128° 18 ' 16.0 ")
- Date & Time: May 8, 2010 at 15:50 (Korea Standard Time¹⁾)

Synopsis

On May 8, 2010, about 15:50, a rotorcraft HL9406 affiliated with the HeliKorea Co. Ltd. (hereinafter referred to as "the HeliKorea") made an emergency landing since the main reduction gear box (hereinafter referred to as "the main gear box") chip warning light came on during takeoff while airlifting ready-mixed concrete from a lifting site to a construction site where high-voltage power lines were being built between Inje and Yangyang in Gangwon-do, and subsequently, damage was found as a result of the aircraft inspection. The HL9406 aircraft was a business use rotorcraft operating under visual flight rules (VFR) in accordance with the provisions of the Republic of Korea Aviation Act. Aboard the aircraft were one captain and one co-pilot at the time of the incident, and there was no damage to persons other than to the aircraft.

The Korea Aviation and Railway Accident Investigation Board (hereinafter referred to as "the ARAIB") determines that the probable causes of the incident were (1) the main gear box roller bearing was damaged because its parts deteriorated due to the fatigue flaking caused by considerable off-design vibro-dynamic axial and radial load from the fan drive shaft direction, and this load was caused by the destruction of Main Rotor brake parts; and (2) the Main Rotor brake was damaged due to a sudden growth of vibro-dynamic load in the

1) Unless otherwise indicated, all times in this report are Korea Standard Time, based on a 24-hour clock.

system caused by the imbalance in the 「brake shoe A」, and this imbalance was caused when the 「brake shoe A」's return spring was uncoupled from the bracket mounting pin (5.00.1540.0015.000).

Contributing to the incident were (1) the failure to tighten a bolt in accordance with the Technical Specification requirements when combining the fan drive flange with the flexible coupling; and (2) the failure to meet the Technical Specification requirements when jointing the brake shoe return spring pin (5.00.1540.0015.000) with the bracket (5.00.1540.0011.000) mounting hole, Ø 6mm in diameter - the actual gap was 0.05mm, whereas the max. gap permitted is 0.017mm.

On the basis of the findings of this incident investigation, the ARAIB addresses one safety recommendation to the HeliKorea and to the KumApe, respectively.

1. Factual Information

1.1 History of Flight

On May 8, 2010, about 15:50, a rotorcraft HL9406 made an emergency landing because the main gear box chip warning light came on during takeoff while airlifting ready-mixed concrete from a lifting site to a construction site where high-voltage power lines were being built between Inje and Yangyang in Gangwon-do, and subsequently, damage was found as a result of the aircraft inspection.

The HL9406 aircraft was operating under visual flight rules (VFR), and at the time of the incident, aboard the aircraft were one captain and one co-pilot, and there was no damage to persons other than to the aircraft.

The HeliKorea made a contract with the Woori-Electric Co. Ltd. (hereinafter referred to as "the Woori-Electric") stipulating that the HeliKorea should use its rotorcraft to airlift materials to a construction site of a high-voltage power line tower connecting Inje and Yangyang. Against this backdrop, from April 9, 2010 until the day of the incident, the HeliKorea was supporting the airlift of materials by dispatching²⁾ a KA-32A rotorcraft (HL9406) at the request of the Woori-Electric.

The flight mission of the HL9406 aircraft on the day of the incident was to airlift ready-mixed concrete from the lifting site³⁾ to the construction site of the high-voltage power line tower No.78. Refer to [Photo 1].

According to the captain's statement, on the day of the incident, the HL9406 aircraft completed the morning flights, and about 14:00 in the afternoon, started the engine to commence the flight mission, and airlifted ready-mixed concrete 10 times from 14:00 until 15:50.

About 15:50, when the aircraft took off from the lifting site to airlift the

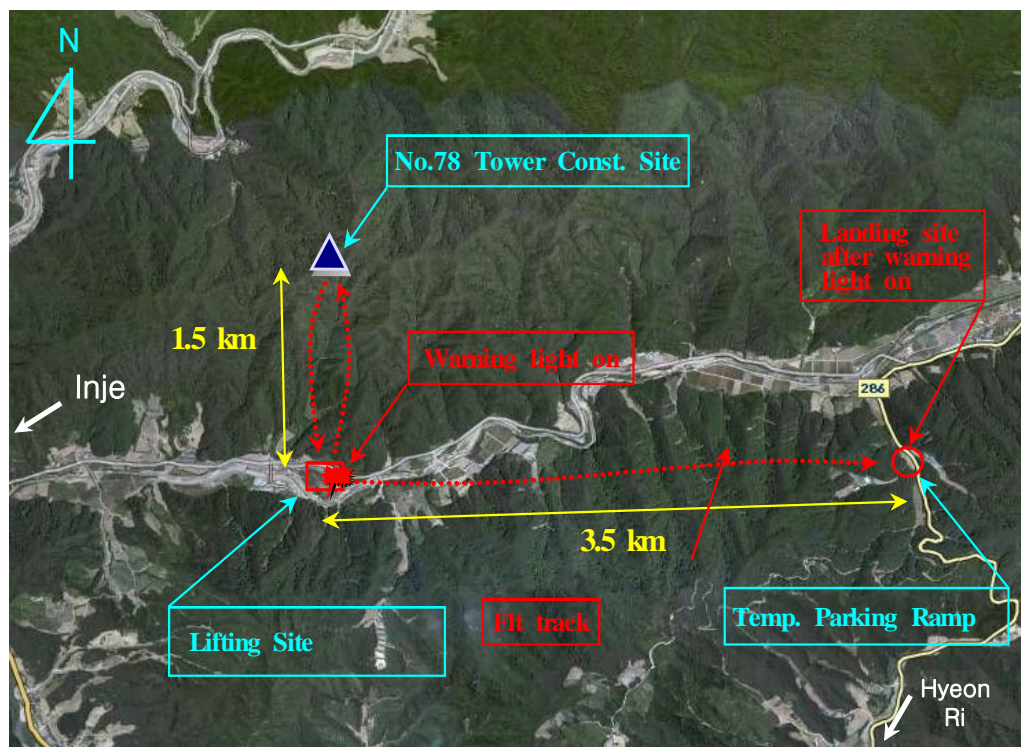
2) The mission was performed by a team composed of 2 pilots, 1 mechanic, 1 tanker driver, and 2 helicopter load masters per 1 aircraft.

3) A prepared location such as a vacant lot adjacent to a road, where the equipment and materials needed for the construction of towers are assembled and airlifted by a helicopter to a construction site as the need arises.

remaining ready-mixed concrete of 2 flights, the main gear box chip warning light came on.

In response to this, the captain immediately separated the outside sling, moved to a temporary parking ramp⁴⁾ located 3.5km east of the lifting site, and stopped the engine. Until this time, the main gear box oil temperature and pressure were within normal range.

After landing, the captain and the mechanic in charge inspected the aircraft, and as a result, metal chips exceeding the permitted limits were detected in the main gear box, and it was found that the components such as the main gear box roller bearing, the engine oil cooling fan drive shaft, and the rotor brake system were damaged.



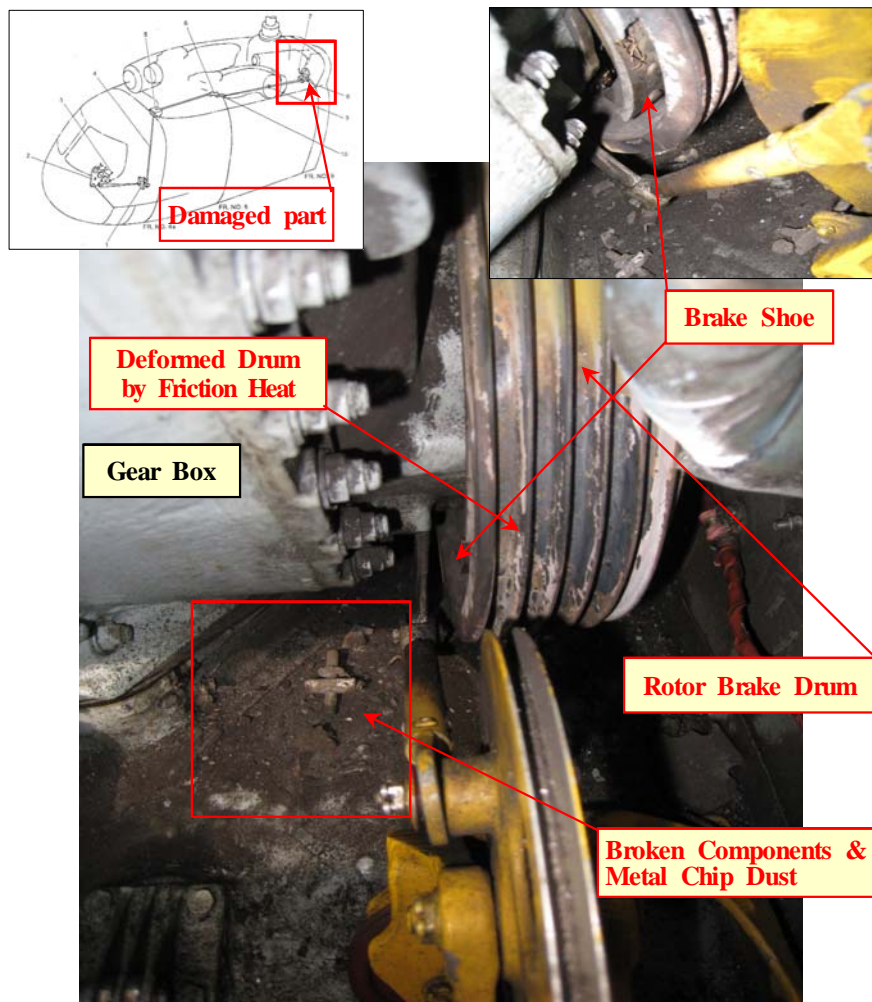
[Photo 1] HL9406 Mission Area and Flight Route

4) A vacant lot adjacent to a road, prepared to be utilized as a temporary place for aircraft parking, maintenance, and fuel supply during a period of airlifting materials.

1.2 Injuries to Persons

Category	Crew	Passenger	Others	Total
Fatal	0	0	0	0
Serious/Minor	0	0	0	0
None	2	0	0	2
Total	2	0	0	2

1.3 Damage to Aircraft



[Photo 2] Heat Damaged Rotor Brake & Separated Surrounding Components

The damage found after the HL9406 aircraft landed in the temporary parking ramp was (1) metal chips exceeding the permitted limits detected in 3 main gear box chip detectors; (2) the rotor brake drum deformed by friction heat; and (3) the brake shoe, the mounting bracket, and related components destroyed and separated.

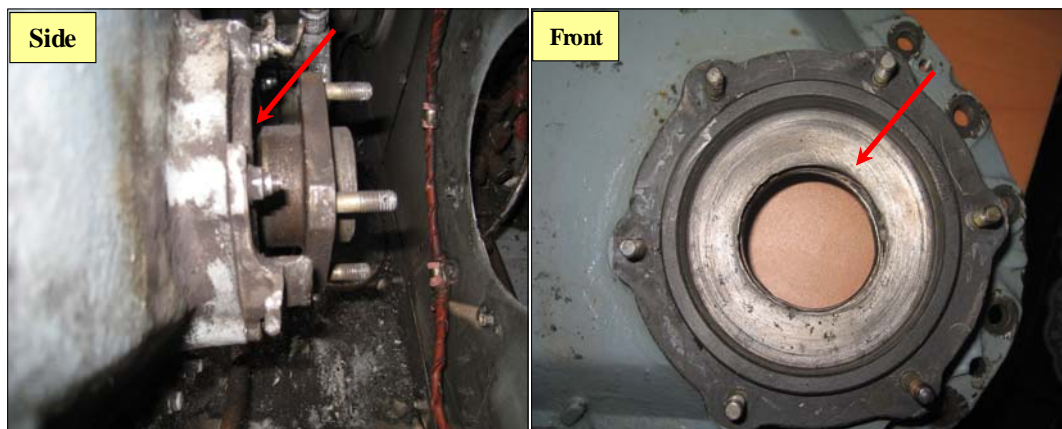
Also, there was a gap found exceeding the permitted limits in the oil cooling fan drive shaft, along with scratch marks made by rotation found in the inner wall of the bracket and the brake drum. Refer to [Photo 2 & 3].



[Photo 3] Damaged Components Removed

In addition, when the cooling fan drive shaft and the rotor brake system were removed for inspection, as shown in [Photo 4], the abrasion and damage (red

arrows) in the main gear box roller bearing were verified.



[Photo 4] Damaged Part of Main Gear Box Roller Bearing

1.4 Other Damage

None.

1.5 Personnel Information

1.5.1 The Captain

The captain (male, age 57) accumulated 8,294.5 total flight hours, including 3,649.5 hours⁵⁾ during his military service and 4,645 hours⁶⁾ in civil aviation. His flight time of the same type aircraft was 1,200.8 hours, including the instructor flight time of 406.3 hours and the captain flight time of 739.7 hours.

He had flown 7.7 and 58.1 hours in the 24 hours and 90 days, respectively, before the day of the incident, and all his flight related licenses were verified valid.

5) AH-1: 1,349.7 hrs, OH-23: 20 hrs, 500MD: 373.5 hrs, O-1: 919 hrs, UH-1H: 906 hrs, SFTS: 81 hrs, total 3,649.5 hrs.

6) S-76: 301.3 hrs, W-3A: 1,530.4 hrs, B214: 1,612.5 hrs, KA-32A: 1,200.8 hrs, total 4,645 hrs.

The captain received the aviation physical examination⁷⁾ in accordance with the provisions of the Aviation Act, Article 31 (Certification of Aviation Physical Examination), and the result was 「suitable」 .

1.5.2 The Co-Pilot

The co-pilot (male, age 48) accumulated 4,491.9 total flight hours, including 484 hours⁸⁾ during his military service and 4,007.9 hours⁹⁾ in civil aviation. His flight time of the same type aircraft was 86.8 hours, including the captain flight time of 39.7 hours.

He had flown 4.7 and 57.7 hours in the 24 hours and 90 days, respectively, before the day of the incident, and all his flight related licenses were verified valid.

The co-pilot received the aviation physical examination¹⁰⁾ in accordance with the provisions of the Aviation Act, Article 31 (Certification of Aviation Physical Examination), and the result was 「suitable」 .

1.6 Aircraft Information

The HL9406 aircraft was manufactured¹¹⁾ by the FSUE KumApe, Russia on September 21, 1986, was delivered to the LG International Corp. on November 19, 2007, and was leased to the HeliKorea. Then the aircraft was registered for aerial work aviation on February 18, 2008.

7) Validity: Oct. 05, 2009 - Oct. 31, 2010, Issuance No.: 025-7619.

8) 500MD: 378 hrs, UH-1H: 46 hrs, OH-23: 40 hrs, SFTS: 20 hrs, total 484 hrs.

9) Bell214: 3,641.4 hrs, H369D: 268.1 hrs, R-22: 29.8 hrs, Bell206: 3 hrs, H300: 1.6 hrs, AS350: 2.7 hrs, W-3A: 12.6 hrs, KA-32A: 48.7 hrs, total 4,007.9 hrs.

10) Validity: Nov. 09, 2009 - Nov. 30, 2010, Issuance No.: 025-7674.

11) Type: KA-32A (Type Certificate No.: 36-32A), Manufacture Serial No.: 55-03/014.

The airframe of the HL9406 aircraft was served for a total of 2,587.4 hours before the day of the incident, and the aircraft was equipped with 2 engines of TB3-117BMA model manufactured by the Ukraine Mortosich. The total service times of the left and right engines are 1,053.5 and 1,121 hours, respectively, before the day of the incident.

The HL9406 aircraft was maintained in accordance with the manufacturer's laid down methods and procedures, and the latest maintenance activity was the 100 hour inspection on April 22, 2010.

The HL9406 aircraft's registration certificate¹²⁾, airworthiness certificate¹³⁾, operation limitations specification¹⁴⁾, noise certificate,¹⁵⁾ and radio station license¹⁶⁾ were all verified valid.

1.6.1 Main Gear Box

The main gear box¹⁷⁾ of the HL9406 aircraft was overhauled at No.150 factory in Russia on May 23, 2008 when it reached the 500 hour service time, and was installed on the HL9406 aircraft on August 09, 2008, then after the service time of 495.2 hours, the incident occurred.

According to the main gear box log book, the LG International Corp.¹⁸⁾ supplied Mobil Jet-254 when installing the main gear box on the HL9406 aircraft, and after that, the HeliKorea replaced it with Mobil Jet-II¹⁹⁾ and supplied Mobil

12) Registration certificate No.: 2010-099 (Oct. 27, 2010), First (Feb. 2, 2008).

13) Airworthiness certificate No: A10091 (Oct. 26, 2010).

14) Issue No.: ASOL10091, Issued on Oct. 27, 2010.

15) Certificate No.: KNC940600, Issued on Mar. 26, 2008.

16) License No.: 46-2007-10-0000025, Issued on Nov. 28, 2007.

17) Serial No.: II8410343K (BP 252)

18) A business entity that carries out Kamov aircraft maintenance in Korea and assists the HeliKorea with the maintenance service for the same type aircraft.

19) The oil instructed by the manufacturer not to be used.

Jet-II at the service time of 200.9 hours on August 16, 2009.

When the relevant work log book, the oil purchase and control book, the oil stock inventory, etc. were inspected, however, it was verified that the mechanic had supplied Mobil Jet-254 normally, whereas a wrong entry was mistakenly made on the log book.

1.6.2 Rotor Brake and Fan Drive Shaft

The HL9406 aircraft's fan drive shaft and rotor brake were installed when the aircraft was manufactured, and every 100 hours, the radial clearance of the drive shaft should be measured, and the gap between brake drum and shoe should be inspected.

The latest 100 hour inspection of the HL9406 aircraft was carried out on April 22, 2010 in the HeliKorea, and it was verified by the maintenance log book that the clearance of the fan drive shaft and the gap of the rotor brake were within normal range at that time.

1.6.3 Aircraft Maintenance Defects

According to the statements of the captain and mechanic in charge, there were no defects found in the aircraft engine, the power transmission system, and the flight control system before and during flight, nor did they notice any failures with the aircraft in the preflight inspection.

Further, in the on-site investigation after the incident, there was no evidence found indicating that the pilots were using the rotor brake during flight or

started the aircraft engine while the rotor brake was in the up position.

1.7 Meteorological Information

The meteorological conditions at the time of the incident to the HL9406 aircraft on May 8, 2010 were referred to the captain's visual observation and the meteorological information observed in the Inje Meteorological Observation Post²⁰⁾, and the information is as described in the following:

Category	Time	Wind Direction/Speed(m/s)	Visibility	Cloud Amount	Cloud Ceiling	Temp (℃)	Atmospheric Pressure (hpa)
The captain	App. 15:00	S / 5 kts	6	Clear	–	–	–
Inje Observation Post	15:00	S / 3.3 kts				22.9	1005.8
	16:00	S / 3.9 kts				22.4	1005.8

※ Inje Meteorological Observation Post: An unmanned observatory where only temperature, precipitation, wind, humidity, and sunshine duration are observed.

1.8 Aids to Navigation

The HL9406 aircraft did not use navigation aids for its flight operation on the day of the incident.

1.9 Communications

The communications equipment of the HL9406 aircraft did not affect this incident.

20) Located app. 13km northwest of the incident site.

1.10 Heliport Information

The heliport (a takeoff and landing site other than aerodrome) used by the HL9406 aircraft for its mission was a legitimate location as a temporary parking ramp for lifting and discharging the cargo. A vacant lot adjacent to a newly paved road between Inje and Hyeonri was utilized as this heliport, and the heliport did not affect this incident.

1.11 Flight Recorder

The FDR records showed that the gear box chip warning light came on 1 time each at 17:01:13 and 17:01:33, and kept on from 17:01:50 until 17:06:40 when the FDR recording ended after the aircraft engine had stopped (17:05:00).

However, there was no evidence found indicating that the FDR and the CVR affected this incident.

1.12 Wreckage and Impact Information

None.

1.13 Medical and Pathological Information

There was no evidence found indicating that the medical and pathological factors affected this incident.

1.14 Fire

Not applicable.

1.15 Survival Aspects

Not applicable.

1.16 Tests and Research

In order to identify the root cause of the malfunction in the main gear box and the fan drive shaft occurred at the time of the incident, the ARAIB had the relevant components analysed (the 1st time) from December 20 until December 29, 2010 in the Interstate Aviation Committee, Russia (hereinafter referred to as "the IAC"), the airframe manufacturer (Moscow), and the main gear box manufacturer (St. Petersburg), and held the Korea-Russia technical meeting, however, a clear determination of the cause of the malfunction could not be made, so it was decided to carry out a detailed analysis for the 2nd time under the supervision of the IAC.

According to this decision, the IAC proceeded with the detailed analysis from February 18, 2011 until March 15, 2011, and the ARAIB was notified of its results.

The subjects for the detailed analysis were 17 items, and they are as stated in the following:

- 1) Fan Drive Shaft;
- 2) Flange Spline Drive including Aft Flexible Coupling;
- 3) Rotor Brake Disk Mount Assembly including Brake Bracket and Rod;
- 4) Rotor Brake separated from Rotor Brake Disk Shoe;
- 5) Rotor Brake Drum;
- 6) Fan Drive Shaft Cover (2 sheets);

- 7) Gear Box, Gear Serial No.257 (Drawing No.076.14.1200);
- 8) Radial Roller Bearing Damage, Serial No.642 (Drawing No.75-4 2206B - Outer Ring including Roller and Separator Separated from Inner Ring);
- 9) Radial Roller Bearing (Drawing No.75-4 2206B1);
- 10) Splined Flange (Drawing No.076.14.1500);
- 11) Oil Reflector (Drawing No.7971.0113);
- 12) Special Nut (Drawing No.7971.0144);
- 13) Special Lock Washer 7971.0142;
- 14) L/H Gear Box Cover (Drawing No.076.14.0320);
- 15) Brake Shoe Spring (2);
- 16) Shoe Stroke Limiters (2);
- 17) Mounting Pin separated from Return Spring.

As a result of the detailed analysis, it was determined that the malfunction started originally from the rotor brake, and the detailed sequence of the malfunction was as described in the following:

- 1) The parts of the main gear box roller bearing²¹⁾ were damaged by the fatigue flaking under a normal oil intake. The fatigue flaking of the bearing parts was caused by the bearing assembly's operation under the influence of considerable off-design vibro-dynamic axial and radial load from the fan drive shaft direction, and this load was caused by the destruction of Main Rotor brake parts;
- 2) The Main Rotor brake was damaged due to a sudden growth of vibro-dynamic load in the system. The sudden growth of the load was due to the rotor brake shoes imbalance caused when the brake shoe's return spring was uncoupled from the bracket mounting pin;

21) Serial No.: 642 75-4 220B1 (Radial Roller Bearing)

- 3) The additional factor contributing to the growth of the considerable vibro-dynamic load in the drive shaft assembly is a gap between the flexible couple flanges on the side of the gear box caused by the failure to tighten a bolt in accordance with the Technical Specification requirements.

In the course of analysis, it was found that there was the failure to meet the Technical Specification requirements when jointing the brake shoe return spring pin²²⁾ with the bracket²³⁾ mounting hole, Ø6mm in diameter – the actual gap was 0.05mm instead of 0.017mm, the max. gap permitted.

1.17 Organizational and Management Information

The organizational and management factors did not affect this incident.

1.18 Additional Information

Not applicable.

22) 5.00.1540.0015.000

23) 5.00.1540.0015.000

2. Analysis

2.1 General

The certifications that the HL9406 crew members held were in accordance with the provisions of the Republic of Korea Aviation Act and the HeliKorea regulations. The crew members were qualified for the flight operations, and they took an adequate rest before the flight. There was no evidence of any medical problems that would have affected their flight performance in association with this incident.

In accordance with the provisions stipulated in the Republic of Korea Aviation Act, the HL9406 aircraft was duly registered, certified for airworthiness and operation limitations specification, obtained the noise certificate and the radio station license, and was approved for the flight operations.

The aircraft weight and balance were within the prescribed limits. Further, there was no evidence indicating defects in the aircraft flight control system, power transmission system or engine before the incident.

2.2 Weather Factors

The wind direction and speed in the mission area observed visually by the captain on the day of the incident were southerly wind of app. 5 knots. And the wind direction and speed observed in the Inje Meteorological Observation Post located 13 km northwest of the incident site were also below 4 knots, thus did not affect this incident.

2.3 Damage Progress of Aircraft Components

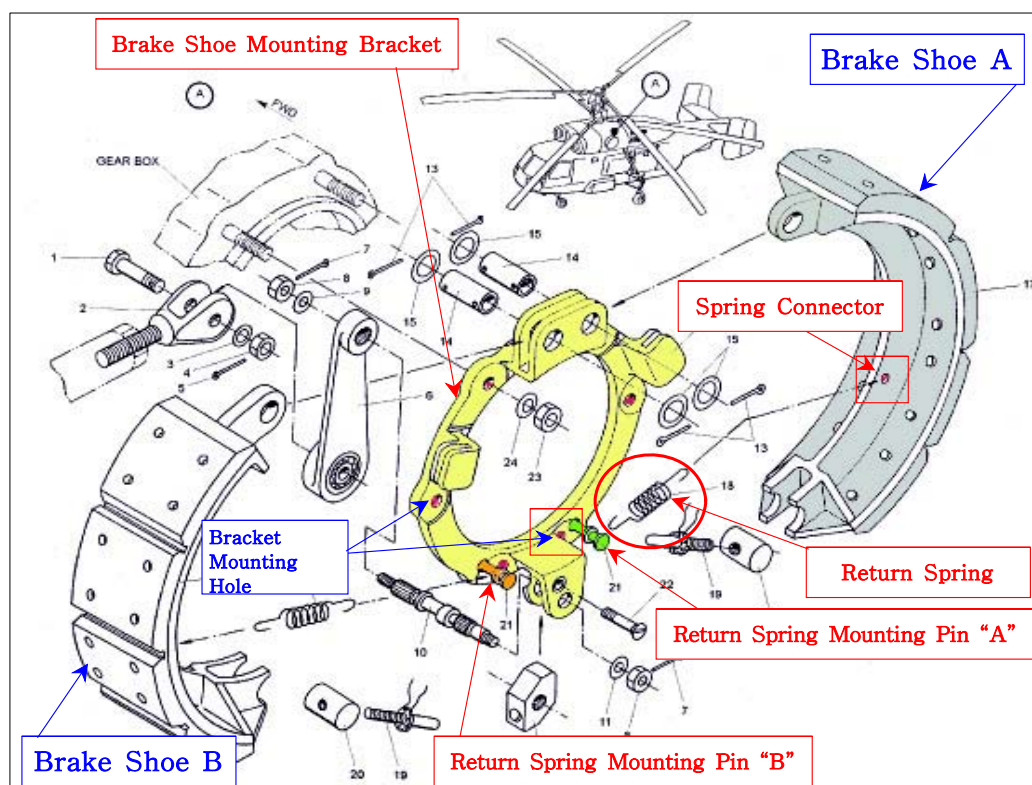
As a result of the HL9406 aircraft inspection carried out after the

emergency landing, it was found that there were heat damage in the rotor brake drum, damage in the brake shoe and related components, a gap and rotation damage in the fan drive shaft, and damage in the main gear box roller bearing.

In order to identify the root cause of the malfunction, a joint investigation with the IAC was carried out with the support of the manufacturer's facilities and experts.

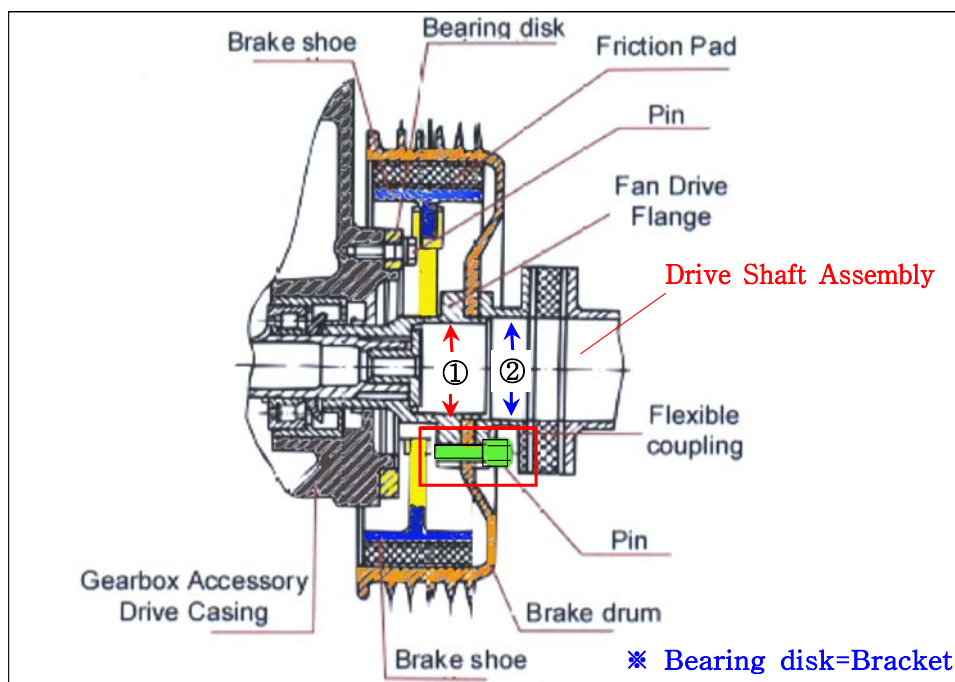
The result of the investigation showed that related parts were damaged as follows:

As shown in [Fig. 1], the return spring (red circle) jointed with the rotor brake 「brake shoe A」 was separated during flight, thus resulting in the imbalance in the 「brake shoe A」, and this imbalance caused the 「brake shoe A」 to contact the drum abnormally, thus resulting in the vibro-dynamic load in the system.



[Fig. 1] Disassemble Drawing of Brake Shoe

As shown in [Fig. 2], this vibro-dynamic load was suddenly grown since the gap was generated between the fan drive flange (red arrow ①) and the flexible coupling (blue arrow ②) due to a failure to tight the bolt (red square) in accordance with the Technical Specification requirements when the drive shaft assembly was installed.



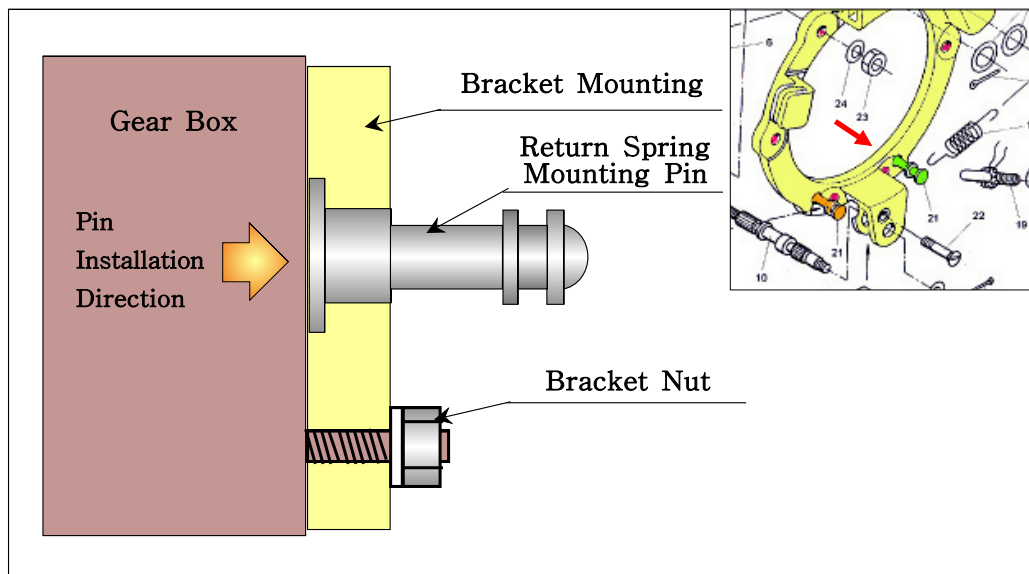
[Fig. 2] Rotor Brake System and Drive Shaft Assembly

As a result of the analysis of the cause and progress mentioned above, the ARAIB concluded that the cause of the damage in the cooling fan drive shaft, the rotor brake system, and the main gear box roller bearing is the separation of the return spring.

In addition to this conclusion, however, the ARAIB determined that the cause of the return spring separation should be reexamined, so analyzed various probable causes based on the following:

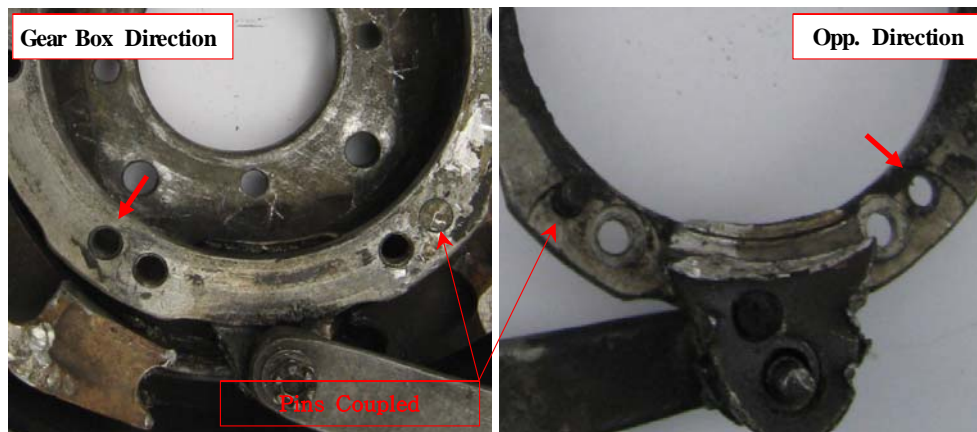
- 1) Separation of the return spring by the deformed bracket
- 2) Separation of the return spring by the severance of the return spring mounting pin
- 3) Separation of the return spring by the gap of the return spring mounting pin
- 4) Separation of the return spring by the weakening of the return spring elasticity

When the return spring mounting pin is coupled to the bracket, as shown in [Fig. 3], the pin is inserted from the gear box direction, then the mounting nut is tightened, thus it is structured that the pin cannot uncouple unless it is broken or the bracket is deformed.



[Fig. 3] Structure Drawing of Coupled Return Spring Mounting Pin

Nevertheless, according to the result of damaged bracket inspection, the hole with the mounting pin decoupled (red arrow) shows no sign of expansion or deformation as shown in [Photo 5]. Therefore, there is no possibility that the return spring mounting pin "A" was separated by the deformation of the bracket.



[Photo 5] Connector Hole of Return Spring Mounting Pin

As verified in the Korea-Russia joint investigation, the gap (0.05mm) when coupling the mounting pin was not wide enough to make the return spring fell off. Therefore, it is highly unlikely that the return spring "A" was separated only by the gap.

Further, the mounting pin "A" was not retrieved in the on-scene investigation, thus the detailed investigation could not be carried out. Therefore, there is no clear evidence that it was broken and separated.

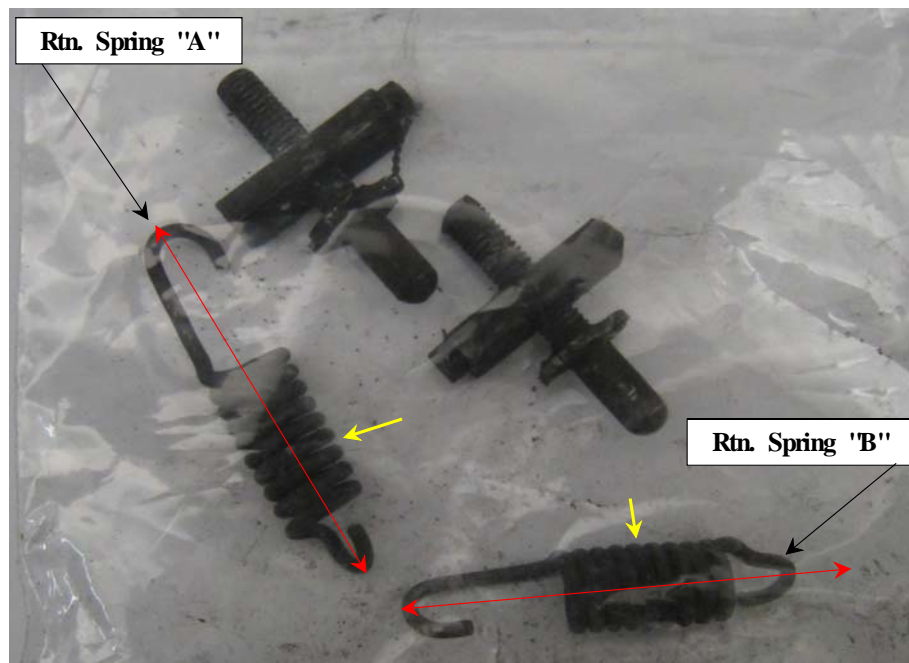
As shown in [Photo 6], the return spring connector of the brake shoe "B" almost maintains the original shape, whereas the connector of the brake shoe "A" is more expanded by abrasion and severely damaged than "B".



[Photo 6] Damage in Return Spring Connector of Brake Shoe

When compared the length of the return springs "A" and "B" using same length arrows, as shown in [Photo 7], the length of the spring "A" is extended, and the gaps between the spring rings of the spring "A" are bigger.

On the basis of the aforementioned facts, therefore, it is assumed that the gap between the mounting pin and the bracket hole along with the weakening of the return spring elasticity resulted in the vibro-dynamic load, thus separating the return spring from its original installation position.



[Photo 7] Deformation of Return Spring

2.4 Other Factors

It was revealed in the gear box detailed investigation process that a wrong entry was mistakenly made by a mechanic on the 「Gear Box Maintenance Log Book」, recording that Mobil Jet-II had been supplied at 100 hour inspection, whereas the oil was not dealt by the HeliKorea, which means that the

maintenance activities are carried out as a habitual routine, and the supervision and verification function for this kind of maintenance activities is inadequate.

Therefore, the ARAIB determines that the HeliKorea needs to examine independence of the quality control function of its maintenance division, and practically separate the function from the division so as to make the multiple checks for maintenance activities a reality.

3. Conclusions

3.1 Findings

1. The certifications that the HL9406 captain and co-pilot held were in accordance with the requirements of the Republic of Korea Aviation Act and the HeliKorea regulations. The crew members were qualified for the flight operations.
2. In accordance with the provisions stipulated in the Republic of Korea Aviation Act, the HL9406 aircraft was duly registered, certified for airworthiness and operating limitations specification, obtained the noise certificate and the aircraft station license, and was approved for the flight operations.
3. There was no particular malfunction recorded on the maintenance log book of the HL9406 aircraft, and there was no evidence indicating defects in the airframe, the flight control system, the engine, and the power transmission system on the preflight inspection and before the incident.
4. The meteorological conditions did not affect this incident.
5. On the day of the incident, about 15:50, at a moment when the HL9406 aircraft was lifting ready-mixed concrete for constructing a high-voltage power line tower, the main gear box chip warning light came on, and until landed at a refueling location situated about 3.5 km east of the lifting site, the gear box oil pressure and oil temperature were within normal range.
6. After the HL9406 aircraft landed at a refueling location, the aircraft was inspected, and damage was found in the 「Engine Oil Cooling Fan Drive Shaft」

and the 「Rotor Brake System」 .

7. The damage in the gear box roller bearing (75-4 2206B1) resulted from its parts' deterioration caused by the fatigue flaking under a normal oil intake.
8. The fatigue flaking of the bearing parts was caused by the bearing assembly's operation under the influence of considerable off-design vibro-dynamic axial and radial load from the fan drive shaft direction, and this load was caused by the destruction of Main Rotor brake parts.
9. The Main Rotor brake parts and other parts related to the fan drive shaft were damaged due to a sudden growth of the load in the system. The sudden growth of the off-design vibro-dynamic load in the system, "Main Rotor brake - fan drive shaft" was due to the rotor brake shoes imbalance caused when the lower brake shoe return spring was uncoupled from the bracket mounting pin.
10. It was recorded in the HL9406 aircraft 「Main Gear Box」 log book that Mobil Jet-II, in violation of the relevant regulation, had been supplied at 100 hour inspection, however, it was verified that the mechanic in charge made a wrong entry by mistake.

3.2 Causes

The ARAIB determines the causes of this incident as follows:

The cause of the damage in the Main Rotor brake and the main gear box roller bearing is the considerable off-design vibro-dynamic axial and radial load from the fan drive shaft direction, and this load was caused by the destruction

of Main Rotor brake parts.

The Main Rotor brake was damaged due to a sudden growth of vibro-dynamic load in the system caused by the imbalance in the 「brake shoe A」, and this imbalance was caused when the 「brake shoe A」's return spring was uncoupled from the bracket mounting pin.

Contributing to the incident were (1) the failure to tighten a bolt in accordance with the Technical Specification requirements when combining the fan drive flange with the flexible coupling; and (2) the failure to meet the Technical Specification requirements when jointing the brake shoe return spring pin (5.00.1540.0015.000) with the bracket (5.00.1540.0011.000) mounting hole, \varnothing 6mm in diameter - the actual gap was 0.05mm, whereas the max. gap permitted is 0.017mm.

4. Safety Recommendations

As a result of the investigation of the incident that occurred to a HL9406/KA-32A rotorcraft affiliated with the HeliKorea on May 8, 2010, about 15:50, the ARAIB makes the following safety recommendations:

To the Helikorea Co. Ltd.

1. Examine the actual multiple checks for maintenance activities of the maintenance division so that the erroneous recording of the maintenance results can be prevented. **(AIR1002-01)**

To the KumApe Co.

1. Devise a measure to improve the rotor brake system installation work and the quality control of the brake shoe return springs. **(AIR1002-02)**