

Aircraft Accident Report

CX003-0/01
March 2002

Factual Information

Occurrence: accident
Date of the occurrence: 08. March 2001
Location: Hamburg
Aircraft: aeroplane
Manufacturer/type: Cessna / C 525 Citation Jet
Injuries to persons: none
Damage to the aircraft: Aircraft severely damaged
Other damage: one runway edge light destroyed

History of the flight

The aeroplane was on a flight under IFR (instrument flight rules) from Mannheim (EDFM) to Hamburg (EDDH). At appr. 20:45 hrs Central European Time, the pilot contacted Hamburg TWR (Tower) for a landing on runway 15. The aeroplane did not touch down on the runway but the pilot initiated a go-around.

With the next radio contact ten minutes later, the pilot reported to the TWR controller that his *Citation Jet* had landing gear problems. During an arranged fly-by of the aeroplane by the tower, the controller recognized all landing gear wheels in the landing position. The visual and acoustic signals in the cockpit continued to indicate an unsafe landing gear condition to the pilot. For the expected landing alert was initiated and the airport fire services were placed.

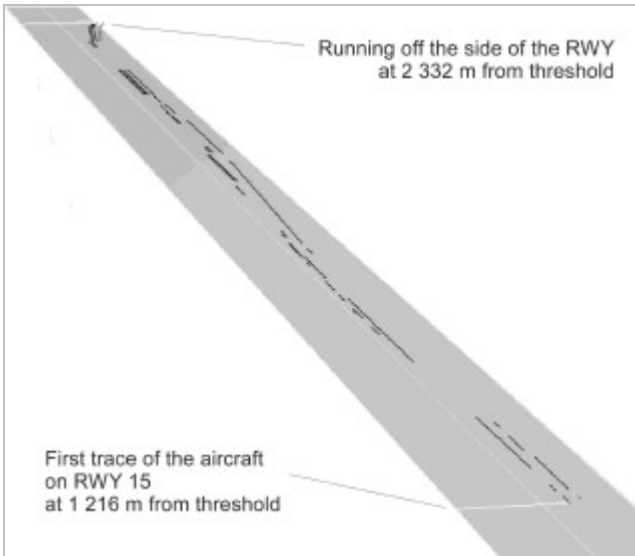


At appr. 21:20 hrs Central European Time, the Citation Jet was on final approach to runway 15. According to the statement of the pilot, the aeroplane touched down normally with the right-hand landing gear yielding immediately. By counteracting the aeroplane movement, the pilot managed in delaying ground contact of the right-hand wing and afterwards holding the Citation Jet over a distance of 1000 m on the runway. Finally the aeroplane stopped 30 m to the right beside runway 15 und appr. 300 m in front of the intersection with runway 23.

There was no fire and the pilot left the aeroplane without injuries.

Investigation

Field inspectors of the BFU at Hamburg Airport secured impermanent traces and controlled the access to the aeroplane. On the next morning, two staff members of the Federal Bureau of Aircraft Accidents Investigation (hereafter referred to as BFU) Braunschweig started the field investigation. Maintenance personnel of the aircraft, salvage experts of the airport and police detectives attended in the investigation. An accredited representative of the aircraft manufacturer participated in the subsequent investigation of the hydraulic system.



Situation at the accident site

Due to many tyre traces on the runway the first touch down point of the aeroplane could not be identified. A first scratch mark in the asphalt, which could be attributed to the right-hand landing gear door of the C 525 Citation Jet, was located 1216 m from the threshold. Further on marks left by the joints of the flaps and by other parts of the RH wing were found at irregular distances. At the end tyre traces allocated to the nose wheel and to the left main landing gear marked a right turn into the grass. In addition the lamp socket left behind and the remains of a lamp of the runway edge lighting substantiate this track. The deceleration distance from the first mark found up to the point where the aeroplane stopped was 1162 m.

Situation found on the aeroplane

The right wing of the aeroplane had ground contact. Its lower surface showed large areas of scratches near the wing tip; below the fuselage there was a deep imprint left by the lamp of the runway lighting. The joints of the right flap had been damaged by the ground contact. Both flaps were in the retracted position.

The following conditions were found in the cockpit: On the right-hand seat the abbreviated checklist with the *abnormal procedures and emergency checklist* was found. The gear handle was in the down position. The red T-handle for auxiliary gear control had been pulled and was locked in the end position. The red knob, which is mounted co-axially with the T-handle was in the original position. The circuit breaker for the gear control circuit was closed.

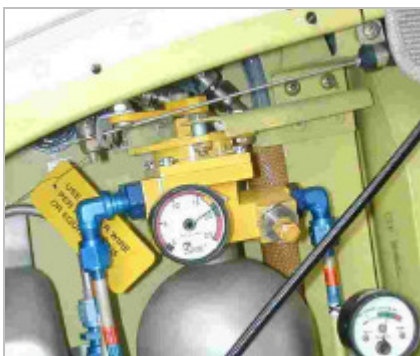


After the power supply had been switched on (battery ON) the condition indications GEAR UNLOCKED (red), NOSE (green) and LH (green) illuminated; the lamp for RH (green) kept on dark. On the annunciator panel among others the warning lights for the hydraulic system HYD FLOW LOW (orange), LH (orange) and RH (orange) were on. With the starting of the left-hand power plant the warning light LH *hyd flow low* (orange) went out. The speed brakes and the flaps did not work by actuation of their controls.

The hydraulic fluid tank installed in the rear of the aircraft was well filled.



With the lifting of the right wing, the landing gear swivelled down by gravity and nearly reached the fully extended position. The landing gear strut, the wheel and the tyre were undamaged.



The bottle with the nitrogen serving as a propellant for emergency extension of the landing gear was installed in the nose compartment. The manometer of the bottle indicated a pressure of more than 1 800 PSI in the green range. The locking wire on the lever of the bottle valve was unbroken. The control of this system, the red knob in the cockpit, could be pulled to the stop by one hand. With the actuation of this knob the RH landing gear was driven to the stop and locked mechanically. Afterwards, the a.m. manometer indicated a remaining pressure of 900 PSI, which was maintained even a few days later.

The control line to the nitrogen bottle could be moved manually on the valve lever. The cover in front of the bottle did not show any traces of a contact with the lever. Between the components a minimum distance of 7 mm was measured.

Emergency Procedure

For this problem with the hydraulic system and the landing gear the manufacturer has described appropriate actions in the abbreviated check list. Under Chapter 2 of the section *emergency/abnormal procedures* the manufacturer deals with the problem *landing gear will not extend*.

1. GEAR CONTROL CIRCUIT BREAKER – **CHECK IN**
2. LANDING GEAR CONTROL – **CHECK DOWN**

IF HANDLE FAILS TO MOVE (FROM UP POSITION) OR GEAR WILL NOT EXTEND

3. GEAR CONTROL CIRCUIT BREAKER – **PULL**
4. AUXILIARY GEAR CONTROL – **PULL T-HANDLE AND ROTATE TO LOCK**
5. RUDDER – **YAW AIRPLANE** (IF NECESSARY TO ACHIEVE DOWNLOCK LIGHT)
6. AUXILIARY GEAR CONTROL – **PULL KNOB TO BLOW DOWN** (FOR POSITIVE LOCK)

Steps 4. and 6. were put in slightly different words on a placard (white on black) beside the control elements in the cockpit.

The actions taken by the pilot with regard to the landing gear problem was the subject of the radio communications with ATC (March 8th, 2001), of an enquiry made by staff members of the BFU on the phone (March 9th, 2001) and of a written report by the

pilot (dated March 29th, 2001).

During the radio communications the pilot said: "the gear is not extending, and I just pulled the emergency pull down, ..." and further on originally in German language:

"... well I've got emergency here for the landing gear, the bottle is pulled, silly thing will not come out."

In his written report (in German) he stated:

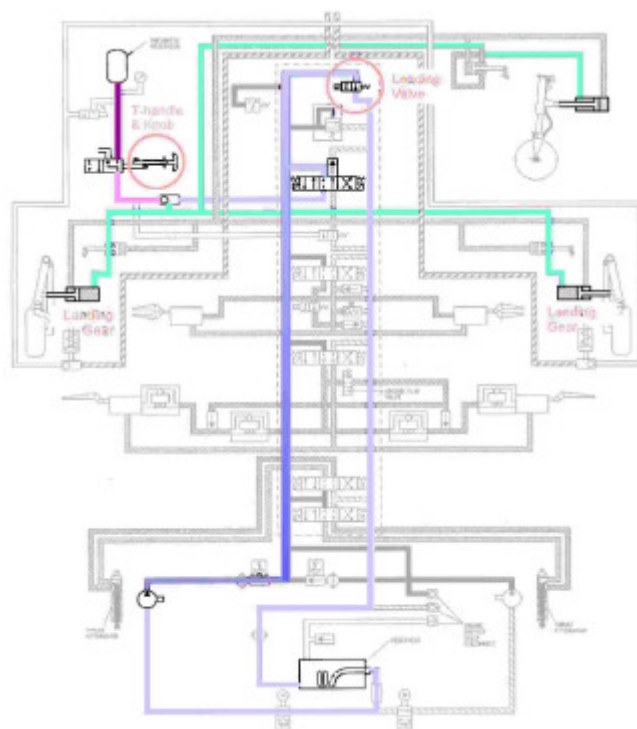
"... and then I tried to actuate the *knob to blow down*, which, however, was blocked." And further on: "... that the red knob to discharge the pressure bottle was blocked."

In his first statements on the phone he neither talked about that particular action nor he mentioned the concerning trouble. And he did not give an appropriate answer to the question as to where the a.m. knob was installed relative to the T-handle.

The above instruction was submitted to a test person who had knowledge of the English language and flight experience but had not been familiarised with the type. On the basis of the check list the test person was not in a position to identify the red knob arranged coaxial with the red T-handle as the knob to be actuated in addition to the T-handle.

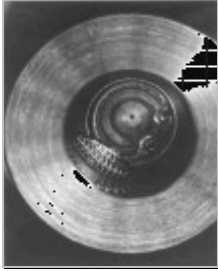
Hydraulic system

The hydraulic system of the aeroplane was investigated immediately after the recovery and a second time six days later in the presence of a representative of Cessna company in a hangar of the airport.



The fault isolation procedure revealed a failure of the valve P/N 9912423-22, S/N 262 (*hydraulic power – solenoid loading valve*). This valve shuts the return line to the hydraulic fluid tank and thus produces the working pressure required by the systems landing gear, flaps and speed brakes.

After the valve S/N 262 had been replaced by a new one (of the same model) the hydraulic system worked properly.



In the cylinder of the defective valve a loose metallic filter screen was found to be stuck between the front edge of the piston and the internal flange of the cylinder.

Maintenance of the aircraft

The type Cessna Citation Jet 525 is a full-metal low wing monoplane with a T-tail and two aft-mounted turbojet engines. It has a tricycle landing gear with a nose wheel.

The aeroplane in question with the serial number (S/N) 525-0249 was manufactured in 1998 and is operated by a company in Hamburg (no air carrier) with an U.S. Registry dated August 5th, 1998.

Since delivery, the maintenance of the aeroplane has been performed by a company at Hamburg airport. On April 14th, 2000, an inspection according to the phases 1, 2, 7, 9, 10, 11, 12E, 12F and at the same time an annual inspection was carried out. The latest action was a replacement of the brake assemblies on both main landing gears, which took place on February 28th, 2001. At that time the aeroplane had accumulated a total time in service of 743 hours with a total of 774 landings.

Pilots on that aeroplane criticised, that its hydraulic system had failed for several times at outside air temperatures below - 20°C recovering at - 8°C. In accordance with a work sheet dated August 23rd, 1999, one hydraulic failure to the aeroplane S/N 525-0249 had been eliminated by the replacement of the loading valve S/N 286 by the loading valve S/N 262. In this aeronautical workshop alone already seven further actions of this kind had been carried out on C 525 Citation Jet aeroplanes since the beginning of 1998.

By the end of 2000 unscheduled replacements of 76 version -22 loading valves had been accomplished according to the statement of Cessna Aircraft Company. The total time of operation of the whole fleet regarding the type Citation Jet was given by 375 765 h.

The aeroplane manufacturer submitted a Service Bulletin SB 525-29-10 dated February 9th, 2001, which on the day of the accident had not been known yet to the German maintenance company. This S.B. recommends the replacement of all valves P/N 9912423-22 by a new version –39.

That process concerning about 400 aircraft was estimated to be completed within 3 years.

The new version of the valve is not provided with the metallic filter screen; the coil and the return spring have been reinforced.

Weather

The routine weather report (METAR) for EDDH for the day of the accident at 21:20 hrs was as follows:

QNH 1001 hPa, temperature and dew point 08°C and 05°C, cloud 5/8 to 7/8 (BKN) in 5800 ft, rain, visibility 7000 m, runway visual range (RVR) 1500 m, wind 130°/12 kt, no significant changes (NOSIG).

For the landing the wind was reported as follows: Wind direction 130°, wind speed 11 kt up to a maximum of 17 kt.

Crew

The C 525 Citation Jet was flown in single-pilot operation under IFR.

According to the register of airmen, the pilot was holding a German licence for Commercial Pilots Class II (CPL II) initially issued on December 29th, 1976. On the latest document valid until August 18th, 2000, a type rating for twin-engine aeroplanes of the series Commander 680T etc. had been entered. An instrument rating had not been entered. The type rating for the Cessna CE 525 had been applied for with the form 16/A-3 dated March 17th, 1998.

In accordance with the documents submitted, the pilot was the holder of an American pilot licence initially issued on July 14th, 1998, and a medical certificate dated June 28th, 2000. The following ratings were entered on the licence: *commercial pilot, airplane multi-engine land, instrument airplane, CE-525S*.

According to his own statements, the pilot had a total flight experience of 5350 hours, of which 530 flight hours under IFR. His flight experience on the type CE 525 was indicated with 700 flight hours and 740 landings.

Analysis by BFU

Failure of the Hydraulic System

The filter screen, which had separated from its fit, had blocked the solenoid loading valve P/N 9912423-22 in the opened position. This explains the total failure of the hydraulic system.

This problem had been known to the aircraft manufacturer already from many other occurrences. Certainly the failure rate is higher than the replacement rate of 21 per 100,000 h. The supplier reacted to the unreliability of the component by a design change.

With the new design of the valve without a filter screen a similar failure as in this case is precluded.

In Germany, the Service Bulletin to introduce the modified component version had not been issued early enough with regard to this accident. On the other hand the modification could not be realised at one time.

In order to reduce the effects of a total failure of the hydraulic system, system back-ups and abnormal procedures are provided as a standard. There were three possibilities to extend the landing gear into the locked landing position.

Actions by the pilot

The examination and inspection of the system for auxiliary gear control revealed clear results. Everything indicates that the red blow down knob to discharge the pressurized gas bottle had not been actuated.

The statements of the pilot during the radio communications, during the enquiry and in his written report are contradictory:

His spontaneous statements indicate that he thought to have opened the pressurized gas cylinder just by pulling the red T-handle in the cockpit. Due to this error he did not perceive the red knob as the actual blow down knob.

The subsequent report of the pilot contradicts the a.m. hypothesis. The report of the pilot, however, is also in contradiction with any other findings.

Instruction given by the manufacturer

In this case the instruction for auxiliary gear control was no help to the pilot. The instruction was incomprehensible also to other people.

The terms GEAR CONTROL and AUXILIARY GEAR CONTROL sometimes designate the system and sometimes the control. This may give the impression that item 6 of the check list is just a repetition of item 4. The text does not make sufficiently clear that

- a) the actuation of the T-handle only causes the landing gear to be released from the upper lock and hydraulic pressure,

- b) the knob is a second control which has to be actuated to drive the landing gear into the down locks by means of compressed gas.

The placard beside the knob is hard to perceive at night.

Flight experience of the pilot

Due to the great number of flight hours accumulated on the type the pilot was familiarised with the type. The incomplete locking of the landing gear was an exceptional situation, which happened to him for the first time.

During the familiarisation with the type the compressed gas bottle is normally not discharged in order to reduce costs. Therefore the pilot to be familiarised cannot really comprehend the procedure and thus may easily forget it.

Conclusions

The cause of the accident was that

- a) the hydraulic system failed as a result of a defective valve
- b) the pilot did not accomplish the procedure recommended by the manufacturer in case the landing gear is not positively locked.

A contributing factor to b) was that the instruction given by the manufacturer is not clearly formulated.

Safety Recommendation

The BFU considers that the aircraft manufacturer already initiated sufficient actions to exclude the detected flaw within the hydraulic system for the future. Thus a regarding safety recommendation by the BFU is dispensable.

Investigator-in-Charge Gernot Leibe