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Report C 1997:49
**Incident involving aircraft SE-DRG,
13 January 1997,
in controlled airspace west of
Stockholm, AB county, Sweden**

L-05/97

1997-12-16

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Swedish Civil Aviation
Administration

601 79 NORRKÖPING

Report C 1997:49

The Swedish Board of Accident Investigation (Statens haverikommission, SHK) has investigated a serious incident which occurred on 13 January 1997 in controlled airspace west of Stockholm, AB county, Sweden.

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

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1	Not applicable in this English version	
2	FDR-readout	

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Report finalised 1997-12-16

<i>Aircraft: registration and type</i>	SE-DRG , BAe 146 Series 200
<i>Owner</i>	Malmö Aviation Schedule AB, Box 37, 201 20 Malmö
<i>Time of incident</i>	13-01-1997 between 1700 hours and 1800 hours in darkness <i>Note:</i> All times in the report are given in Swedish normal time (SNT) = UTC + 1 hour
<i>Place</i>	In controlled airspace west of Stockholm, AB county, after takeoff at an altitude of around 1 300 ft above ground
<i>Type of flight</i>	Scheduled traffic
<i>Weather</i>	METAR Norrköping/Kungsängen 1750 hrs: Wind 260°/31 kts, visibility 9 km, haze, cloudbase 900 ft, temp/dp +5/+3°C, QNH 1003 hPa
<i>Numbers on board: crew</i>	2/3
<i>passengers</i>	38
<i>Personal injury</i>	None
<i>Damage to aircraft</i>	None
<i>Other damage</i>	None
<i>Captain's age and licence</i>	32 yrs, Airline Transport Pilot's Licence
<i>Captain's total flying hours</i>	4 390 hrs, of which 2 640 hrs on the type
<i>Captain's flying hours and number of landings previous 90 days</i>	74 hrs/73 landings, all on the type
<i>Copilot's age and licence</i>	38 yrs, Commercial Pilot's Licence with instrument rating
<i>Copilot's total flying hours</i>	3 175 hrs, of which 197 hrs on the type
<i>Copilot's flying hours and number of landings previous 90 days</i>	130 hrs/130 landings all on the type

The Board of Accident Investigation (SHK) was notified on 13 January 1997 that a serious incident with an aircraft registered SE-DRG had occurred in controlled airspace west of Stockholm, AB county, on the same day between 1700 hrs and 1800 hrs.

The incident has been investigated by SHK represented by Olof Forssberg, chairman up to 26 May 1997, Sven-Erik Sigfridsson thereafter, Monica J Wismar, Chief investigator flight operations, Henrik Elinder, Chief technical investigator (aviation) and Jan Mansfeld, Chief investigator rescue services.

SHK was assisted by Max Danielsson, also representing the Swedish Civil Aviation Administration, as operational expert.

Accredited Representative of the British Air Accident Investigation Branch was Mr Robert D.G. Carter.

The purpose of the investigations performed by SHK is solely to prevent accidents and incidents in the future.

SUMMARY

The aircraft took off from Stockholm/Bromma airport 13 January 1997 at 1706 hrs. When the copilot, at an altitude of approximately 1 300 ft above ground and in a left turn, intended to straighten out, he could not move the wheel more than 10 to 20 degrees right from its neutral position. The jamming was confirmed by the captain who by turning the left wheel with considerable force disconnected the left aileron control system from the right system. The captain was then able to manoeuvre the aircraft from his left seat using large wheel inputs. The crew declared an emergency and decided finally to divert to Norrköping/Kungsängen. The landing there was uneventful and the passengers disembarked at the terminal building.

The probable cause of the incident was a loose cover plate on the right aileron which, under the influence of aerodynamic forces during flight could catch against the trailing edge of the wing skin thereby jamming the upward movement of the aileron.

In its Preliminary Report dated 31 January 1997 the Board has recommended the Swedish Civil Aviation Authority to encourage their British counterpart, initially, to direct all operators of the aircraft type to perform a special check of the chain tension in the control column and of the installation of the cover plate.

Recommendations

None except the one in the Preliminary Report.

1. FACTUAL INFORMATION

1.1 History of the flight

1.1.1 *The flight*

The aircraft took off from Stockholm/Bromma airport (ESSB), runway 30, on January 13 1997 at 1706 hrs as regular flight 6E 153 to Göteborg/Landvetter (ESGG). The takeoff was normal and the copilot was flying from the right seat.

When at an altitude of approximately 1 300 ft above ground and in a left turn, he intended to straighten out, he could not move the wheel more than 10 to 20 degrees right from its neutral position. The jamming was confirmed by the captain who, by turning the left wheel with considerable force, disconnected the left aileron control system from the right. The captain could then manoeuvre the aircraft using large wheel inputs on the left control column.

The crew declared an emergency and asked for and received clearance to land at Stockholm/Arlanda (ESSA). En route there the pilots took action following the Emergency Checklist and informed the cabin crew and the passengers about the situation. Considering the weather situation in the area, with low clouds and strong surface wind, the crew somewhat later decided to divert to Norrköping/ Kungsängen (ESSP) as the landing there could be performed upwind. En route to Norrköping the crew realised that they could fly the aircraft quite normally from the left side even though large inputs on the wheel were needed for roll control. Before the landing, emergency preparation of the cabin had been completed.

The landing was uneventful with the passengers in the brace-for-impact position. The aircraft taxied to the terminal building where the passengers disembarked.

1.1.2 *Rescue services*

A "Risk of accident" alert was recorded at the SOS centre in Norrköping at 1733 hrs and passed on to the local rescue services in Norrköping. The fire engineer on duty was also directly alerted by the Aeronautical Rescue Co-ordination Centre (ARCC) in Gothenburg. In addition to the normal routines in an alert phase the rescue co-ordinator at the ARCC asked for a rescue vehicle to be positioned 10 km east of the airport on the centreline.

The fire engineer reported that his intention was to follow the landing from the tower. During his transfer there he ordered the local rescue services control centre to send a rescue vehicle to the position required by the ARCC. Because of radio communication difficulties during his transfer this order was never executed, according to the fire engineer. The local rescue service vehicles arrived at the airport at 1742 hrs and took position as ordered.

The airport rescue group consisted of three vehicles, one foreman and six firemen on civil duty. The local rescue force consisted of four vehicles and one command vehicle with a fire engineer on duty.

No rescue action became necessary.

1.2 Personal injuries

	<i>Crew</i>	<i>Passengers</i>	<i>Other</i>	<i>Total</i>
Fatal	-	-	-	-
Seriously injured	-	-	-	-
Slightly injured	-	-	-	-
No injuries	5	38	-	43
Total	5	38	-	43

1.3 Damage to the aircraft

None.

1.4 Other damage

None.

1.5 The crew

The captain was 32 years old at the time and had a valid Airline Transport Pilot's Licence (Swedish D).

Flying hours

<i>previous</i>	<i>24 hrs</i>	<i>90 days</i>	<i>Total</i>
All types	1.3	74	4 390
This type	1.3	74	2 640

Number of landings this type previous 90 days: 73.

Flight training on A/C type concluded in 31-05-1990.

Latest PFT (periodic flight training) carried out in 03-10-1996 on BAe 146/BAe 146 simulator.

The copilot was 29 years old at the time and had a valid Commercial Pilot's Licence (Swedish B) with instrument rating.

Flying hours

<i>previous</i>	<i>24 hrs</i>	<i>90 days</i>	<i>Total</i>
All types	1.3	130	3 175
This type	1.3	130	197

Number of landings previous 90 days: 130.

Flight training on A/C type concluded 30-07-1996.

Latest PFT (periodic flight training) carried out 04-11-1996 on BAe 146.

1.6 The aircraft

1.6.1 *General*

<i>Owner:</i>	Malmö Aviation Schedule AB, Box 37, 201 20 Malmö			
<i>Type:</i>	BAe 146 Series 200			
<i>Serial number:</i>	E2054			
<i>Year of manufacture:</i>	1986			
<i>Gross weight:</i>	Max. permissible 89 419 lbs (40 596 kg), actual unknown			
<i>Centre of gravity:</i>	Unknown			
<i>Engine manufacture:</i>	Textron Lycoming (now Allied Signal)			
<i>Engine model:</i>	ALF502R-5			
<i>Number of engines:</i>	4			
<i>Fuel loaded before event:</i>	Jet A-1			
<i>Aircraft flying time:</i>	13 598 hrs			
<i>Aircraft cycles:</i>	14 176			
<i>Number of cycles since latest periodic check:</i>	2			
<i>Engines operating time:</i>				
<i>Engine #</i>	1	2	3	4
<i>Serial number</i>	LF0527586	LF05145	LF05187	LF05724A
<i>Hours</i>	13 981	12 903	15 051	8 298
<i>Cycles</i>	13 934	14 711	16 073	8 408

The aircraft had a valid Certificate of Airworthiness.

1.6.2 *Aileron (control) systems*

The aircraft type has two separate aileron control systems. The left wheel is linked to the left aileron and the right wheel to the right aileron. The two systems are normally mechanically coupled but can in an emergency situation be separated by a special mechanism (Aileron disconnect). The disconnection can be achieved by either turning the wheels in opposite directions with considerable force or by moving a lever on a console between the pilots. By means of movable servo tabs on the trailing edges of the ailerons, aerodynamic servoassistance is achieved in flight.

1.6.3 *Action taken on the right aileron*

Three days, 1.3 flying hours, before the incident the right aileron was changed due to damage caused during ground handling. The work was performed by company staff at the maintenance base at Malmö/Sturup airport. The aileron, P/N HC576C0077-001, S/N SAAB-DH-054 then installed had been repaired and approved by Marshall Aerospace in Cambridge, England.

1.7 **Meteorological information**

METAR 1750 hrs:

Norrköping/Kungsängen: Wind 260°/31 kts, visibility 9 km , haze, cloudbase 900 ft, temp/dp +5°/+3 °C, QNH 1003 hPa.

Stockholm/Bromma: Wind 250°/12 kts, visibility 10 km, cloudbase 800 ft, temp/dp +5/+4 °C, QNH 1000 hPa.

Stockholm/Arlanda: Wind 250°/23 kts, visibility 8 000 m, haze, cloudbase 700 ft, temp/dp +5/+4 °C, QNH 998 hPa, windshear runway 26.

Västerås/Hässlö: Wind 240°/17 kts, visibility 10 km, cloudbase 800 ft, temp/dp +6/+5 °C, QNH 999 hPa.

1.8 Navigational aids

Norrköping/Kungsängen runway 27 was equipped with precision approach facilities. The aircraft was equipped with Instrument Landing System (ILS).

1.9 Radio communications

Shortly after the incident the crew sent an emergency message to Stockholm Control. Thereafter the communications were normal with stations concerned along the route.

1.10 Airport data

The status of the airport was according to AIP Sweden.

1.11 Flight and sound recorders

The Flight Data Recorder (FDR) and the Cockpit Voice Recorder (CVR) were removed from the aircraft after the incident. They were sent to the Air Accident Investigation Branch (AAIB) for decoding and analysis.

Recordings of parameters important for the incident are graphically presented in appendix 2. There it can be seen among other things that the aircraft around 24 seconds after the lift-off started to bank left with increasing bank angle. The altitude above ground was then around 1 200 ft. A little more than 13 seconds later the bank angle was 24°.

The sound recorder contained no useful information, due to overcycling.

1.12 Site of accident and aircraft wreckage

Not applicable.

1.13 Medical information

Nothing indicates that the mental and physical condition of the crew had been impaired before the flight.

1.14 Fire

There was no fire.

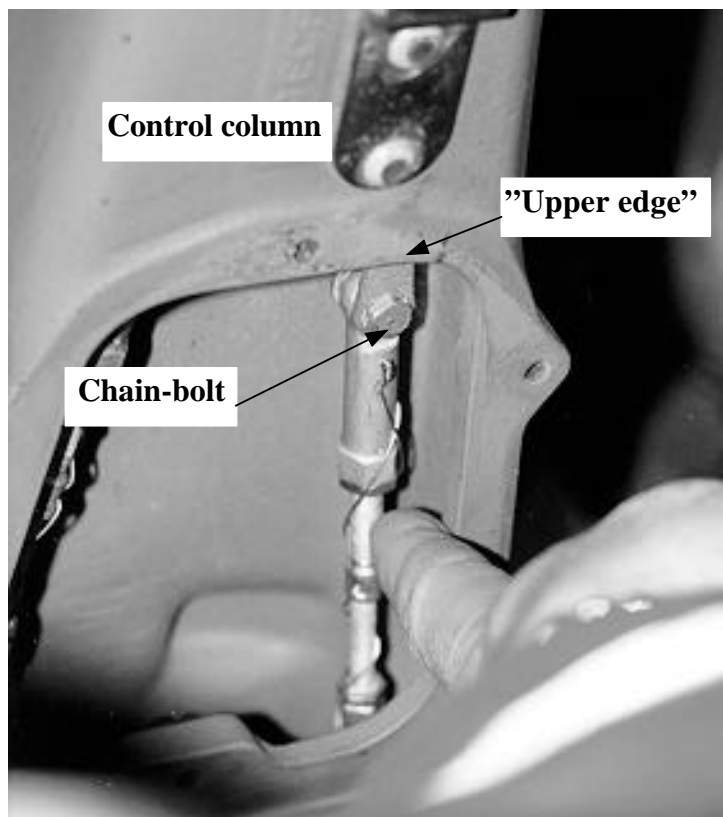
1.15 Survival aspects

The aircraft landed normally at the airport and the occupants were able to disembark through the usual passenger door.

1.16 Special tests and investigations

1.16.1 *Trouble-shooting on the aileron control system*

During the technical investigation of the aircraft after the incident performed at Norrköping/Kungsängen airport in co-operation with representatives of the manufacturer, British Aerospace (BAe), it was found that the chain in the right control column (Chain assy, P/N AS7877-24P) assembly which transfers the wheel movement to the right aileron control system was slack. With the column pulled fully back the chain could "fall back" allowing a bolt head on the chain (Bolt, P/N DHS 1426-2-5DD) to catch against the upper edge of the inspection hole in the column. Scratches in the paint on the upper edge of the hole indicated that there had been mechanical contact during a wheel movement to the right. "The feeling" in the control-wheel during a simulated locking was verified by the captain.



The left control column as well as all other control columns of the airline's other aircraft proved when checked also to have chains that were more or less slack.

The type of fault was new for BAe. In the manufacturer's Aircraft Maintenance Manual (AMM) the control column was defined as a "component" requiring no specified or periodical maintenance as long as it was mounted in the aircraft ("On condition").

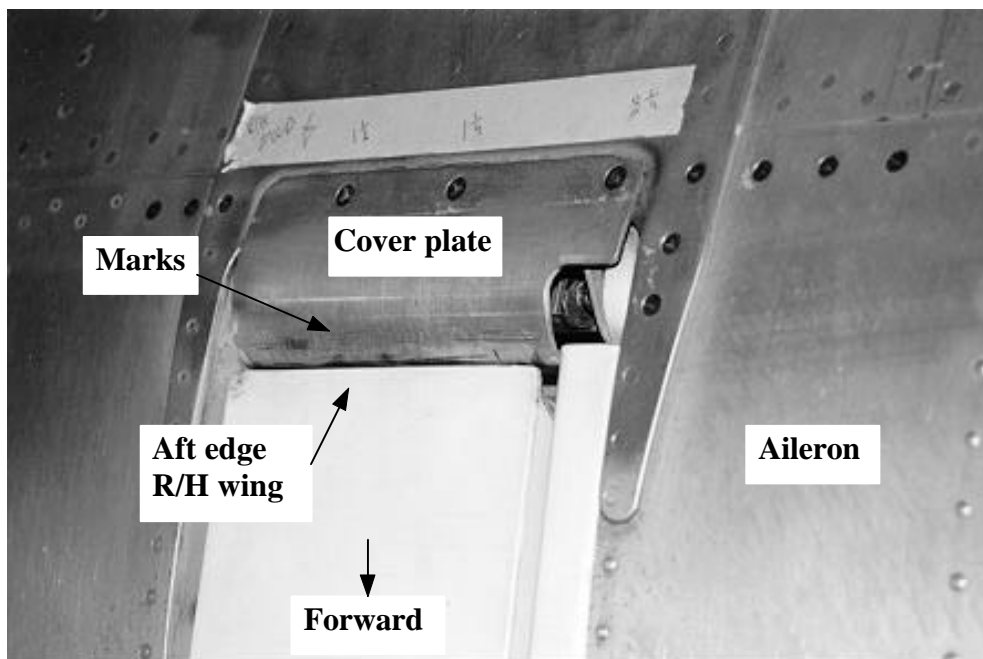
1.16.2 *Test flight*

During the test flight flown after the actions on the control columns had been taken and the inspection and functions control of the aileron control system had been performed on ground, the same type of stuck aileron control as the day before (after the start from Stockholm/Bromma) appeared shortly after take off. By trimming the aircraft "right wing down" the crew was able to fly the aircraft without disconnecting the aileron control systems. The flight proceeded to Gothenburg/Landvetter airport and landed there without major problems.

1.16.3 *Further trouble-shooting on the aileron control system*

During the technical trouble-shooting at Gothenburg/Landvetter airport it was found that the top cover plate (Cover plate, P/N HC576H0032-001) over the centre hinge of the right aileron was loose. The three fixing screws (Bolt, P/N NAS4403-7) in the aft edge of the plate holding it fast to the aileron were not fully tightened. With the aileron in neutral position, the play between the forward edge of the plate and the aft edge of the wing at the level of the hinge was approximately 1.1 mm. In flight, however, the aerodynamic forces lifted the forward edge of the plate so that it could catch against the trailing edge of the wing skin thereby jamming the upward movement of the aileron (right wheel throw) at around neutral position.

Marks on the forward edge of the cover plate indicated that the aileron had been jammed on one or more than one occasion in connection with upward manoeuvring of the aileron.



All corresponding cover plates in question in the company's fleet were inspected. It was found that the screws were tightened but that the play at the aft edge of the wing varied between 0.0 and 2.0 mm.

The cover plate was already mounted on the aileron when the latter was installed on the day before the incident. No special inspection of the installation of the plate

was made then. It has not been possible to determine whether the plate was already loose before the repair in England or came loose after the repair.

Also, this type of fault was new to the manufacturer. The AMM contained no special mounting instructions for the cover plates or any special regulations regarding a check on the play between cover plates and wing trailing edges.

1.17 The airline's organisation and management

The airline, Malmö Aviation Schedule AB, has its headquarters in Malmö and runs heavy national and international scheduled traffic. A survey of the company's operations and routines has revealed no operational or technical shortcomings which may have had contributed to the incident.

1.18 Other information

1.18.1 *Preliminary Report*

In the Preliminary Report, L-05/97 dated 31-01-1997, SHK recommends the Swedish Civil Aviation Authority to encourage their British counterpart, initially, to direct all operators of the aircraft type in question to perform a special check of

- the chain tension in the control column and
- the installation of the cover plate on the ailerons.

1.18.2 *Action taken by the airline*

Following the incident control columns and cover plates of all aircraft operated by the airline were checked and action taken. The task was completed within 24 hours of the defects being discovered.

1.18.3 *Action taken by BAe*

Representatives from BAe took part in the trouble-shooting after the incident. On 11 February 1997 BAe in an All Operators Message (AOM) recommended all operators of the aircraft type to check at the earliest the control columns and covering plates and where necessary to take remedial action. As long-term action BAe has;

- a) supplemented the AMM with a requirement to check the chain tension periodically and
- b) modified the cover plates in such a way that they will no longer cause jammed ailerons. In a Mandatory Modification Service Bulletin BAe will order replacement of all existing plates by the new ones, when manufactured.

1.18.4 *Rules and regulations for the Rescue services*

The Swedish Rules and Regulations for Aviation (Bestämmelser för Civil Luftfart -BCL-), section F 3.4 paragraph 5.3.3 requires every airport to have a Rescue Instruction. It must contain rules for the following situations: "Accident, site known"; "Risk of accident"; "Accident or assumed accident, site unknown".

When "Risk of accident" has been announced the rescue services of the airport must increase their readiness and furthermore the local rescue services must be alerted. Increased readiness means that the rescue vehicles are positioned so as to be prepared for immediate action in the shortest time possible. The rescue co-ordinator decides the site, normally in connection with the runway.

2 ANALYSIS

2.1 The flight

At the time of departure from Stockholm/Bromma airport darkness, low clouds and strong wind prevailed. The jamming of the aileron system, which occurred at low altitude was therefore extremely serious from a flight safety point of view. According to the flight recorder transcript the aircraft started to roll more to the left after having climbed through around 1 200 ft above ground. A little more than 13 seconds later the bank angle had increased to 24°.

The copilot, who was piloting, immediately informed the captain who verified the jamming and managed to separate the two aileron systems. By quick and correct action, the pilots were able to regain control of the aircraft before it assumed an uncontrollable attitude.

The decision to divert to Norrköping/Kungsängen airport and make an emergency landing on runway 27 was wise considering the reduced manoeuvrability of the aircraft and the prevailing weather situation.

It is the opinion of SHK that the flight to Norrköping, the preparations for the emergency landing and the emergency landing were executed by the whole crew in exemplary fashion. The positive outcome of the incident with many persons involved is mainly attributed to the crew, its competence and good co-operation.

2.2 Technical malfunctions

The investigation of the aileron (control) system after the incident revealed two isolated and serious faults. Both could cause jamming during flight. Furthermore both faults were unknown to the manufacturer and to the airline.

Scratch marks on the control column and the covering plate indicate that either fault had at least once caused temporary catching or jamming. It is not possible, however, to establish with certainty which of these faults caused the jam during the flight in question. The fact that jamming also occurred during the test flight after the correction of the fault in the control column points to the loose cover plate as being the cause of the jamming after the takeoff from Stockholm/Bromma.

Already the day after the incident representatives from BAe joined in the trouble shooting and contributed with technical information. The faults revealed were treated with high priority and on 11 February the manufacturer recommended all operators to check the control columns and cover plates without delay.

The Board is of the opinion that the action taken, as well as current action to eliminate the risk of this type of rudder jamming, are relevant and sufficient.

2.3 Rescue services

In this case the rescue co-ordinator required a rescue vehicle to be positioned east of the airport on the centreline. Without taking a stand to the need for that from a tactical point of view, SHK finds it remarkable that this order was not executed.

3 CONCLUSIONS

3.1 Findings

- a)* The pilots were qualified to perform the flight.
- b)* The aircraft was airworthy.
- c)* Mechanical jamming of the aileron (control) system occurred in flight.
- d)* The actions of the crew during the flight were correct and carried out in a professional manner.
- e)* The aircraft had been maintained according to current regulations.
- f)* Two isolated technical faults, either of which may have caused the jamming, were found in the aircraft. The fault more likely to have caused the jamming was the loose cover plate on the right aileron.
- g)* The types of fault were unknown to the manufacturer and to the airline.
- h)* The maintenance manuals at the time did not cover checks necessary to reveal such faults.
- i)* The rescue services functioned adequately.

3.2 Causes of the incident

The probable cause of the incident was a loose cover plate on the right aileron which, under the influence of aerodynamic forces during flight could catch against the trailing edge of the wing skin thereby jamming the upward movement of the aileron.

4 RECOMMENDATIONS

None except for the one in the Preliminary Report.