



Final report RL 2015:12e

Serious incident in Umeå on 9 November 2014 involving helicopter SE-JRH of model Agusta Westland 139, operated by The Swedish Maritime Administration.

File no. L- 0140/14

28/08/2015

SHK investigates accidents and incidents from a safety perspective. Its investigations are aimed at preventing a similar event from occurring again, or limiting the effects of such an event. The investigations do not deal with issues of guilt, blame or liability for damages.

The report is also available on SHK´s web site: www.havkom.se

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General observations

The Swedish Accident Investigation Authority (Statens haverikommission – SHK) is a state authority with the task of investigating accidents and incidents with the aim of improving safety. SHK accident investigations are intended so far as possible to determine both the sequence of events and the cause of the events, along with the damage and effects in general. The results of an investigation shall provide the basis for decisions aiming at preventing a similar event from occurring again, or limiting the effects of such an event. The investigation shall also provide a basis for assessment of the performance of rescue services and, when appropriate, for improvements to these rescue services.

SHK accident investigations thus aim at answering three questions: *What happened? Why did it happen? How can a similar event be avoided in future?*

SHK does not have any inspection remit, nor is it any part of its task to apportion blame or liability concerning damages. This means that issues concerning liability are neither investigated nor described in association with its investigations. Issues concerning blame, responsibility and damages are dealt with by the judicial system or, for example, by insurance companies.

The task of SHK also does not include, aside from that part of the investigation that concerns the rescue operation, an investigation into how people transported to hospital have been treated there. Nor does it include public actions in the form of social care or crisis management after the event.

Investigations of aviation incidents are governed mainly by Regulation (EU) No 996/2010 on the investigation and prevention of accidents and incidents in civil aviation and by the Accident Investigation Act (1990:712). The investigation is carried out in accordance with Annex 13 of the Chicago Convention.

The investigation

SHK was informed on 9 November 2014 that a serious incident involving a helicopter with registration SE-JRH had occurred in Umeå, Västerbotten county, that same day at 13.30.

The incident has been investigated by SHK as represented by Mikael Karanikas, Chairperson, Stefan Carneros, Investigator in Charge and Christer Jeleborg, Technical Investigator.

SHK has hired Exova AB as an expert in materials analysis.

Mats Bernelind has acted as advisor to the Swedish Transport Agency.

The investigation team of SHK was assisted by David Wright from Moog Component Group.

Alessandro Cometa and Mitchell Gallo have participated as accredited representatives for the Italian air accident authority, (Agenzia Nazionale per la

Sicurezza del Volo, ANSV) and the National Transportation Safety Board, NTSB (USA) respectively.

Luigi Candiani, AgustaWestland has acted as advisor to ANSV.

The following organisations have been notified: The International Civil Aviation Organisation (ICAO), the European Aviation Safety Agency (EASA), the European commission, ANSV, NTSB, TSB Canada and the Swedish Transport Agency.

The investigation has been limited to the scope of the faulty component belonging to the anti-icing system.

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Aircraft:	
Registration and type	SE-JRH
Model	AW 139
Class/Airworthiness	Normal, Certificate of Airworthiness and valid ARC ¹
Operator	The Swedish Maritime Administration
Time of occurrence	2014-11-09, at 13.30 in daylight Note: all times are given in Swedish standard time (UTC ² + 1 hr)
Place	Umeå, Västerbotten county, (position approx. 64°18N, 020°97 E, 150 metres above sea level)
Type of flight	SAR
Weather	According to SMHI's analysis: Wind: South-westerly/5-10 knots Wind at 1 000ft: south-westerly/15 knots. Visibility: > 10 km. Cloud: The route from Luleå to just north of Skellefteå: no low clouds. The route from just north of Skellefteå to Umeå cloud base: 800-1 200 feet. Temperature: + 3°C, dewpoint: +1° C. QNH ³ : 1 008-1 011 hPa, lowest in Luleå.
Persons on board:	4
Crew including cabin	4
Passengers	0
Injuries to persons	None
Damage to aircraft	Limited
Other damage	None
Commander:	
Age, licence	47, ATPL(H) ⁴
Total flying hours	4 300 hours, of which 213 hours on type
Flying hours previous 90 days	39 hours, of which all hours on type
Number of landings previous 90 days:	50
Co-pilot:	
Age, licence	41, ATPL(H)
Total flying hours	4 327 hours, of which 208 hours on type
Flying hours previous 90 days	49 hours, of which 49 hours on type
Number of landings previous 90 days:	44

¹ ARC (Airworthiness Review Certificate).

² UTC (Coordinated Universal Time) is a reference for the exact time anywhere in the world.

³ QNH indicates barometric pressure adjusted to mean sea level.

⁴ ATPL(H) - Airline Transport Pilot License (Helicopter).

SUMMARY

A helicopter of the type AgustaWestland AW 139 had been on a training mission and was on its way to the operating base in Umeå. Then, about 10 minutes to landing a caution was activated for fail on FIPS⁵ linked to the tail rotor. The crew asked for a priority landing, which was carried out without any further problems.

The helicopter was equipped with a so-called slipring whose task was to transfer the electrical power to the rotating parts of the tail rotor.

During the technical examination, it was discovered that slipring had become loose from its fix points at the tail rotor gearbox. The slipring was mounted very near the rotating parts of the tail rotor and only its electric harness prevented the solid state parts from starting to rotate and thus risk damaging the tail rotor.

The SHK's examinations have shown that screws with incorrect length had been used during manufacture, which broke after a short operating time. In addition, the investigation highlighted that too low tightening torque has previously been used; that locking wires has been installed in the wrong direction. Despite this an FAA form 8130-3 has been issued.

Safety recommendations

It is recommended that the FAA assess the need of more effective oversight of PMA holders so that:

- Compliance with the applicable authority requirements and internal procedures is ensured. (*RL 2015:12 R1*)
- All manufactured parts are airworthy upon signing of the FAA Form 8130-3. (*RL 2015:12 R2*)

⁵ FIPS – Full Ice Protection System.

1. FACTUAL INFORMATION

1.1 History of the flight

The helicopter, with a full crew complement of four persons, had been on a training assignment and was on its way towards its operating base in Umeå when the incident occurred.

There were good weather conditions and an altitude of 1 000-1 500 feet was chosen. However, the crew noted heavy cloud cover in the area they were headed for, prompting them to activate FIPS in order to cover the eventuality of flying into a cloud where there would be a risk of ice formation. The speed was approximately 140 knots. When approaching the area of heavy cloud cover, they descended to 500 feet and turned towards the outer archipelago. With around 10 minutes to landing, a caution for a fault with the FIPS, related to the tail rotor, was triggered. The crew requested priority over other traffic and landed without further incidents. No signs of increased level of vibrations or other warnings were noted.

After engine shut down and in connection with fault isolation, it was discovered that the slip ring, which in its entirety weighs 5.9 kg and which was mounted adjacent to the tail rotor, had come loose, and the cables had prevented it from coming into contact with the tail rotor's moveable parts.

During a “walk-around check” prior to the flight, in connection with a stop at Sunderbyn, no signs of a fault were seen. Nor can the slip ring be reached without a ladder.

The incident occurred at the approximate position of N 64°18, 020°97 E, 150 metres above sea level.

1.2 Injuries to persons

None.

1.3 Damage to aircraft

The damages were limited to the slip ring. These damages are described in more detail in section 1.6.3.

1.4 Other damage

None.

1.5 Personnel information

Due to the nature of the incident, there is no need to provide detailed information on the crew.

1.6 The Aircraft



Figure 1. The helicopter, SE-JRH.

1.6.1 General

AgustaWestland 139 is a twin engine transport helicopter with conventional configuration consisting of a five-blade main rotor and a four-blade tail rotor, featuring three wheels fitted with retractable landing gear.

It was a relatively new type of helicopter for the operator. The helicopters were equipped for air and sea rescue. The helicopter type is approved for flying in icing conditions in the Swedish SAR model.

1.6.2 Helicopter

TC-holder	AGUSTAWESTLAND S.p.A.
Model	AW 139
Serial number	31499
Year of manufacture	2013
Gross mass, kg	Max permissible take-off and landing mass 6 800 actual 6 300.
Centre of gravity	Within permitted area.
Total flying time, hrs	342
Operating time since overhaul	27
Number of cycles	318
Outstanding remarks	None

The aircraft had a Certificate of Airworthiness and a valid ARC.

1.6.3 Description of parts or systems significant to the incident

The slip ring constitutes a part of FIPS and is intended to transfer electrical current from the helicopter's solid structure to the heated up parts of the rotating tail rotor blades. FIPS allows the pilot to fly into weather which entails a risk of ice formation.

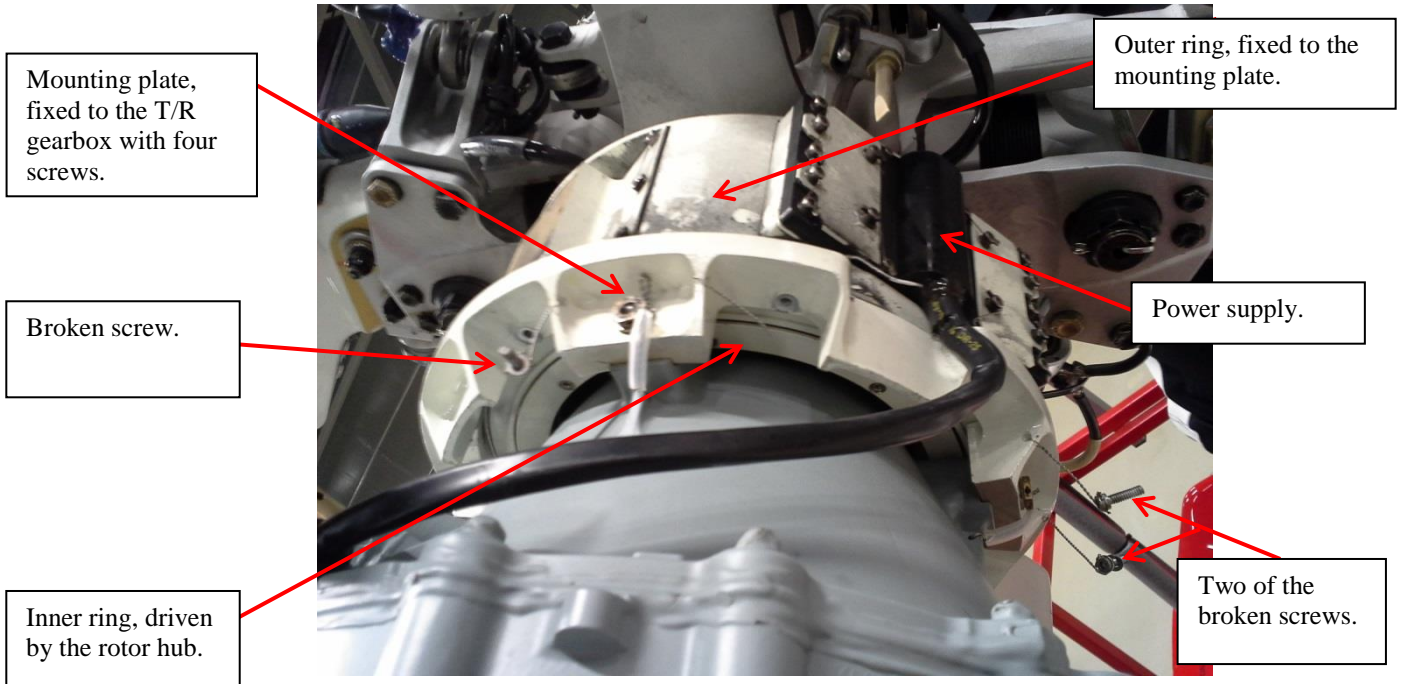


Figure 2. Slip ring Photo: The Swedish Maritime Administration.

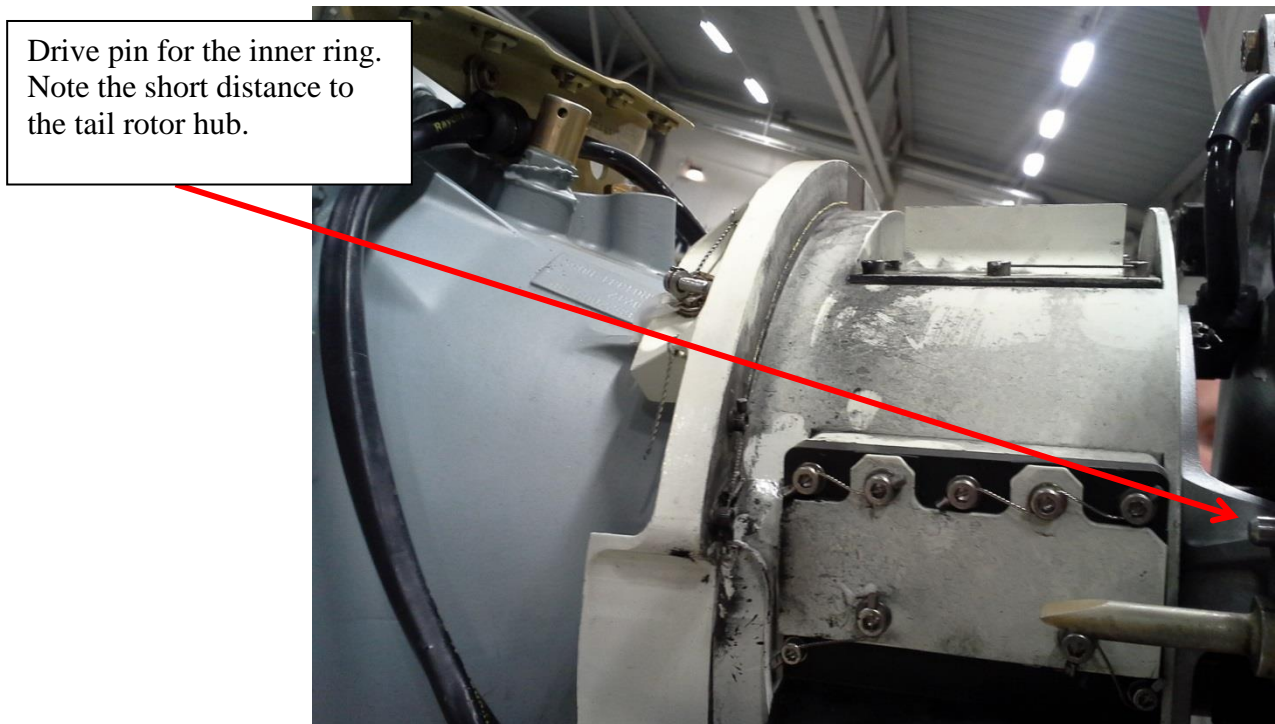


Figure 3. Slip ring Photo: The Swedish Maritime Administration.

The slip ring consists of the following parts: mounting plate, outer ring with electrical connections, carbon brush holder and inner ring driven by the tail rotor hub. The mounting plate is fixed with four screws to the tail rotor gearbox and to the outer ring with eight smaller screws. From the inner ring, separate electrical cables are led to the respective rotor blade's anti-icing coating.

The slip ring carries the serial number 2005C.

1.7 Meteorological information

According to SMHI's analysis:

General weather conditions: A weak cold front passed eastwards over the area.

Weather 09/11/2014, 12:30 local time, Luleå-Umeå.

Wind: south-westerly, 5-10 knots.

Wind at 1000ft: roughly south-westerly/15 knots.

Visibility: > 10 km.

Cloud: The route from Luleå to just north of Skellefteå: no low clouds.

The route from just north of Skellefteå to Umeå cloud base: 800-1 200 feet.

Temp: 3 degrees, dewpoint: 1 degrees.

QNH: 1 008-1 011 hPa, lowest in Luleå.

1.8 Aids to navigation

Not applicable.

1.9 Communications

Not applicable.

1.10 Aerodrome information

Not applicable.

1.11 Flight recorders

The helicopter was equipped with recording equipment of type MPFR. The recorder has not been examined as it was not deemed necessary in order to investigate the incident.

1.12 Site of occurrence



Figure 4. Approximate site of occurrence. Map: Google.

1.13 Medical information

Not applicable.

1.14 Fire

There was no fire.

1.15 Survival aspects

1.15.1 *Rescue operation*

No rescue operation was initiated.

1.16 Tests and research

1.16.1 *Examination of the mounting plate and the broken screws*

The SHK has had Exova AB to examine the mounting plate and the remaining screws examined with the purpose of assessing the type of screw fracture, etc. The mounting plate and the rest of the slip ring are made of an aluminum alloy and the screws of a steel alloy with a high tensile strength. The thread of the screws has damaged the lateral surface in the holes on the mounting plate. The examination has revealed that all screws broke due to a large number of low-level stresses. This is known as a fatigue fracture. The formation of the fracture began in the thread bottom, roughly 16 mm from the screw head of all screws, which also show signs of final fracture. According to the Exova examination, the likely cause of the fatigue fracture is excessively low prestressing of the screws.

1.16.2 Inspection and dismantling of the faulty slip ring

Supervised by SHK, an inspection was performed by the type certificate holder, the slip ring manufacturer and a helicopter workshop, to a full dismantling of the component in question, as well as inspections of two additional reference components.

The purpose of the examination was to conduct an unbiased investigation into whether or not there were faults in the slip ring. These faults could thus have contributed to the screw fractures, e.g., via abnormally high friction between the outer and inner rings. During the dismantling and subsequent examination, it was established that the wrong type of screws were used when attaching the mounting plate to the slip ring. These screws were 4 mm longer than those intended for the position, which meant that they bottomed out in the screw holes (see figure 5 and 6). Apart from the length, these screws were identical to the correct ones. The incorrectly mounted screws were of the type used for the lid on the power connection (see figure 2). It was also noticed that a significantly lower tightening torque than that prescribed was required to loosen all eight screws on one of the reference slip rings. SHK has taken into account the great difficulty of determining the amount of tightening torque that was actually applied. Furthermore, the majority of lock-wires for the screws on both reference slip rings were set in the wrong direction (see figure 7). No other faults in the slip ring could be found.

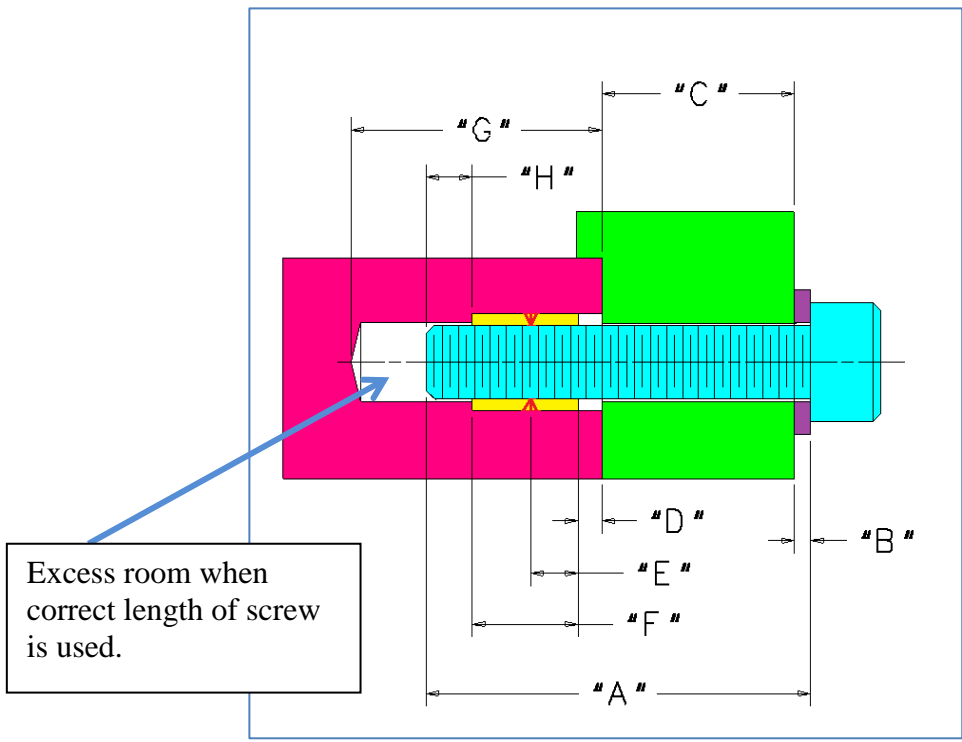


Figure 5. Diagram of the mounted screws.

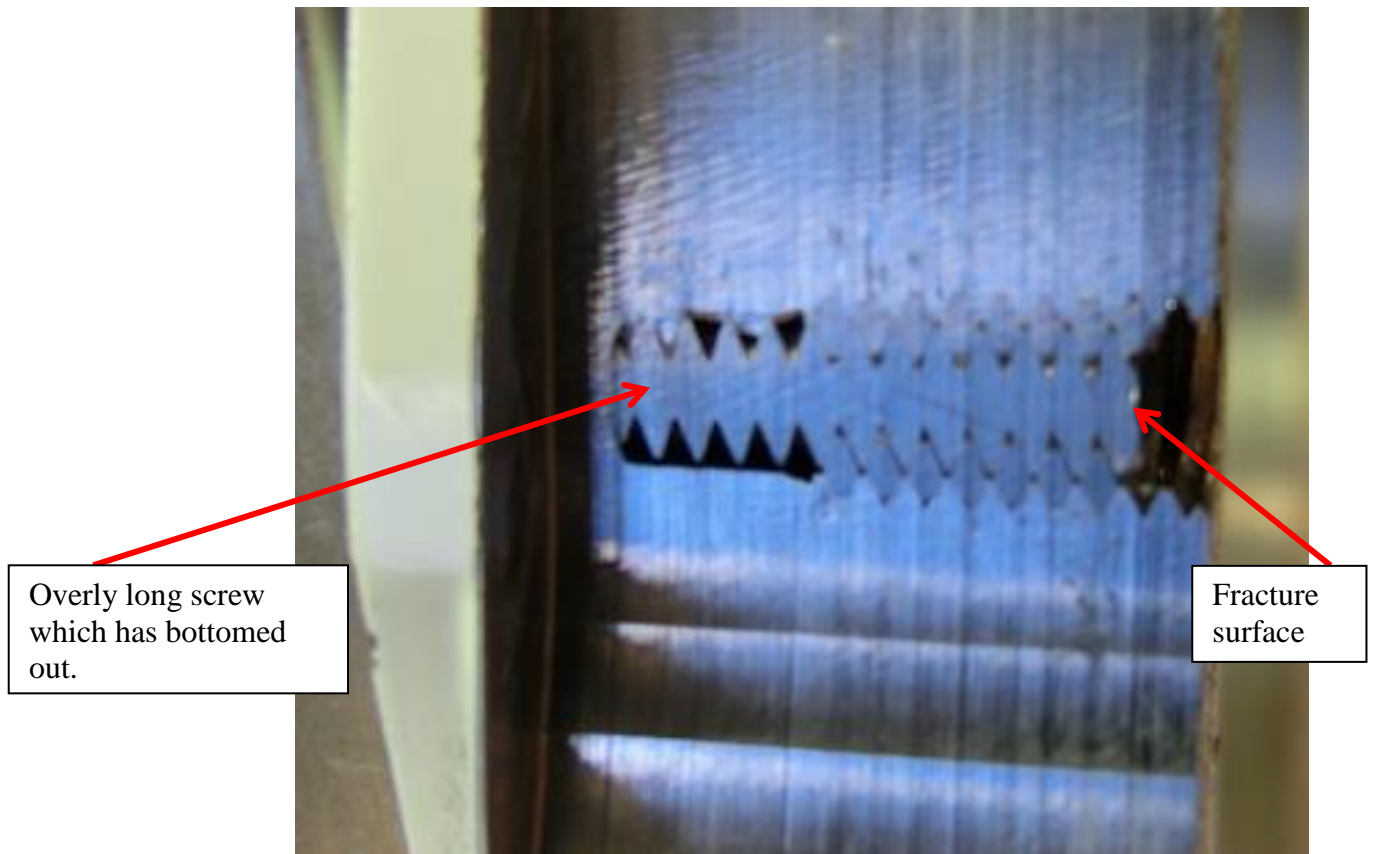


Figure 6. One of the fractured screws which was too long.

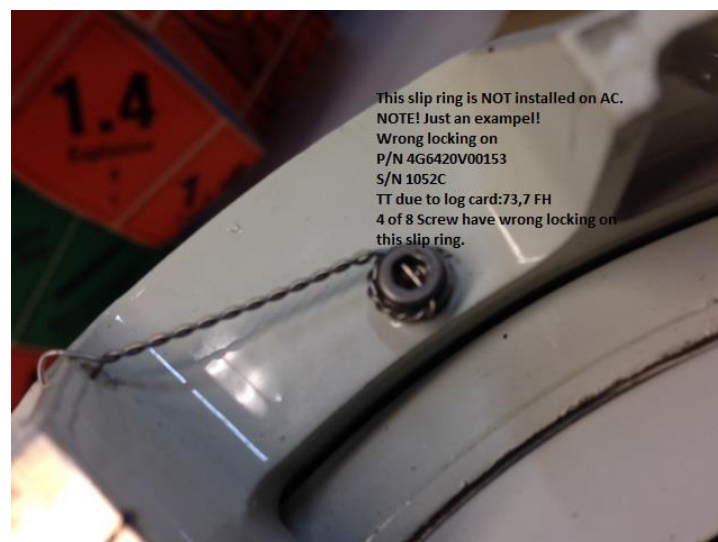


Figure 7. Example of wrong locking in the reference component.
Photo: The Swedish Maritime Administration.

1.17 The operator's organisation and management

The Swedish Maritime Administration is an authority which conducts official aviation operations in the form of air and sea rescue with helicopters. The localities in which its bases of operations are situated along the Swedish coastline, in Umeå, Norrtälje, Visby, Ronneby and

Göteborg. The crews consist of four persons; two pilots, a winch operator and a rescue swimmer. During the rescue operations, the helicopters are directed by JRCC in Göteborg, where the Swedish Maritime Administration's organisation, SMA Maintenance AB carries out maintenance in accordance with a contract with the operator.

1.18 Additional information

1.18.1 PMA parts

The slip ring is produced in the USA under a Part Manufacturer Approval (PMA) issued by the Federal Aviation Authority (FAA).

In order to obtain a PMA it is necessary, in accordance with FAA part 21 subpart K, that the applicant, among other things, must make all inspections and tests necessary to determine compliance with the applicable airworthiness requirements, and that the manufacturing processes, construction and assembly conform to those specified in the design (§ 21.303). The applicant must also describe how its organization will ensure compliance with the provisions of this subpart (§ 21.305). There must also be a quality system and a quality manual (§§ 21.307 and 21.308). The quality system must meet the requirements of § 21.137, which includes a *Manufacturing process control*, i.e. procedures for controlling manufacturing processes to ensure that each product and article conforms to its approved design.

Every applicant for or holder of a PMA must allow the FAA to inspect its quality system, facilities, technical data and any manufactured articles necessary to determine compliance with the provisions (§ 21.310).

The FAA has stated that its oversight is dependent upon the criticality of the component. Most Manufacturing Inspection District Offices (MIDO) will normally perform audit inspections annually, but again this might vary.

There is a bi-lateral agreement between the EU and the USA which is put into force 1 May 2011, which means among others that new parts manufactured under a PMA are accepted to be installed in an aircraft without special approval within the EU, on the condition that the part is not considered to be critical. For parts considered to be critical, a special approval must be issued by EASA.

The slip ring in question has not been assessed to be a critical part of the aircraft. EASA is not authorized to perform supervisory oversight on the manufacturer; the responsibility for this is incumbent on the FAA.

1.18.2 Measures taken

The Swedish Maritime Administration took action before this incident had even taken place, following a series of less serious faults found in the sliprings, and decided to remove them from all AW 139 helicopters in operation. In the short-term perspective, this eliminated the risk for operational disturbances but limited the ability to operate in weather which entails the risk of icing.

Once AgustaWestland and the manufacturer of sliprings had carried out a number of modifications to these, the Swedish Maritime Administration decided to reinstall them. This incident involved the first of these reinstallations; the slipring had an operating time of 27 hours at the time of the incident.

Following the incident the type certificate holder, AgustaWestland, has published a Technical Bulletin, TB 139-404, which prescribes inspections and among other items changing certain screws in the slip ring.

The manufacturer of the slip rings has announced that they have introduced procedures for ensuring that the correct length of screw is used when assembling the component. An independent inspection is also used in order to verify that the correct screws have in fact been used. These measures are also employed in other areas of the manufacturer's production.

1.19 Special methods of investigation

None.

2. ANALYSIS

The slip ring was prevented by the electrical harness from coming into contact with the moveable parts of the tail rotor. It is not possible with any great certainty to establish whether this could have happened, and if so, after how long flight time. A seriously damaged tail rotor function, however, can result in a catastrophic⁶ condition and this must therefore be considered a serious incident.

The fact that the examined screws which fixed the slip ring to the mounting plate were too long meant that these bottomed out in the screw holes before the correct clamping force was achieved. Due to this, the friction between the slip ring and the mounting plate was lower than intended, which in turn meant that the screws were overloaded and finally broke from fatigue.

The screws used for mounting were very similar to the correct ones, which may explain why the wrong screws were used when assembling

⁶ Ref to 2.14.7 and 2.14.8 and graph 2.12 in ICAO Doc 9859 - Safety Management Manual (SMM).

the component. The only difference was that the screws used were 4 mm longer than the ones that should have been used.

It is the SHK's opinion that the selected type of screws introduced risks for human errors.

In addition, the investigation has revealed that too low a tightening torque was applied and lock-wires were set in the wrong direction. Despite this an FAA form 8130-3 was issued.

This combination of conditions means that it can be questioned as to whether the component manufacturer worked in the manner laid down in FAA Part 21, subpart K. Whilst the component manufacturer has taken measures after the incident, i.e. introduction of new procedures and independent inspections, the scope of the faults has prompted the authority to recommend that the FAA assess the need for more effective oversight of PMA holders.

3. CONCLUSIONS

3.1 Findings

- a) The helicopter had a Certificate of Airworthiness and valid ARC.
- b) The slip ring came loose from the mounting plate due to the screws which fixed it to the mounting plate broke.
- c) The screws broke as they were of the wrong model and were too long. This resulted in too low a tension in the bolted joint.

3.2 Causes

The incident was caused by the wrong screws being mounted onto the slipring. This in turn indicates insufficient control in the manufacturing process.

4. SAFETY RECOMMENDATIONS

It is recommended that the FAA assess the need of more effective oversight of PMA holders so that:

- Compliance with the applicable authority requirements and internal procedures is ensured. (*RL2015:12 R1*)
- All manufactured parts are airworthy upon signing of the FAA Form 8130-3. (*RL2015:12 R2*)

The Swedish Accident Investigation Authority respectfully requests to receive, by **30 November 2015** at the latest, information regarding measures taken in response to the recommendations included in this report.

On behalf of the Swedish Accident Investigation Authority,

Mikael Karanikas

Stefan Carneros