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Aircraft accident investigation bureau

Final Report No. 1885 by the Aircraft Accident Investigation Bureau

concerning the serious incident

to the Dassault Falcon 2000 aircraft, N105LF

on 24 October 2004

at airway position BAMUR

Bundeshaus Nord, CH-3003 Berne

Ursache

Der schwere Vorfall ist darauf zurückzuführen, dass ein Generator eine Funktionsstörung entwickelte, welche zu schwer interpretierbaren Fehlwarnungen, verbunden mit Druckschwankungen im Flugzeug, führten. Dies bewog die Besatzung, einen Notsinkflug durchzuführen.

General information regarding this report

This report has been prepared in accordance with ICAO annex 13 solely for the purpose of accident/incident prevention. The legal assessment of accident/incident causes and circumstances is no concern of the investigation (art. 24 of the Air Navigation Law).

The masculine form is used in this report regardless of gender for reasons of data protection.

All times in this report, unless otherwise indicated, are indicated in coordinated universal time (UTC) format. At the time of the accident, Central European Summer Time (CET) applied as local time (LT) in Switzerland. The relation between LT, CET and UTC is: LT = CET = UTC + 2 h.

The report in the German language contains the valid formulations.

Any person able to prove a legitimate interest in the result of the investigation may within 30 days of delivery of the investigation report request that it be verified for completeness and conclusiveness by the Federal Aircraft Accident Commission (Eidg. Flugunfallkommission – EFUK).

The Aircraft Accident Investigation Bureau thanks the authorities and organizations for the given support throughout the investigation.

Final Report

Aircraft	Dassault Aviation Falcon 2000			N105LF	
Operator	Jet Aviation Business Jets AG, 8058 Zurich-Airport				
Owner	Sergej Bugachev, International Industrial Bank, Moscow/Russia				
Commander	Austrian citizen, born 1962				
Licence	Commercial pilot licence, issued by the Federal Aviation Administration (FAA)				
Flight Experience	**total**	6980	**in the previous 90 days**		127
	on Falcon 2000	681	**in the previous 90 days**		127
Copilot	Swiss citizen, born 1970				
Licence	Commercial pilot licence, issued by the Federal Aviation Administration (FAA)				
Flight Experience	**total**	3012	**in the previous 90 days**		96
	on Falcon 2000	128	**in the previous 90 days**		96

Place	Airway position BAMUR		
Coordinates	N04732.7 / E00932.6	**Altitude**	FL 360
Date and Time	24 October 2004, 15:57 UTC		

Type of flight	IFR private
Phase of flight	Cruise
Type of incident	Emergency descent

Injuries to persons

	Crew	Passengers	Others
Fatal	---	---	---
Serious	---	---	---
Minor or none	3	1	

Damage to aircraft	None
Other damage	----

Summary

Investigation

The Swiss Air Rescue Services (*Schweizerische Rettungsflugwacht - REGA)* informed the Swiss Federal Aircraft Accident Investigation Bureau about the serious incident.

An investigation according to ICAO Annex 13 was opened the same day. The crew was interviewed in the office of the airport authority Zurich. A technical investigation was completed.

The digital flight data recorder (DFDR) and the cockpit voice recorder (CVR) were removed from the aircraft and the data were evaluated.

1. Factual information

1.1 History of the flight

On 24 October 2004, at 15:31 UTC, the aircraft N105LF took of from Geneva on a private flight to Moscow-Vnukovo. Besides the flight crew one passenger and one flight attendant were on board.

The climb to the cruising altitude went uneventful. During this phase of flight the copilot was pilot flying (PF). As the aircraft passed the waypoint BAMUR in the area of the Lake of Konstanz at 15:57 UTC, the aural warning “CABIN” could be heard and the corresponding warning light appeared. At this time the aircraft was at flight level (FL) 360.

The pilots felt a considerable pressure fluctuation in their ears. This caused them to done the oxygen masks and to initiate an emergency descent. The flight attendant and the passenger also used oxygen mask. At about the same time the left generator failed.

According to the radar plot the aircraft began the emergency descent from FL 360 at 15:57:58 UTC. At 15:58:18 UTC the flight crew requested the permission for emergency descent from Munich air traffic control. They immediately received the clearance to descent and to proceed towards Zurich airport. The commander took over control of the aircraft.

The flight crew made an attempt to reengage the left generator. The generator, however, worked only for a short time.

At 16:16 UTC the flight crew received permission for a visual approach to runway 14 at Zurich. Approach and landing were uneventful.

After leaving the runway, the flight crew attempted to start the auxiliary power unit (APU), without success. Simultaneously the nose wheel steering failed and the controllability of the aircraft was restricted. The flight crew stopped the aircraft and shut down the engines. The aircraft was subsequently towed to the parking stand where the crew and the passenger left the aircraft.

1.2 Flight data recorders

The digital flight data recorder (DFDR) was evaluated. It turned out that no relevant data concerning cabin pressurization or electrical system were available.

The cockpit voice recorder (CVR) was evaluated. The recordings began at the time when the flight crew requested clearance for an emergency descent and the pilots donned their oxygen masks. With the mask microphones the recording was heavily overmodulated which had a negative effect on the audibility. During the approach into Zurich and after removal of the oxygen masks, the volume of the cockpit communication was very low and hardly intelligible. For the investigation, the recordings were only of limited use.

1.3 Aircraft systems and there operation

1.3.1 Cabin pressurization system

The cabin pressurization system of the Falcon 2000 consists of an electronically controlled main system and a pneumatically controlled auxiliary system. During normal operation the main system controls the cabin pressure automatically. When using the auxiliary system the cabin pressure has to be manually controlled and monitored. In case of loss of electrical power the system automatically switches from the main system to the auxiliary system. In case of abnormal system behavior the switching has to be performed manually.

The cabin pressure regulation valve (electropneumatic valve) of the main system closes automatically in case of loss of electrical power or after manually switching to the pneumatically controlled auxiliary system. The pressure regulation valve (pneumatic valve) of the auxiliary system is normally closed. After the pressure regulation valve of the main system had closed as a result of a fault, both valves stay closed until the valve of the auxiliary system has been operated manually.

1.3.2 Electrical system

During normal operation the left bus tie rotary switch is in closed position and the right tie rotary switch is in open (FLIGHT NORM) position. In this configuration the battery is charged by generator 1 via the essential bus. If generator 1 looses power and if the right bus tie rotary switch stays in position FLIGHT NORM, the battery will discharge provided that the APU is not running.

When the APU is in use it supplies electrical power to the left bus via the essential bus provided the left bus tie rotary switch stays closed. In this configuration the battery will be charged by the APU.

In case of a generator 1 fault, the checklist provides for the right bus tie rotary switch to be selected to the TIED position in order for the essential bus to be supplied by the generator 2 and consequently the battery being charged. If the left bus tie rotary switch stays closed, the left bus will be powered by the generator 2 (Annex 1).

1.3.3 Nose wheel steering

The nose wheel steering is electrically controlled and hydraulically activated. The electrical part of the steering is redundant. It consists, among others, of two steering units, which are supplied by two independent power sources.

1.4 Meteorological information

The following data are derived from MeteoSchweiz:

The general weather situation over Switzerland was influenced by high pressure.

The following data refer to airway position BAMUR at FL 360:

Clouds:	clear
Weather:	-
Visibility:	more than 10 km
Wind:	south southwest about 30 kt
Temperature:	-55 °C
Dew point:	-68 °C
0° boundary:	11 500 ft AMSL
Atmospheric pressure:	QNH LSZH 1013 hPa, QNH LSZA 1020 hPa
Danger:	none

Airport weather report (METAR) from Zurich:
LSZH 24.10.2005 16:20 METAR 15001KT CAVOK 16/12 Q1013 NOSIG

2. Analysis

2.1 Technical Aspects

There were no technical malfunctions documented before the serious incident.

2.1.1 Technical malfunctions during flight

The triggering of the acoustical and optical cabin pressure warnings was most probably the result of a generator fault. This fault was reproducible after the flight.

Troubleshooting revealed that the malfunction of the left generator was caused by an intermittent interruption of the excitation circuit.

Based on the malfunction found in the generator system it has to be assumed that the cabin pressure regulator valve of the main system had been closed as a result of the loss of electrical power. As both valves were now closed and the aircraft was at a relatively high altitude the differential pressure[1] was close to the maximum allowable value. It can be further assumed that the cabin pressure increased beyond the maximum differential pressure causing the safety feature in the pressurization system to trigger. This probably caused the mentioned pressure fluctuations.

During the emergency descent the cabin pressure was manually operated by the flight crew. This function worked normally.

According to the checklist it is left to the flight crew to start the APU in case of a generator fault. This, to prevent the battery from supplying the essential bus, should the second generator fail. After landing an attempt was made to start the APU. This allows the conclusion that the APU was not running during the flight.

Based on the CVR recordings an attempt was made to reset the generator 1 at about 5000 ft QNH during descent to Zurich, which was successful. Shortly after, the generator disconnected again. At about 1000 ft above ground the flight crew mentioned that the left bus and the essential bus were not powered. This allows the conclusion that the right bus tie rotary switch must have been in position FLIGHT NORM at this time. The checklist, however, provides for the right bus tie rotary switch to be brought in position TIED in case of generator 1 fault in order for the essential bus to be powered by generator 2. With that the battery would be continuously charged.

2.1.2 Technical malfunctions after landing

After landing the flight crew made an attempt to start the APU. According to the flight crew the voltage broke down during the APU start. At the same moment the nose wheel steering failed.

If one considers that the right bus tie rotary switch remained in position FLIGHT NORM one could assume that the charge of the battery was not enough to start the APU.

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[1] Differential pressure = cabin pressure – outside pressure

Based on the redundant electrical supply of the nose wheel steering control units it is difficult to see the connection between the generator 1 fault and the malfunction of the nose wheel steering. When considering that the generator 2 had supplied electrical power to the second control unit the nose wheel steering should have functioned normally. It cannot be ruled out, that as a result of voltage fluctuations in consequence of the APU start, also this second nose wheel control unit was affected.

During further flight operation no complaints in this connection were reported.

2.2 Human and operational aspects

Simultaneously with the perceptible pressure fluctuations the acoustical warning "CABIN" sounded and a corresponding warning light was presented. In fact these alerts were nuisance warnings which were caused by the generator fault. The perception of the pressure fluctuations had obviously given the flight crew the impression of a decompression. This might have influenced the flight crew's decision to perform an emergency descent.

The interpretation of the optical, acoustical and physical perceptions was difficult based on the nuisance warnings and did not lead to the identification of the actual problem. The decision of the flight crew to initiate an emergency descent for flight safety reason and to abandon the flight was appropriate.

3. Conclusion

3.1 Findings

- The pilots held valid licences.
- During cruise the left generator produced a serious malfunction and as a consequence it failed. The malfunction was caused by a defective contact in the excitation circuit of the generator.
- The serious malfunction of the generator most likely triggered a nuisance cabin pressure warning.
- The failure of the generator led to the loss of electrical supply to the cabin pressure controller causing the outflow valve to close automatically which in turn generated pressure fluctuations in the aircraft.
- The noticeable pressure fluctuations and the simultaneous triggering of the cabin pressure warning motivated the flight crew to execute the emergency descent.
- In case of a generator 1 fault, the checklist stipulates that the right bus tie rotary switch be set to the TIED position to allow the essential bus to be powered from generator 2. With this, the battery will be charged continuously.
- With high probability, the flight crew left the right bus tie rotary switch in the position FLIGHT NORM until after the landing. This resulted, among others, that the battery was being discharged.
- The attempt to start the APU after landing failed. Presumably the charge of the battery was not enough to allow an APU start.
- The simultaneous break down of the nose wheel steering during the unsuccessful APU start could not be explained conclusively.
- The cabin pressure controller was examined by the manufacturer. No failure was found.
- The weather conditions were favourable and had no influence on the occurrence.

3.2 Cause

The serious incident is attributable to the fact that a generator produced a malfunction which caused difficult to interpret nuisance warnings coupled with pressure fluctuations in the aircraft. This motivated the flight crew to execute an emergency descent.

Berne, 2 March 2006 Aircraft Accident Investigation Bureau

Annex 1

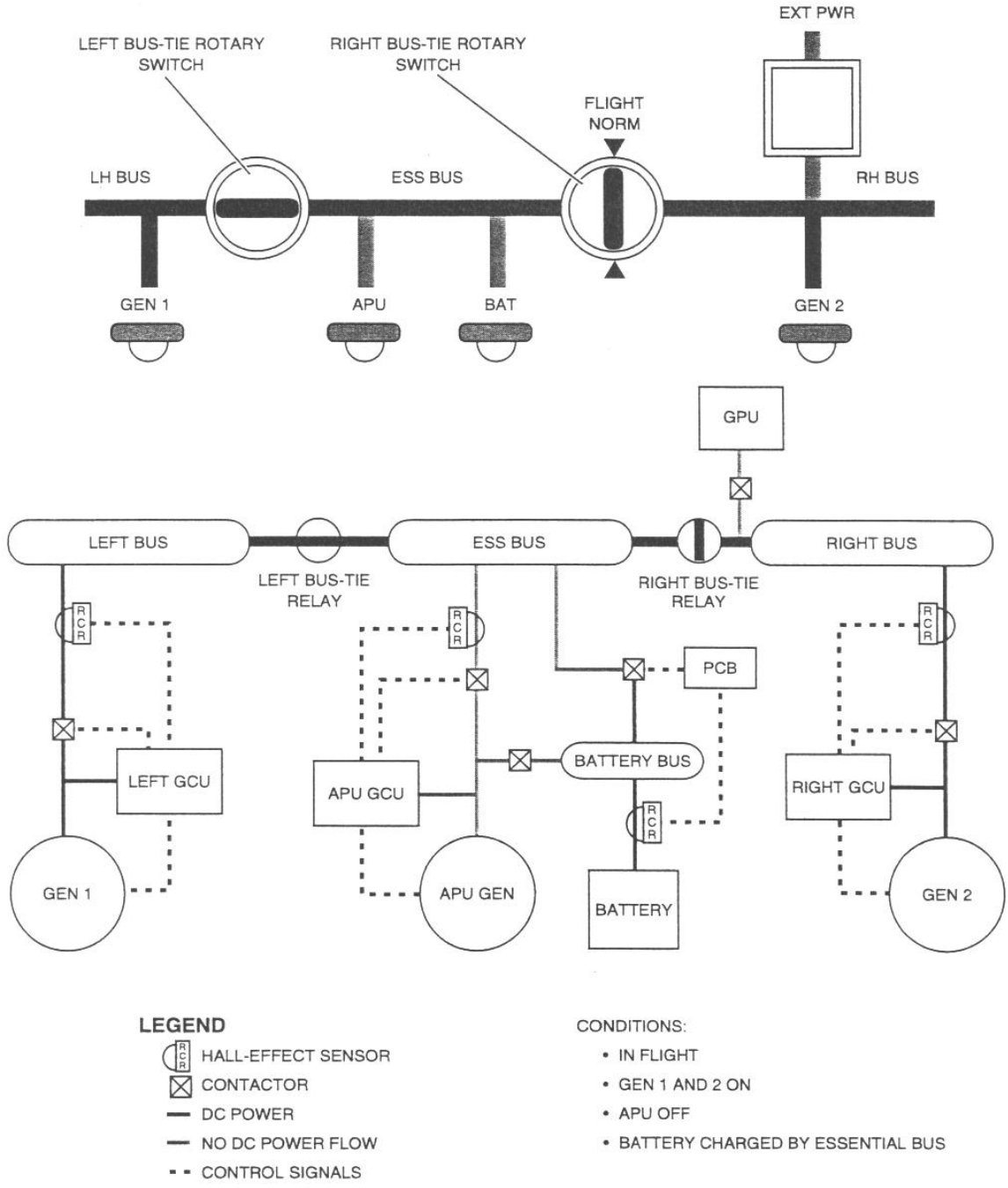

Figure 2-8. DC Electrical System