Statens haverikommission
Swedish Accident Investigation Board

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Report RL 2003:29e

Accident involving aircraft SE-GSS at Örebro airport, T County, Sweden, on the 5th of June 2002

Dnr L-037/02

SHK investigates accidents and incidents with regard to safety. The sole objective of the investigations is the prevention of similar occurrences in the future. It is not the purpose of this activity to apportion blame or liability.

Translated from the original Swedish by Dennis Lynn Anderson, at the request of the Swedish Accident Investigation Board.

In the event of discrepancies between the English and the Swedish texts, the Swedish version is to be considered to be the authoritative version.

The report is also available on our web site: www.havkom.se

Statens haverikommission (SHK) Swedish Accident Investigation Board

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2003-08-22 L-037/02

Swedish Civil Aviation Administration

601 79 NORRKÖPING

Report RL 2003:29e

The Swedish Accident Investigation Board (Statens haverikommission, SHK) has investigated an accident which occurred on the 5th of June 2002, at Örebro airport, T County, Sweden, involving an aircraft with registration SE-GSS.

In accordance with section 14 of The Ordinance on the Investigation of Accidents (1990:717), the Board herewith submits a final report on the investigation.

The Accident Investigation Board kindly awaits a reply by the 1st of March 2004 concerning how the recommendations issued in the report have been complied with.

Göran Rosvall

Sakari Havbrandt Dan Åkerman

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APPENDIX

1 Extract from Register of Licenses regarding the pilot (to The Swedish Civil Aviation Administration only)

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Report finalized 2003-08-22

Aircraft; registration, type	SE-GSS, Rockwell Commander 690C
Class, airworthiness	Normal, valid certificate of airworthiness
Owner/Operator	Ljusnäs Transport AB/AB Värmlandsflyg Bergbyvägen 49 B, Box 43, 685 21 Torsby
Date and time	2002-06-05, 08:45 hours in daylight *Note:* All times refer to Swedish Daylight Savings Time (UTC + 2 hours)
Place of occurrence	Örebro airport, T County, Sweden
Type of flight	Aerial work
Weather	According to SMHI's analysis: wind: 060/05 knots, visibility: unlimited, sky clear, temperature/dew point: 20°/11°C, QNH: 1019 hPa
Persons on board; crew	2
Injuries to persons	None
Damage to aircraft	Limited
Other damage	None
Pilot in command:	
Age, sex, licence	63 year-old male, Commercial Pilot Licence (Swedish B) with Instrument Rating
Total flying time	15,170 hours, of which 2,200 hours on the type
Flying hours previous 90 days	75 hours, of which 65 hours on the type
Number of landings previous 90 days	Unknown
Aerial photographer:	
Age, sex	61 year-old male

The Swedish Accident Investigation Board (SHK) was notified on the 5th of June 2002 that an accident had taken place on that same day at 08:45 hours in the airspace near Örebro airport, T County, Sweden, involving an aircraft with registration SE-GSS.

The accident has been investigated by SHK represented by Olle Lundström, Chairman to the 15th of September 2002, thereafter Göran Rosvall, Chairman, Sakari Havbrandt, Chief Investigator Flight Operations and Dan Åkerman, Chief Technical Investigator Aviation.

The investigation has been followed by the Swedish Civil Aviation Administration through Daniel Hummerdal.

Summary

The pilot departed from Gävle-Sandviken airport at 08:40 hours. After approximately five minutes into the climb, the pilot detected an odor that he initially believed was caused by detergent residue in the fresh-air system from the previous day's aircraft wash.

Gradually the smell of smoke became stronger and smoke was observed coming from both sides of the instrument panel. The aircraft was now at FL 220[1].

At this time the pilot decided to land as soon as possible at Örebro airport, which was almost straight ahead of him. The landing was accomplished approximately 10 minutes later after a visual approach to runway 01. During the approach to Örebro the crew tried to suppress the smoke emissions using the aircraft's halon fire extinguisher.

Immediately after landing the pilot turned the main electrical power switch to off and taxied into the parking ramp.

As soon as the aircraft came to a stop, the airport rescue team acted to extinguish the smoke emission.

The day after the occurrence the aircraft was inspected inside a hangar at the Örebro airport.

The instrument panel glareshield had melted in two areas that were located immediately above the left and right heaters of the side window defogger system. It could also be noted that both heaters had been overheated and that their heat insulation had been partially charred. In addition to this, the fan that supplies the system with air was inoperable.

The accident was caused by the side window defogger heaters becoming over-heated when the fan that supplies them with air stopped or failed to start. This caused the development of smoke from adjacent material, as it became heated. Contributory has been that the maintenance program for the aircraft does not include periodical maintenance of the fan or its motor.

Recommendations

The Swedish Civil Aviation Administration is recommended to work for that the aircraft type's design and maintenance program are revised; on the one hand so that a risk of fire does not arise if the fan stops, and on the other hand so that the probability of the fan stopping is diminished to an acceptable level. *(RL 2003:29e R1)*.

[1] FL: Flight Level, altitude in hundreds of feet based on an atmospheric pressure of 1013 hPa. FL 220 = 22,000 feet, approximately 6,700 meters.

1 FACTUAL INFORMATION

1.1 History of the flight

The pilot and a photographer had been commissioned to accomplish high-altitude aerial photography over the Gothenburg district.

The pilot took-off from Gävle-Sandviken airport at 08:40 hours. After approximately five minutes into the climb the pilot detected an odor that he initially believed was caused by detergent residue in the fresh-air system from the previous day's aircraft wash. Gradually the smell of smoke became stronger and smoke was observed coming from both sides of the instrument panel. The aircraft was now at FL 220[2].

At this time the pilot decided to land as soon as possible at Örebro airport, which was almost straight ahead of him. The landing was accomplished approximately 10 minutes later after a visual approach to runway 01. During the approach to Örebro the crew tried to suppress the smoke emissions using the aircraft's halon fire extinguisher.

Immediately after landing the pilot turned the main electrical power switch to off and taxied into the parking ramp.

As soon as the aircraft came to a stop, the airport rescue team acted to extinguish the smoke emission.

Neither of those on board was injured by the occurrence.

1.2 Injuries to persons

	Crew	*Passengers*	*Other*	*Total*
Fatal	–	–	–	–
Serious	–	–	–	–
Minor	–	–	–	–
None	2	-	–	2
Total	2	-	–	2

1.3 Damage to aircraft

Limited.

1.4 Other damage

None.

1.5 The crew

1.5.1 The Pilot in command

The Pilot in command was 63 years old at the time and held a valid Commercial Pilot Licence, (Swedish B).

Flying hours			
previous	*24 hours*	*90 days*	*Total*
All types	0	75	15,170
This type	0	65	2,200

Number of landing on this type previous 90 days: unknown.
Flight training on the type carried-out in 1980 in the USA.

[2] FL: Flight Level, altitude in hundreds of feet based on an atmospheric pressure of 1013 hPa. FL 220 = 22,000 feet, approximately 6,700 meters.

Latest PC (proficiency check) carried-out 2000-04-07 on the AC6T.

The Pilot in Command has stated that he considered the workload to be high, as he was the only pilot on board and he therefore decided to land as soon as possible instead of consulting the flight manual or emergency checklists. He did not experience the smoke emissions, as being so serious that it was necessary for the crew to don their oxygen masks.

1.5.2 The aerial photographer

The photographer was 61 years old at the time and had previous experience with photographic missions with the aircraft type.

He was used to using the oxygen system since many missions are performed at such an altitude that the cabin pressurization is insufficient.

1.6 The aircraft

THE AIRCRAFT	
Manufacturer	Rockwell Commander
Type	690C
Serial number	11613
Year of manufacture	1980
Gross weight	Within allowable limits
Center of mass	Within allowable limits
Total flight hours	8,293 hours
Number of cycles	Unknown
Operating hours since latest periodic check	20 hours

ENGINES	
Engine manufacturer	Honeywell
Engine model	TPE-331-5
Number of engines	2

The aircraft had a valid Certificate of Airworthiness.

1.7 Meteorological information

According to SMHI's analysis:
Wind: 060/05 knots, visibility: unlimited, sky clear, temperature/dew point: 20°/11° C, QNH: 1019 hPa.

1.8 Aids to navigation

R-nav, ADF and GPS [3] were utilized.

1.9 Communications

Radio communication was established with Stockholm Control and Örebro tower.

There was no formal emergency message (mayday) transmitted from the aircraft. However, the air traffic controller issued the aircraft clearance so that the landing could be accomplished without delay.

[3] R-Nav: Area navigation equipment, ADF: Automatic Direction Finder, GPS: Global Positioning System

1.10 Aerodrome information

The airport had operational status in accordance with the Swedish AIP[4]

1.11 Flight and voice recorders

There was no requirement to carry a Flight Data Recorder (FDR) or a Cockpit Voice Recorder (CVR) on board the aircraft and neither was fitted.

1.12 Accident site and the aircraft

1.12.1 Accident site

The accident occurred in the airspace northeast of Örebro at FL 220.

1.12.2 The aircraft

The visible damage was confined to the instrument panel glareshield having melted in two small areas on the right and left sides.

1.13 Medical information

Nothing has been found that would indicate that the physical or mental condition of the pilot was impaired prior to or during the flight.

1.14 Fire

There was no fire.

1.15 Survival aspects

The crew fought the smoke emissions with the aircraft's fire extinguisher during the descent. It cannot be ruled-out that this action prevented the igniting of material in the area nearest the heat source.

The Emergency Locator Beacon was not activated during the incident, as the landing was normal.

1.16 Tests and research

The day after the occurrence the aircraft was inspected inside a hangar at Örebro airport.

The instrument panel glareshield had melted in two areas that were located immediately above the left and right heaters of the side window defogger system. It could also be ascertained that both heaters had been overheated and that their heat insulation had been partially charred. In addition to this, the fan that supplies the system with air was inoperable.

1.16.1 Description of the side window defogger system

The defogger system consists of an electric motor-driven fan (Blower Assy[5]) that takes cabin air from under the instrument panel via the left and right heater assembly to supply the outlet ducts at the side windows with air. In order to amplify the effect of the system, the side windows have been equipped with "inner windows" of transparent plastic. Both heaters are

[4] AIP –Aeronautical Information Publication
[5] Assy = Assembly, here meaning the fan and motor as a unit.

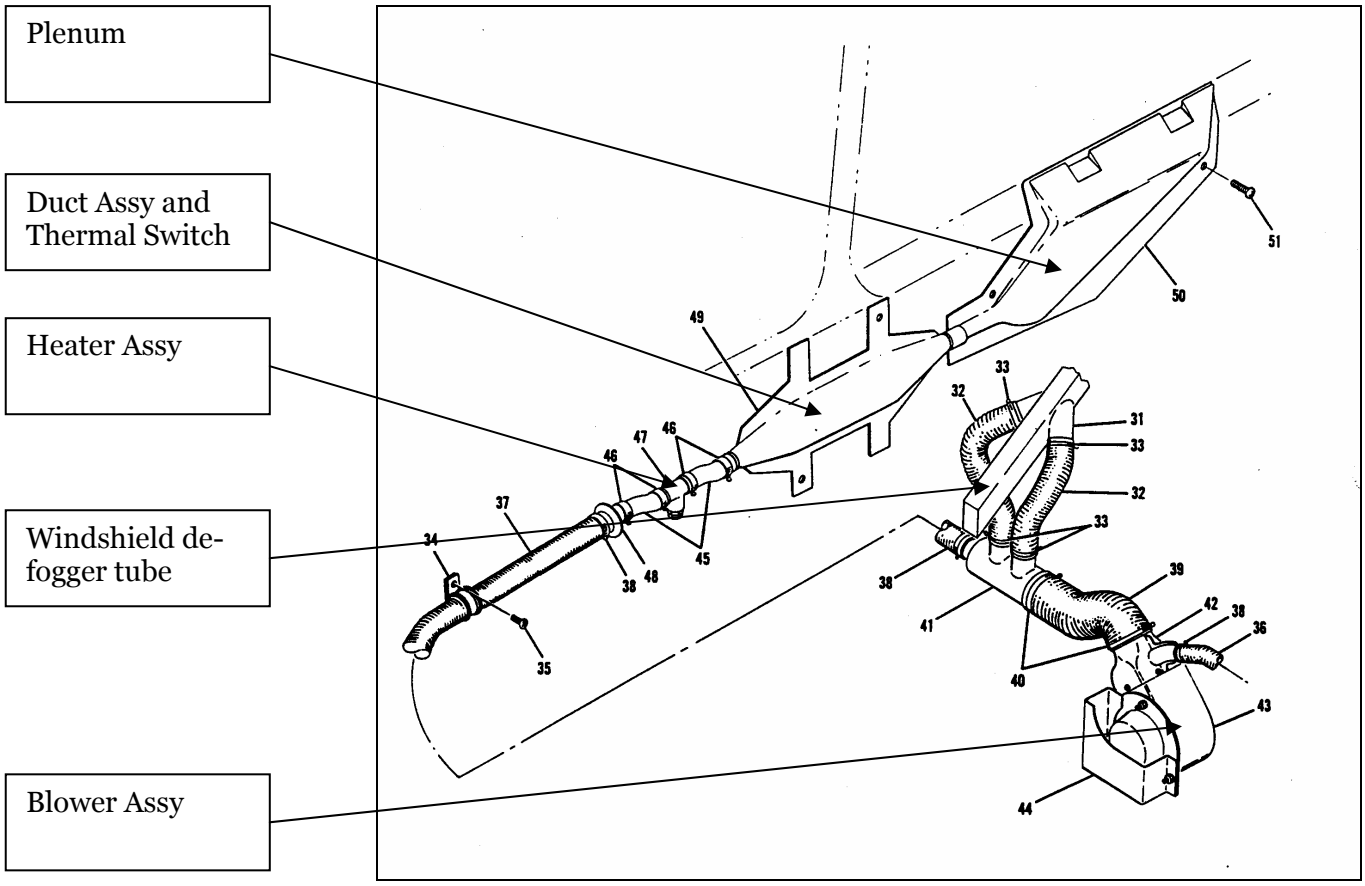
connected electrically in parallel with the fan motor and are therefore provided with electrical current when the fan switch is turned on.

There is no system to warn the pilot or to automatically turn-off the heaters, should the fan fail to start or stop during operation.

In order to maintain the defogger air at a suitable temperature there is a thermostat (Thermal Switch) in each air duct which, when required, disconnects the ground circuit to the heater so that an air temperature of approximately 50° C (125° F) is not exceeded.

The fan is used as required and always during flight at FL300, which is the highest altitude during aerial photography.

The fan also delivers air to the windshields but this air is not heated.



Side window defogger system, right side.

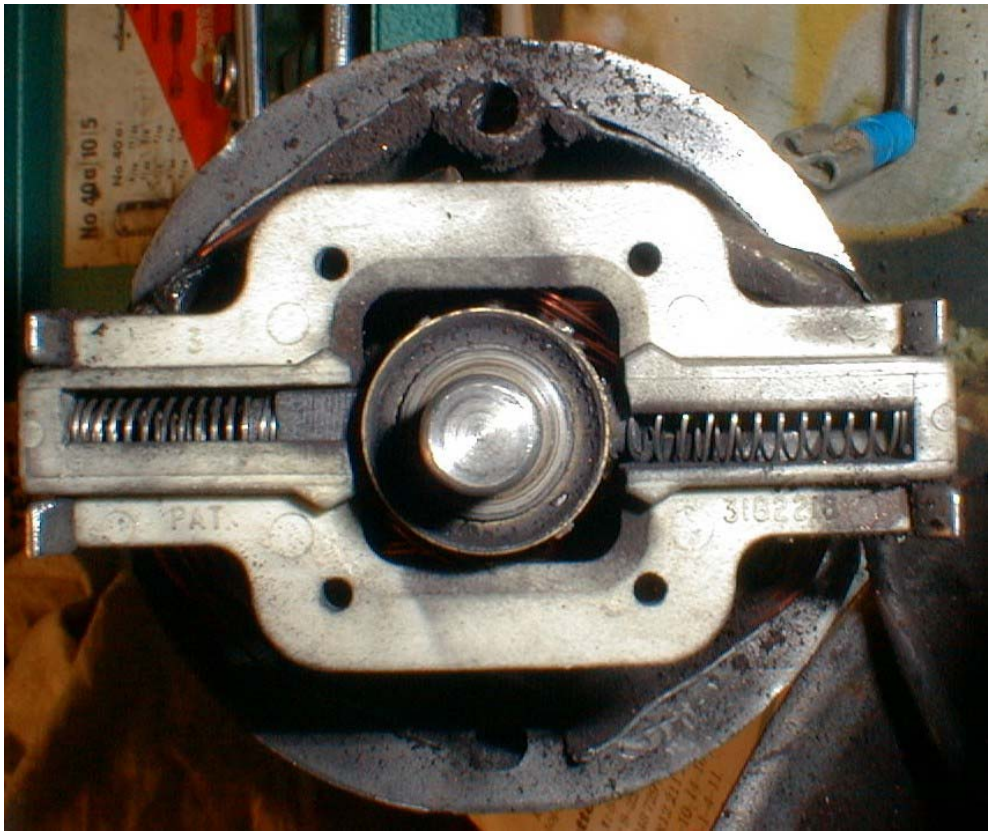
1.16.2 Examination of components

The fan motor, both heaters and the thermostats have been examined in detail with the following results:

The left and right heat shrouds were severely heat damaged while the internal heating elements were fully operational.

One of the motor brushes in the fan motor was completely worn-out and the motor did not run when supplied with electricity.

Both thermostats were closed at room temperature but opened at approximately 50° C.



The fan motor collector with motor brushes and brush holders. The brush on the right in the picture is worn-out.

Right-hand side window defogger.

1.17 Organizational and management information

The company AB Värmlandsflyg held a JAR-OPS[6] permit, issued by the Swedish Civil Aviation Administration, which included the type of activities here under discussion.

For this type of aviation activity with a single-pilot system there was no specific plan concerning what was to be carried-out in connection with the pilots' recurring periodical training. PC[7] was accomplished with externally acquired instructors. The instructor decided from case to case the contents of the PC.

1.18 Additional information

1.18.1 Maintenance basis (Aircraft Maintenance Manual, AMM)

The following statement is from the aircraft AMM, Section 30-40-00 B(1): "Maintenance on the defog blower is limited to removal and replacement. The blower does not require any servicing."

Additionally, it is described in "Maintenance Practices-Windshield Anti-Icing System 30-40-00-1", how a functional check of the system is to be accomplished concerning the confirmation of the existence of airflow. There is a warning that fire may develop if the heaters are in operation without airflow from the fan. This functional check is to be performed every 12th month.

1.18.2 Modifications of the side window defogger system

On the 15th of September 1981 the aircraft manufacturer produced a material kit (Custom Kit No. 133 "Improved Side Window Defog System") where the possibility was given to improve the function of the system by removing the heaters and sealing the ducting to them. A new air duct is then mounted between an air outlet on the floor and the discharge nozzle next to the side window.

With this configuration the entire airflow goes from the fan to the windshields.

Installation of Custom Kits is optional.

1.18.3 Checklists

Among other things, the aircraft manual and checklists contain the following checklist:

ELECTRICAL FIRE OR SMOKE IN FLIGHT

1.	Oxygen masks		On
2.	Oxygen		On
3.	All non essential electrical equipment	Off	
4.	Cabin depress switch	Depress	
5.	Fire extinguisher		Prepare

IF SMOKE OR ELECTRICAL FIRE CONTINUES:

6.	Generators		Off
7.	Battery Switch		Off
8.	All electrical switches	Off	

WHEN SMOKE OR FIRE IS GONE:

9.	Battery switch		On
10.	Generators (one at a time)		On
11.	Essential electrical equipment (one at a time)		On

[6] JAR: Joint Aviation Regulations, OPS: Operations, the designation stems from the common European aviation regulations.
[7] PC: Proficiency Check

2 ANALYSIS

2.1 The accident

The emission of smoke on board during flight is always serious from the viewpoint of safety of flight. If corrective measures are not immediately taken a possible over-heating or fire can rapidly deteriorate and have catastrophic results. It is therefore important that a useful and practical checklist is available to the pilots and that they are trained to apply it in different conceivable emergency situations.

SHK understands to a certain degree that the pilot, who was the only pilot on board, experienced stress when he realized that the smoke emissions probably were due to a fire or some sort of over-heating on board and then chose to land immediately at a nearby airport without using the emergency checklist.

If the pilot had used the emergency checklist, he would have found as the first two items in the checklist ”ELECTRICAL FIRE OR SMOKE IN FLIGHT” the recommendation to don the oxygen mask. Furthermore, there is much to indicate that the smoke emissions would have ceased if he had thereafter taken the steps according to the following six points in the checklist. By not using the oxygen equipment he exposed himself to the risk of being affected by the smoke gases during flight, which could have diminished his capacity and in the worst case rendered him unable to accomplish the landing.

The applicable items in the available checklist must in this case be considered to be relevant and easy to use. Also, it would probably not have delayed the pilot’s approach to the airport if he had used them. Contributory to the fact that the pilot did not use the checklist, may have been that the aviation company did not have a plan for periodic training in dealing with emergency situations, wherein the use of emergency checklists is an important element. This was a deficiency within the company’s operational routines.

2.2 The generation of smoke

Everything would indicate that the heaters became over-heated when the airflow stopped or was absent due to the fan having stopped. The thermostats, which are mounted in an air duct (Duct Assy) between the heater and the discharge nozzle (Plenum) were not affected by the increase in temperature, partially due to the distance to the heater and partly due to the cessation of the airflow. Consequently, the thermostats did not function as overheat protection.

As the heaters became too hot, they over-heated and charred the adjacent insulation and partially melted the instrument panel glareshield, which in turn caused the generation of smoke. The crew’s use of the halon fire extinguisher may have prevented a fire from breaking-out in nearby material.

2.3 The side window defogger system

The design of the system, with a fan that blows air through electrical heating elements, entails a built-in risk of over-heating if the fan should stop due to any reason. SHK has investigated whether the design fulfills the requirements in the certification criteria. The aircraft type is certified in accordance with CAR3 dated 15 May 1956 and FAR23 Amdt. 23-7 dated 14 September 1969. As far as SHK is able to ascertain the system does not violate the criteria of certification.

The 1st of February 1977, Amendment 23-17 to FAR23 was issued. Sec. 23-1309 was introduced at that time with the text:
(Equipment, Systems and Installations)
(b) The equipment, systems, and installations of a multiengine aircraft must be designed to minimize hazards to the airplane in the event of a probable malfunction or failure.

The design of the system would probably not have been approved after a review according to Sec. 23-1309.

Aircraft manufacturers are not however obliged to continuously modify their products so that they fulfill applicable certification requirements on a day to day basis. The previously mentioned Custom Kit No. 133 would have prevented the accident if it had been incorporated into the aircraft. It is however, uncommon that aircraft operators, considering costs and aircraft down time etc., modify a system that appears to function in flight operations.

2.4 Maintenance program

SHK finds it remarkable that the maintenance program does not require any periodical service on the fan or its motor. The functional check which is to be accomplished every 100th flying hour appears to be insufficient to prevent fan failure and therewith the accompanying over-heating of the side window defogger heaters.

The function of the fan to keep the windshield free from mist must be considered as vital and should in and by itself motivate a suitable maintenance program.

2.5 Emergency training

Emergency training, including practical hands-on use of controls, equipment and such, exists in order to diminish the workload during an emergency situation. Emergency training can also be of help in learning to quickly determine how serious a situation is.

It can be difficult to realistically train all conceivable emergency situations, but it is nevertheless important to have a plan so that one insures that the pilots continually and systematically are able to practice different emergency situations.

The aviation company lacked a plan for emergency training, which was probably contributory to the actions of the crew.

3 CONCLUSIONS

3.1 Findings

a) The pilot was qualified to perform the flight.
b) The aircraft had a valid Certificate of Airworthiness.
c) The aircraft was maintained according to an approved maintenance program.
d) Over-heated side window heaters caused the development of smoke.
e) The defogger heaters were over-heated as a consequence of the system fan being inoperable.
f) The maintenance program for the side window defogger system did not prevent the fan motor from ceasing to function due to a worn-out motor brush.
g) The pilot did not follow the checklist for electrical fire or smoke in flight.
h) The crew did not don oxygen masks.

i) No formal emergency message was transmitted.
j) The company did not have a plan for the systematic training of emergency situations during flight.

3.2 Causes

The accident was caused by the side window defogger heaters becoming over-heated when the fan that supplies them with air stopped or failed to start. This caused the development of smoke from adjacent material, as it became heated.

Contributory has been that the maintenance program for the aircraft does not include periodical maintenance of the fan or it's motor.

4 RECOMMENDATIONS

The Swedish Civil Aviation Administration is recommended to work for that the aircraft type's design and maintenance program are revised; on the one hand so that a risk of fire does not arise if the fan stops, and on the other hand so that the probability of the fan stopping is diminished to an acceptable level. *(RL 2003:29e R1)*.