

FINAL REPORT

on

investigation of a serious incident realized on 11.02.2015 with F2000 aircraft, registration nr. LZ-OOI, upon takeoff from Sofia Airport



2016

Purpose of the Report and responsibility

In accordance with Annex 13 for aircraft accident and incident investigation to the Chicago Convention on International Civil Aviation dt. 07.12.1944, Regulation Nr. 996/2010 of the European Parliament and the Council on the investigation of civil aviation accidents and incidents, and Ordinance Nr. 13 of the Ministry of Transport, Information Technology and Communications (am. and suppl. 16.11.2012), the purpose of the investigation of an aviation event shall be: establishment of the cause of its realization, in view of its elimination and prevention in the future, **without searching for anybody's guilt or responsibility.**

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01. LIST OF ABBREVIATIONS

AO	- Air Operator;
A/C	- Aircraft;
DG CAA	- Directorate General “Civil Aviation Administration”;
SG	- State Gazette;
CAA	- Civil Aviation Act;
AMRAIUD	- Aircraft, Maritime and Railway Accident Investigation Unit Directorate;
MTITC	- Ministry of Transport, Information Technology and Communications;
SO	- Start of operation;
TSO	- Technical service organization;
OYIIIJIT	- Organization managing the maintenance of permanent aircraft airworthiness;
RWY	- RUNWAY
TSP	- Technical service program;
AOM	- Aircraft Operation Manual;
AAIU	- Aircraft Accident Investigation Unit;
TLB	- Technical logbook;
TS	- Technical service;
OPC	- /Operation Permit Certificate;
EASA	- European Aviation Safety Agency;
FM	- Flight Manual;
ICAO	- International Civil Aviation Organization;
ILS	- Instrument landing system;
MTOW	- Maximum take-off weight;
UTC	-Universal coordinated time.

1. Introduction

Date and hour of the aviation event: 11.02.2015, 19:15 h local time (17:55 h UTC).

Notified authorities and parties: Aircraft, Maritime and Railway Accident Investigation Unit Directorate and “Civil Aircraft Administration” Directorate General at the Ministry of Transport, Information Technology and Communications of the Republic of Bulgaria, the European Commission, ICAO and the Manufacturer of the aircraft DASSAULT AVIATION S.A., FRANCE.

On the grounds of Art. 9, par. 1 (am. – State Gazette, issue 83 dt. 2004, suppl., issue 77 dt. 2005, issue 90 dt. 2012) of Ordinance Nr. 13 dt. 27.01.1999 on the investigation of aviation accidents and incidents, the event is classified by the Unit for Investigation of Aviation Events at the Aircraft, Maritime and Railway Accident Investigation Unit Directorate of the Ministry of Transport, Information Technology and Communications as a serious incident. The materials on the aviation event are filed in case Nr. 01/11.02.2015 to the archive of the Unit for Investigation of Aviation Events.

On the grounds of Art. 5, par. 1 of Regulation (EU) Nr. 996/2010 on the investigation and prevention of accidents and incidents in civil aviation, Art. 142, par. 2 of the Civil Aviation Act of the Republic of Bulgaria dt. 01.12.1972 and Art. 10. Par. 1 of Ordinance Nr. 13 of the Ministry of Transport dt. 27.01.1999 on the investigation of aviation events, by Order Nr. ПД-08-96/19.02.15 of the Minister of Transport, Information Technology and Communications a commission is appointed for the investigation of the aviation accident.

The difference between local and universal coordinated time is +2 h. The time applied everywhere in the Report is local time.

On 11.02.2015 aircraft FALCON 2000, registration marks LZ–OOI, operated by the air operator “Aviodetachment 28”, takes off from Sofia Airport for the performance of flight BGF 004 on route SOF-BRU. After takeoff, the left main stand of the landing gear (L/G) does not retract. The crew fulfills the relevant control card and drops down the L/G, then takes a decision for spending a part of the fuel and landing at Sofia Airport. Two approaches are carried out for visual check from the ground of the L/G position and landing is carried out normally. There are not any consequences for the passengers, the crew and the aircraft.

Probable causes for the realized serious incident with aircraft FALCON 2000, SN 123, registration marks LZ-OOI, result from structural peculiarities of the systems, providing L/G functioning, the increased operative load in connection with the specifics of the aircraft’s use, and the adverse impact of the external environment.

2. Factual information

2.1. History of the flight

2.1.1. Flight number, type of operation, last point of departure, time of departure and point of intended landing

Number of flight: BGF 004.

Type of operation: VIP flight for passenger transportation.

Last point of departure: Sofia Airport.

Time of departure: 19:13 h.

Point of intended landing: Brussels Airport.

2.1.2. Flight preparation and description of the flight

Before the flight, in conformity with the technical service program of the aircraft, Daily + Preflight Check service forms are fulfilled. There are no malfunctions detected upon servicing of the aircraft. After takeoff, on command of the piloting pilot the servicing pilot performs L/G retraction. After retraction red and green signals of the left main L/G remain illuminated on the configuration panel. The indication for right main and nose L/G is normal (switched off). After a delay of about 20 s the light in the L/G retraction lever starts flashing as well. In conformity with the procedure in QRH of the aircraft, the crew drops down the L/G, upon which three green lights switch on (normally dropped down and locked L/G). The Commander takes a decision for suspension of the performance of the task. After spending of fuel for reducing the weight of the aircraft to the requested landing weight, a normal landing is performed. Before landing two approaches above the runway are made, for visual inspection by the ground services for the L/G normal positioning.

Landing has no consequences for the passengers, the crew and the aircraft.

2.1.3. Location of the aviation event

After takeoff from Landing Strip 09 at Sofia Airport.

2.2. Injuries to persons

Bodily injuries	Crew	Passengers	Other persons
Mortal outcome	0	0	0
Serious	0	0	0
Absent	4	8	0

2.3. Damages to aircraft

Upon the performed examinations of the aircraft after realization of the aviation event no damages were established.

2.4. Other damages

There are no other damages.

2.5. Personnel information

2.5.1. Piloting pilot – Commander – instructor – man, 63 years of age

Professional capability certificate: Professional capability certificate of a professional pilot ATPL (A). Date of initial issue: 17.07.2013. Valid classification class PIC, TRI (A) at the time of realization of the event.

The piloting pilot is holder of a medical capability certificate class 1, issued on 01.12.2014, valid till 10.06.2015. At the time of realization of the event, the medical capability certificate of the pilot is valid.

Flying experience:

Total hours in flight: 9160:25 h;

On aircraft of the concerned type: 3005:49 h;

For the last 90 days: 62:35 h.

Information on working hours and rests:

During the 24 hours before the flight, the pilot has not flown and during the night, he has enjoyed a normal rest.

The commission accepts that the piloting pilot possesses the requested training and experience for the functions performed on his part.

2.5.2. Servicing pilot – Commander – man, 52 years of age

Professional capability certificate: Professional capability certificate of a professional pilot ATPL (A). Date of initial issue: 09.06.2014. Valid classification class PIC at the time of realization of the event.

The servicing pilot is holder of a medical capability certificate class 1, issued on 18.06.2014, valid till 19.06.2015. At the time of realization of the event, the medical capability certificate of the pilot is valid.

Flying experience:

Total hours in flight: 11375:35 h;

On aircraft of the concerned type: 671:35 h;

For the last 90 days: 53:35 h.

Information on working hours and rests:

During the 24 hours before the flight, the pilot has not flown and during the night he has enjoyed a normal rest.

The commission accepts that the servicing pilot possesses the requested training and experience for the functions performed on his part.

2.5.3. Technician – man, 53 years of age.

Professional capability certificate: The technician is holder of professional capability certificate for Aircraft Technician AML, category B2 for aircraft FALCON 2000, valid till 21.08.2019. He is approved by the “Civil Aircraft Administration” Directorate General as head of the Technical Service Organization of Aviodetachment 28. At the time of realization of the event he has had 29 years of experience in the sphere of aircraft technical servicing.

2.6. Aircraft information

2.6.1. Airworthiness information

Aircraft FALCON 2000, serial number Nr. 123, registration marks LZ–OOI, is manufactured on 15.06.2001 by DASSAUL AVIATION and has Registration Certificate Nr. 1922, issued on 02.11.2004 by “Civil Aircraft Administration” Directorate General of the Republic of Bulgaria.

The airworthiness certificate of the aircraft Nr. 25-0009 is issued on 29.11.2012 by “Civil Aircraft Administration” Directorate General. The certificate on examination of the airworthiness of the aircraft with reference Nr. BG-ARC-1922 is issued on 11.12.2012 and after a second extension of the period of validity on 02.12.2014, it is valid till 10.12.2015.

Since the beginning of its operation, the aircraft has 4068:45 h in flight and has performed 3005 landings. After the performance of the last basic examination in the city of Geneva, Switzerland, by OTO TAG Aviation SA, the aircraft has had 84:10 h in flight and has performed 57 landings.

Two engines CFE738-1-1B are mounted on the aircraft.

Engine Nr. 1 with plant Nr. P-105322 has worked 2997 cycles from the start of the aircraft’s operation.

Engine Nr. 2 with plant Nr. P-105330 has worked 2985 cycles from the start of the aircraft’s operation.

Technical servicing of the aircraft is carried out after a technical service program, approved by “Civil Aircraft Administration” Directorate General.

The aircraft has Operation Permit Certificate, issued by TAG Aviation SA on 29.10.2014. In accordance with it, the aircraft has undergone basic technical maintenance in the scope of Form 2A/2A+ and 800 Engine Hours Inspection.

On 11.12.2014, in conformity with its technical servicing program, the aircraft has undergone a basic inspection, performed by the Technical Service Organization of Aviodetachment 28, for which Operation Permit Certificate Nr. 14F284 is issued.

On 11.02.2015 in accordance with technical onboard logbook Nr. 000597 the aircraft has undergone operative technical servicing under form „Daily check + Preflightcheck”, the aircraft was charged with fuel of 10900 lbs and was accepted after the procedure without any comments on the part of the Commander of flight.

On the basis of the above, the conclusion may be drawn that at the time of realization of the serious incident the aircraft was airworthy.

2.6.2. Brief information on the technical characteristics of the aircraft

„FALCON-2000” aircraft:

WEIGHT LIMITATIONS		lb	kg
Maximum Ramp Weight	MRW	36,700	16,647
Maximum Take-Off Weight	MTOW	36,500	16,556
Maximum Landing Weight	MLW	34,500	15,650
Maximum Zero Fuel Weight	MZFW	28,660	13,000
Minimum Flight Weight		Refer to CENTER OF GRAVITY limits	

In accordance with Instruction Nr. AT-01-8/14.11.2014 of the Chief Engineer of Aviodetachment 28, the base weight of an empty aircraft is 22497 lbs;

- velocity V1 - 120 kt;
- lifting velocity: 260 kt;
- landing velocity: 125 kt;

The take-off weight of the aircraft upon the takeoff for flight BGF – 004 is 36200 lbs, and the landing weight is 34100 lbs. Such weights are within the operational range for the aircraft.

Aircraft FALCON 2000 has retractable L/G, executed after a three-support scheme with a nose L/G. The general view and the major components of the L/G are exhibited on Figures 1 to 4 from Appendix 1. Figure 5 of Appendix 1 shows the consequence of L/G retraction, and Figure 6 – problems with the normal functioning upon L/G retraction and drop-down.

Service bulletin of FALCON FSA-32-30-016-R05-B, 5 revision, dt. 02.10.2014, provides review of anomalies in the sequence of functioning upon L/G retraction and drop-down for models FALCON 2000 and FALCON 2000EX. The bulletin specifies, 24 induction sensors participate in the management and control and signaling of the sequence of L/G retraction and drop-down. Enclosed is statistical data in connection with the anomalies, caused by the induction sensors depending on the place of their deployment. Determined are causes which may be connected with their improper functioning, such as failure of adjustment, contamination, dropdown of external temperature, etc. In more than 50% of the cases the exact reason for the malfunctions is not established. Prescribed are rectification actions, including the performance of replacements with modified articles.

Service bulletin of FALCON FSA-32-30-017-R02-A dt. 02.10.2014 provides review of anomalies in the functioning of the lock for retracted position of the nose stand. Recommended is its replacement with a modified variant. The same is recommended for the locks for retracted position of the main stands.

2.6.3. Information on the type of fuel used and its condition

In accordance with the record entered in the technical onboard logbook Nr. 000597 of Sofia Airport, upon the preparation of the aircraft for flight 7200 lbs aviation fuel Jet A1 was tanked, with which the total fuel on board was 10900 lbs (4943 kg), a quality sufficient for the performance of the planned flight. After the occurrence of the problem with the L/G, necessitated was spending part of the fuel for reaching the permissible landing weight of the aircraft.

The commission is of the opinion that the condition and quality of fuel, as well as the functioning of the aircraft combustion systems and the engines have not created conditions and have not exercised any impact for the occurrence of the serious incident.

2.7. Meteorological information

At 19.00 p.m. on 11.02.2015 the meteorological conditions at Sofia Airport were as follows:

Wind 060/05kt; Visibility > 10 km; Temperature -5° C; T_d -10° C; QNH 1023; Peculiar meteorological phenomena – none.

As paragraphs 2.16 and 2.18 deal with events realized on 07.01.2015, 18.02.2015, 15.04.2015 and 30.08.2015, provided hereunder is meteorological data for the airports during realization of these events.

At 14.00 p.m. on 07.01.2015 the meteorological situation at Plovdiv Airport was as follows:

Wind 100/07kt; Visibility > 10 km; Temperature -4° C; T_d -11° C; QNH 1031; Peculiar meteorological phenomena – none.

At 12.00 p.m. on 18.02.2015 the meteorological conditions at Sofia Airport were as follows:

Wind 250/05kt; Visibility > 10 km; Temperature -5° C; T_d -13° C; QNH 1035; Peculiar meteorological phenomena – none.

At 17.00 p.m. on 14.04.2015 the meteorological conditions at Sofia Airport were as follows:

Wind 260/07kt; Visibility > 10 km; Temperature 18° C; T_d 1° C; QNH 1022; Peculiar meteorological phenomena – none.

At 21.00 p.m. on 30.08.2015 the meteorological conditions at Varna Airport were as follows:

Wind 140/08kt; Visibility > 10 km; Temperature 26° C; T_d 21° C; QNH 1021; Peculiar meteorological phenomena – none.

2.8. Navigation

Standard navigation equipment of aircraft FALCON 2000.

2.9. Communications

The standard communication equipment of the aircraft. Realized normal radio connection with DP – Kula and DP – Approach to Sofia Airport.

2.10. Aerodrome information

The takeoff of the aircraft was performed from Sofia Airport.

Sofia Airport is with control point coordinates (RWY Centre): N $42^{\circ}41'42''$ and E $023^{\circ}24'30''$. Altitude – 531 m. The Landing Strips are with directions 091° and 271° (designated as 09/27), length of 3600 m and width of 45 m. The LDA (the available length for landing) of landing strip 27 is 3600 m.

2.11. Flight recorders

In the list of parameters recorded by registrator SSDFDR of aircraft FALCON 2000 SN 123, registration marks LZ-OOI, there are no parameters registering the L/G condition.

The analysis of registered parameters proves the following:

The aircraft takes off at 17:12:23 h (GMT) with velocity of IAS 135,5 kt.

17:14:12 at the height of RALT 1494 ft the aircraft starts turning on the right up to course 278 and a height of 4000 ft.

17:15:51 the autopilot is switched on.

17:20:30 turn to heading 90.

17:23:16 turn to heading 283 and a height of 6740 ft.

At this height till 17:58:11, 5 orbits are made for spending of fuel. After that the aircraft lowers to ALT 5730 ft, making two more orbits.

18:10:00 starts the first approach to Landing Strip 27.

18:12:59 the autopilot is switched off at RALT 221 ft, the approach continues and the aircraft flies over the runway at a height of RALT 84 ft and IAS 164 kt. Thereafter the aircraft gathers height and makes a second approach.

18:19:40 – the autopilot is switched off and the approach is continued to RALT 62 ft and IAS 158 kt.

The aircraft configuration is with dropped-down wing flaps at 10⁰.

18:27:23 the wing flaps are dropped down to 20⁰.

18:27:34 the wing flaps are dropped down to 40⁰, RALT 2246 ft, heading for landing on Strip 27. The approach is executed on ILS without deviations in the heading and glissade.

The autopilot is switched off at RALT 259 ft.

18:30:38 the aircraft lands on ILS 27 with overloading of 1,146 g and IAS 130 kt.

The reverse is switched off at 59 kt.

2.12 Wreckage and impact information

In paragraph 2.11, on the grounds of the record of flight parameters, made by registrator SSDFDR of the aircraft, the trajectory of the flight is described, as the aircraft landing at Sofia Airport was without problems for the passengers and the crew.

2.13. Medical and pathological information

Upon the realization of the event there were no consequences for the passengers and the crew, that's why no medical and pathological studies have been performed.

There is no information that any physiological factors or loss of ability have influenced the working capability of the crew.

2.14. Fire

The accident was not accompanied by fire outburst.

2.15. Survival aspects

The crew and the passengers have used protective belts.

The passengers and the crew have had no problems upon leaving of the aircraft.

2.16. Tests and research

For the purposes of the investigation in connection with safety the following measures were taken:

Examination of the L/G of aircraft FALCON 2000, SN 123, registration marks LZ-OOI, after the realized event;

Performance of control retraction and drop-down of L/G on the ground;

Executed is replacement of aggregates whose normal functioning was doubtful;

Control flight of the aircraft was carried out;
Discussions with the aircraft crew – the piloting pilot and the servicing pilot;
Discussions with witnesses of the realized event;
Investigation and analysis of operational documents of the aircraft;
Assessment of the flying and operational characteristics of the aircraft L/G and the systems providing its functioning;
Logic & probability analysis of eventual causes of the aviation event.

The operation of the aircraft in an eight-month period was traced.

Upon the inspection of the aircraft L/G after its landing at Sofia Airport, it was established that the three stands are locked in a dropped-down position and that on the configuration panel three green lights are illuminated, which evidence for normal condition of L/G on the ground.

For the establishment of the causes for the malfunctioning of the system controlling the positioning of the L/G, invited were experts from TAG Aviation, Geneva, the organization performing the base servicing of the aircraft. On 13.02.2015 the aircraft is goisted by jackscrews and four cycles of dropping down and retraction of L/G were carried out. Proven thereupon was that the system of L/G dropping/retracting and its indication in the pilot's cabin function normally, without deviations from the technical requirements. The experts from TAG Aviation together with technical staff from the Technical Service Organization of Aviodetachment 28 performed activities on the investigation, detection and elimination of the causes for the malfunctioning of the L/G retraction/drop down system. Thereupon some components were replaced, whose functioning was connected with an increased risk of failure.

The actions on elimination of the causes for the realized event are described in detail in Work Package Nr. 15F051, elaborated by Aviodetachment 28, and Work Order Nr. 26564 of TAG Aviation. Copies from the two documents are enclosed to the materials on the investigation of the aviation event. As a result therefrom, the following components of the L/G systems were replaced:

- CONFIGURATION PANEL 30CZ;
- LH MLG DOOR UPLOCK BOX L170;
- BOTH AKTUATOR MONITORING PROXIMITY SWITCHES 40GAA AND 45GAA.

To Work Order Nr. 26564 of TAG Aviation is enclosed FALCON's Service Bulletin FSA-32-30-016-R04-B dt. 10.10.2011, providing review of anomalies in the sequence of functioning upon L/G drop-down and retraction for models FALCON 2000 and FALCON 2000EX of the aircraft.

After replacement of aggregates, examinations on the ground were carried, whereupon the aircraft was put in a hoisted position by jackscrews. On 14.02.2015 a control flight of the aircraft was performed. Upon the tests on ground and during the control flight no deviations from the technical conditions were established.

On 18.02.2015 during flight BGF 280 SOF-SOF, where the aircraft has had 4069 hours in flight and 3006 landings (upon the first flight after the control flight of the aircraft), after placing the L/G drop-down/retraction lever in upper (closed) position, three red and the two green lights of the main L/G remained illuminating and a flashing red light of the L/G drop-down/retraction lever, after which the L/G was dropped down and the aircraft landed normally at Sofia Airport.

The Head of Aviodetachment 28 appointed a commission entrusted with the establishment and elimination of the cause for the occurrence of such signaling. For the fulfillment of the entrusted task, the Technical Service Organization of the operator performed the following:

1. Hoisting of the aircraft by jackscrews and retracting and dropping of L/G (four cycles). Proven thereupon was that the L/G drop-down/retraction system and its indication in the pilot's cabin operate without any deviation from the technical requirements.

2. Measurement of all electrical circuits and components, participating in the systems of dropping, retraction and indication of the L/G position.

3. The examinations proved that the air gap of two of the sensors "ground/air" is outside the tolerance according to the technical documentation.

The sensors are mounted and adjusted upon a capital refurbishment repair of the L/G. Such repair of the L/G of aircraft FALCON 2000, SN 123, registration marks LZ-OOI, is carried out on 24.06.2013 upon C/2C inspection, as till the time of realization of the event the aircraft has flown for 390:15 hours and has realized 288 landings.

4. Adjusted is the air gap of the two sensors "ground/air" of the nose L/G in accordance with the requirements of the technical conditions. Two electronic cards (plates) are replaced, partaking in the management and control of the L/G drop-down/retraction system.

5. Hoisting of the aircraft by jackscrews and execution of ten cycles of drop-down and retraction. Established thereupon is that the L/G drop-down/retraction systems and their indication in the pilot's cabin function normally.

On 25, 26.02. and 04.03.2015 test flights of the aircraft are carried out. During the flights totally 25 cycles of L/G drop-down and retraction are executed, to check the normal operation of the systems and the indications in flight. No deviations of parameters from the technical specifications were established.

The commission of the Aviation Operator accepts that the major cause for the realized aviation event is the bigger air gap of the sensors "ground/air" of the nose L/G.

All actions connected with searching of malfunctions and their rectification are described in Working Package Nr. 15 F056, elaborated by Aviodetachment 28. A copy of this package is enclosed to the materials from the investigation.

On 15.04.2015 during flight BGF 021 SOF-ZAG, when the aircraft has operated for 4112:50 flying hours and has 3042 landings, after L/G retraction, the red lights on the configuration panel remain lighting, the green lights switch off, and the red light of the L/G drop-down/retraction lever remains flashing. The crew drops down the L/G, suspends the flight and lands normally at Sofia Airport.

The Technical Service Organization of Aviodetachment 28 hoists the aircraft by jackscrews, performs control retractions and drop-down of L/G and executes checks, as specified in technical board logbook Nr. № 000650/15.04.20015. A copy of the board logbook is enclosed to the materials from the investigation. During the performed works no causes for the committed failure of systems were detected.

On 16.04.2015 the aircraft performs technical flight to the base airport of TAG Aviation, Geneva, for comprehensive investigation of the causes for the problems with its L/G system. Executed is Work Order 26989 of TAG Aviation, a copy of which is enclosed to the investigation materials. Two sensors "ground/air" are replaced on the nose stand, as well as the supplying electric cable of the nose L/G. Complete servicing of the nose L/G is carried out. The requested checks on the functioning of the L/G drop down/retraction system are performed. Operation Permit Certificate is issued by TAG Aviation on 17.04.2015. A copy from the Certificate is enclosed to the investigation materials.

On 30.08.2015 during flight BGF 004 VAR-PDV, when the aircraft has 4200:20 fly hours and 3104 landings, after take-off, upon placing of the L/G drop-down/retraction lever

in an upper position three red lights remain illuminating on the configuration panel and the red light of the L/G drop-down/retraction lever starts flashing. The crew drops down the L/G, suspends the flight and lands normally at Varna Airport.

On 31.08.2015 after L/G examination and testing of the configuration panel, the aircraft performs technical flight with dropped L/G to the base Sofia Airport for investigating the cause of the defect. Figure 9, Appendix 1 exhibits the preparation of FALCON 2000 aircraft, SN 123, registration marks LZ-OOI, for functional tests of the L/G at Sofia Airport. Figure 10 shows the availability of signaling for L/G dropped-down position on the configuration panel. Control L/G retractions and drop-downs were performed which proved that the cause of the event, realized on 30.08.2015, was a defective lock for upper position of the nose L/G. Figure 12 from Appendix 1 shows the non-locked nose L/G upon position of the control lever, corresponding to retracted position, as exhibited on Figure 13, Appendix 1, where the three illuminating red lights on the configuration panel may be seen. Figure 11, Appendix 1 shows that the doors of the main L/G remain in open position. Figure 1 exhibits the failed lock of the nose L/G. Upon the performed works on searching malfunctions in conformity with working package Nr. 15 F212/31.08.2015, enclosed to the investigation materials, elaborated by Aviodetachment 28, the Technical Service Organization of the Air Operator established also that the nitrogen pressure in the nose stand is outside the permissible limits. The defective lock was replaced by a new one, as the defective lock was sent for investigation. The nose stand was charged with nitrogen by a TAG Aviation expert.

On recommendation of the commission on the investigation of events connected with functioning of the aircraft's L/G, the locks of the main stands were also replaced.

After the performed replacements, there are no malfunctions connected with the L/G, which is also confirmed by the control flights of the aircraft, carried out on 09.09 and 10.09.2015.

In connection with the detected deviation of pressure in the nose stand, as a preventive measure, an Instruction of the Chief Aviation Engineer of Aviodetachment 28 is issued under Nr. AT-01-09 for the control of nitrogen pressure in the stand of the nose L/G, with frequency of measurement 15 ± 5 landings, or 30 ± 5 calendar days.

2.17. Organizational and management information

The organizational structure of Aviodetachment 28 is described in the Operation Manual of the Air Operator, Part A, approved by the "Civil Aviation Administration" Directorate General on 09.08.2010. The Operation Manual at the time of realization of the event was not updated and it mentions persons who do not fulfill the obligations specified thereby.

Aviodetachment 28 includes the Organization managing the maintenance of permanent aircraft airworthiness and the Technical Service Organization. The technical service program and the description of the Organization managing the maintenance of permanent aircraft airworthiness often use the wording "Organization for maintenance of permanent aircraft airworthiness" instead of "Organization managing the maintenance of permanent aircraft airworthiness", which needs correction. In paragraph 1.14 "Procedure on reporting of aviation events...", against the description of "Organization managing the maintenance of permanent aircraft airworthiness" there aren't any records included to specify that any and all events that threaten or which may threaten safety of flights shall be reported to the Aircraft Accident Investigation Unit at the Ministry of Transport, Information Technology and Communications. This is also a major requirement of Ordinance Nr. 13 dt. 27.01.1999 on the investigation of aviation accidents.

2.18. Additional information

On 07.01.2015 at Plovdiv Airport, during a flight for checking of the radio-navigation equipment of the Airport, during the second round and upon switching of the L/G control lever at a retraction position, the lights for dropped and closed position of the left and right stands of the main L/G (green ones) and the lights for open position of the doors of the main L/G (red ones) on the configuration panel remain illuminating. A technical flight over the base Sofia Airport is carried out. Actions are undertaken for the detection and rectification of an eventual malfunction. The measures undertaken are reflected in technical onboard logbook Nr. 000552, a copy of which is enclosed to the investigation materials. There are doubts for a loosened electric connector of the electric-hydraulic unit controlling L/G drop-down and retraction „L/G und Door Hydraulic Supply Unit (150GM)“. The connector is checked and cleaned. The aircraft is hoisted by jackscrews and checks are performed on the L/G drop-down and retraction, whereupon no deviations from the technical requirements are established. Established is the lack of codes for defects in the onboard computers.

The aviation event, realized on 07.01.2015, is not reported to the Unit for Accident Investigation in Air, Water and Railway Transport at the Ministry of Transport, Information Technology and Communications.

After the performance of the works, mentioned in technical onboard logbook Nr. 000552, the flight operation of the aircraft is continued.

Together with its designation as passenger and load carrier, aircraft FALCON 2000, SN 123, registration marks LZ-OOI, is used also for fly testing of ILS at the airports in the Republic of Bulgaria, performing in average 12 such flights, each flight including 15 cycles of L/G drop-down and retraction, or 180 cycles annually. For 14 years operation of the aircraft, this counts 2520 cycles, upon total number of reported cycles till 11.02.2015 – 3005 take-off and landing cycles. It may be accepted that the work load of the L/G systems is with 84% greater than that of the type of aircraft, for which the technical service program is elaborated.

3. Analysis

The practice of aviation craft operation shows failures which are repeated on a periodical basis, most often with a non-established frequency of repetition. There are substantial difficulties in the discovery of such malfunctions failures and their rectification. Such malfunction, realized in flight, later upon the ground tests is not revealed. The malfunction is not revealed also again in flight for an indefinite period of time. The rectification of such malfunctions is of greater difficulty. In a number of cases, carried out is replacement of the so-called “week unit” in the chain of units, which form the complex system whose functioning is disturbed. Such replacement anyway does not guarantee the recovery of the system. Such guarantee may be given only upon the replacement of all units, which is economically unfeasible, or under the condition that during the successive test for searching of the defect the cause of failure is revealed.

Of substantial importance for the detection and rectification of malfunctions is the accumulated operational experience and the investigation of circumstances under which the concerned malfunction is displayed.

Paragraph 2.6.2 mentions that Service bulletin of FALCON FSA-32-30-016-R05-B, 5 revision, dt. 02.10.2014 considers anomalies in the sequence of functioning of the L/G drop-down/retraction system for FALCON 2000 and FALCON 2000EX models of the aircraft. It is pointed out that 24 induction sensors partake in the control and signaling of the consequence of L/G retraction and drop-down. Enclosed is statistical data on anomalies caused by the induction sensors depending on the place of their arrangement. Causes are mentioned which may be connected with their improper operation, such as de-adjustment, pollution, lowering of the ambient temperature, etc. In more than 50% of the cases the exact cause for the

malfunctions is not established. Rectification actions are specified, including replacements with modified articles. The bulletin exposure serves as grounds for the elaboration of the programs on the performed works after the realized events on 11.02.2015, 18.02.2015 and 15.04.2015. The common point in the three cases is that the malfunction is not revealed upon ground tests, i.e. the systems function without deviations from the technical conditions. This obstructs the detection of the abnormally functioning components and makes repetition of the condition of failure probable.

The bulletin mentions that the sensitivity area of the induction sensors decreases with lowering of the ambient temperature. The temperature range of the surrounding environment in the months of January, February, March is characterized by low, even negative temperatures. Upon the assessment of the temperature impact, not negligible is the fact that the aircraft is parked outdoors at Sofia Airport. The works connected with maintaining of its airworthiness, the diagnostics of the status of failed systems and replacement of components are also carried out outdoors. This increases the possibility for making of mistakes. As a deficiency in the work of the Air Operator may be mentioned the non-reporting at the Unit for Accident Investigation in Air, Water and Railway Transport of the event dt. 07.01.2015, which in its nature is a serious incident, as its profound investigation would have lead to a more timely establishment of causes for the L/G improper functioning, such as for example the lately established increased air gap in the “ground/air” sensors of the nose L/G.

The analysis of the conditions of the L/G operation underestimates the fact that in connection with the specifics of using the aircraft for inspection flights over ILS of the airports in the Republic of Bulgaria, the operative load of the L/G systems, connected with the number of realized cycles, is with about 84% higher than that of an airplane used only for traffic of passengers and loads, which is the main designation of that type of aircraft. Such an increased load probably leads to increasing the number of failures connected with the L/G functioning. It should lead to adapting the technical service program by increasing the frequency of performed checks or replacement of existing components with modified ones of an improved structure, as recommended by Service Bulletin of FALCON FSA-32-30-017-R02-A dt. 02.10.2014, mentioned in paragraph 2.6.2.

It may be stated that the eventual causes for the occurred events with aircraft FALCON 2000, SN 123, registration marks LZ-OOI, are due to structural peculiarities of the systems, ensuring functioning of its L/G, the increased operational burden connected with the specifics of its use, and the adverse impact of the external environment.

4. Conclusion

4.1. Findings

- Aircraft FALCON 2000, serial number Nr. 123, registration marks LZ-OOI, is manufactured on 15.06.2001 by DASSAUL AVIATION and has Registration Certificate Nr. 1922, issued on 02.11.2004 by the Directorate General “Civil Aviation Administration” of the Republic of Bulgaria.

- The aircraft has valid certificate for airworthiness and is maintained in conformity with the requirements of the applicable regulations.

- The maintenance of the aircraft airworthiness is carried out in conformity with the Program on the technical maintenance of the aircraft, edition 1, revision 2 dt. July, 2014.

- The aircraft has Operation Permit Certificate, issued by TAG Aviation SA on 29.10.2014. In accordance with it, the aircraft has undergone base technical servicing within the scope of Form 2A/2A+ and 800 Engine Hours Inspection.

- On 11.12.2014, in conformity with its technical service program, the aircraft has undergone Base inspection, performed by the Technical Service Organization of Aviodetachment 28, for which Operation Permit Certificate Nr. 14F284 is issued.

- On 11.02.2015 in conformity with technical onboard logbook Nr. 000597, the aircraft undergoes operative technical servicing, executed after Form „Daily check + Preflightcheck”. The aircraft is tanked with fuel 10900 lbs and is accepted after the procedure with no enlisted comments on the part of the Commander of flight, thus the conclusion may be drawn that at the time of realization of the event the aircraft was airworthy.

- On 11.02.2015 after take-off of the aircraft for the execution of flight BGF 004, upon retraction of its L/G, on the information panel remain flashing red and green signaling lights of the left main L/G. The crew drops down the L/G and after spending of fuel for reduction of the flight weight of the aircraft to the permissible landing weight performs the landing successfully.

- During the performance of ground tests, the above mentioned failure of the L/G drop-down/retraction system is not revealed.

- In the list of parameters recorded by SSDFDR registrator of FALCON 2000 SN 123 aircraft, registration marks LZ-OOI, there are no parameters registering the L/G condition.

- The performed works on recovery of the system are described in paragraph 2.16 of the present Report.

- On 18.02.2015 during flight BGF 280 SOF-SOF, after placing the L/G drop-down/retraction lever in an upper position, three red and the two green lights of the main L/G and a flashing red light of the L/G retraction lever remain illuminating, after that the L/G is dropped down and the aircraft lands normally at Sofia Airport.

- Upon ground tests, the above mentioned failure of the L/G Drop-down/retraction system is not revealed. The performed works on recovery of the system are described in paragraph 2.16 of the present Report.

- On 15.04.2015 during flight BGF 021 SOF-ZAG, after L/G retraction, the red lights on the configuration panel remain illuminating, the green lights are switched off, and the red light of the L/G drop-down/retraction lever remains flashing. The crew drops down the L/G, suspends the flight and lands normally at Sofia Airport.

- Upon ground tests, the above mentioned failure of the L/G drop-down/retraction system is not revealed. The performed works on recovery of the system are described in paragraph 2.16 of the present Report.

- On 30.08.2015 during flight BGF 004 VAR-PDV, after take-off, upon placing the L/G drop-down/retraction lever at upper position, there remain flashing three red lights on the configuration panel and the glimmering red light of the L/G drop-down/retraction lever. The crew drops down the L/G, suspends the flight and lands normally at Varna Airport.

- The performed control retractions of the L/G show that the cause for the event, realized on 30.08.2015, is a defective lock for upper position of the nose L/G. The defective lock is replaced with a new lock, as the defective one is sent for investigation.

- Upon the performed works in search of malfunctions in conformity with working package Nr. 15 F212/31.08.2015, enclosed to the investigation materials, developed by the Organization managing the maintenance of permanent aircraft airworthiness of Aviodetachment 28, the Technical Service Organization of the Air Operator proved also that the nitrogen pressure in the nose stand is outside the permissible limits. The nose stand is charged with nitrogen by an expert from TAG Aviation.

- Service bulletin of FALCON FSA-32-30-016-R05-B, 5 revision, dt. 02.10.2014 reviews anomalies in the consequence of functioning of the L/G drop-down/retraction for models FALCON 2000 and FALCON 2000EX of the aircraft. Remedy actions are specified, including replacements by modified articles.

- Service bulletin of FALCON FSA-32-30-017-R02-A dt. 02.10.2014 provides review of anomalies in the functioning of the lock for retracted position of the nose L/G. Recommended is its replacement by a modified variant, the same is recommended also for the locks for retracted position of the main stands.

- On recommendation of the commission on investigation of events connected with L/G functioning, the locks of the main stands are also replaced.

- After the performed replacements, there are no L/G system malfunctions revealed, which is confirmed also by the control flights of the aircraft, carried out on 09.09 and 10.09.2015.

- In connection with the detected deviation of pressure in the nose L/G, as preventive measure, an Instruction of the Chief Aviation Engineer of Aviodetachment 28 is issued under Nr. AT-01-09 on the control of nitrogen pressure in the stand of the nose L/G, upon frequency of measurement 15 ± 5 landings, or 30 ± 5 calendar days.

- Upon the realized events the piloting and the servicing pilots have possessed the requested qualification and have acted in conformity with the requirements of the instruction on flight operation of the aircraft.

- The acts of the pilots confirm that their knowledge and knowing of the aircraft are adequate to the occurred situations.

- On 07.01.2015 at Plovdiv Airport during flight for checking the radio-navigation equipment of the airport, upon the second tour and switching of the L/G control lever to retraction position, the lights for down and locked position on the left and right stand of the main L/G (green lights) and the lights for open position of the doors of the main L/G (red lights) remain illuminating on the configuration panel. Actions are undertaken for detection and rectification of eventual failure. The measures are reflected in technical onboard logbook Nr. 000552.

- The aviation event, realized on 07.01.2015, is not reported to the Unit for Accident Investigation in Air, Water and Railway Transport at the Ministry of Transport, Information Technology and Communications.

- Together with its designation as passenger and load carrier, aircraft FALCON 2000, SN 123, registration marks LZ-OOI, is used also for flight testing of ILS at the airports in the Republic of Bulgaria, performing in average 12 such flights, each flight including 15 cycles of L/G dropping down and retraction, or 180 cycles annually. For 14 years operation of the aircraft, this counts 2520 cycles, upon total number of reported cycles till 11.02.2015 – 3005 take-off and landing cycles. It may be accepted that the work load of the L/G systems is with 84% greater than that of the type of aircraft, for which the technical service program is elaborated.

- The meteorological conditions exercise indirect impact over the realized events, as the aircraft is parked outdoors and in accordance with the bulletins mentioned in paragraph 2.6.2, the ambient temperature variations lead to alteration in the characteristics of the used induction sensors.

- The organizational structure of Aviodetachment 28 is described in the Operation Manual of the Air Operator, Part A, approved by the Directorate General “Civil Aviation Administration” on 09.08.2010. The Operation Manual at the time of realization of the event was not updated and it mentions persons who do not fulfill the obligations specified thereby.

- The technical service program and the description of the Organization managing the maintenance of permanent aircraft airworthiness often use the wording “Organization for maintenance of permanent aircraft airworthiness” instead of “Organization managing the maintenance of permanent aircraft airworthiness”, which needs correction.

- In paragraph 1.14 “Procedure on reporting of aviation events...”, against the description of “Organization managing the maintenance of permanent aircraft airworthiness”

there isn't any records included to specify that any and all events, threatening or which may threaten the safety of flights, shall be reported to the Aircraft Accident Investigation Unit at the Ministry of Transport, Information Technology and Communications. This is also a major requirement of Ordinance Nr. 13 dt. 27.01.1999 on the investigation of aviation accidents.

4.2. Causes

In view of the contents, exposed in the present Report, it may be stated that,

The probable causes for the occurred events with aircraft FALCON 2000, SN 123, registration marks LZ-OOI, are due to structural peculiarities of the systems, providing the functioning of the L/G system, the increased operational load in connection with the specifics of the aircraft's use, and the adverse impact of the external environment.

5. Safety recommendations

In the process of investigation of the events, connected with impairment of the functioning of the systems, providing L/G retraction and drop-down, the following recommendations were made for the provision of safety of flights:

1. The lock of the L/G left main stand P/N C24244007-2 shall be replaced with lock P/N C24244007-3;

2. The lock of the L/G right main stand P/N C24245007-2 shall be replaced with lock P/N C24245007-3.

After the replacement the relevant procedures shall be carried out for the establishment of the normal L/G functioning.

Taking into consideration the causes for the realized aviation incident and the insufficiencies detected upon the investigation, the commission recommends the performance of the following safety measures:

1. The management of Aviodetachment 28 shall explore the possibility for the construction or renting of an airshed for parking of aircraft FALCON 2000, SN 123, registration marks LZ-OOI, during the periods of time when the aircraft is not operated according to its designation.

Responsible person: The Director General of Aviodetachment 28.

2. The Organization managing the maintenance of permanent aircraft airworthiness shall reconsider the technical service program of the aircraft in its part providing the L/G normal operation, taking into account the increased operational loads in connection with the use of the aircraft for testing of ILS at the airports of the Republic of Bulgaria, and the outdoor parking of the aircraft.

Responsible person: The Head of the Organization managing the maintenance of permanent aircraft airworthiness of Aviodetachment 28.

3. The Head in charge of the safety management system of Aviodetachment 28 shall make a recommendation for increasing the number of recorded parameters in flight, aimed at their use upon the analysis of causes of malfunction occurrences in flight.

Responsible person: The Director of the "Safety" Directorate of Aviodetachment 28.

4. The Air Operator Aviodetachment 28 shall perform corrections in the documentation of the operator for rectification of the insufficiencies, pointed out in the Report.

Responsible person: The Director General of Aviodetachment 28.

Appendices: Appendix 1.

The Appendix constitutes an inseparable part of the Report.

The investigation commission reminds hereby to all organizations, to which safety measures have been communicated, that on the grounds of Art. 18 of Regulation 996/2010 on the investigation and prevention of accidents and incidents in civil aviation, and Art. 19, par. 7 of Ordinance Nr. 13 on the investigation of aviation events they are obliged to notify in writing the Unit for Accident Investigation in Air, Water and Railway Transport with the Ministry of Transport, Information Technology and Communications on the status of safety measures.

Chairman of the commission:

..... (Hr. Hristov)

Members:

..... (St. Petrov)

..... (St. Stefanov)

..... (B. Nikolov)

Appendix 1

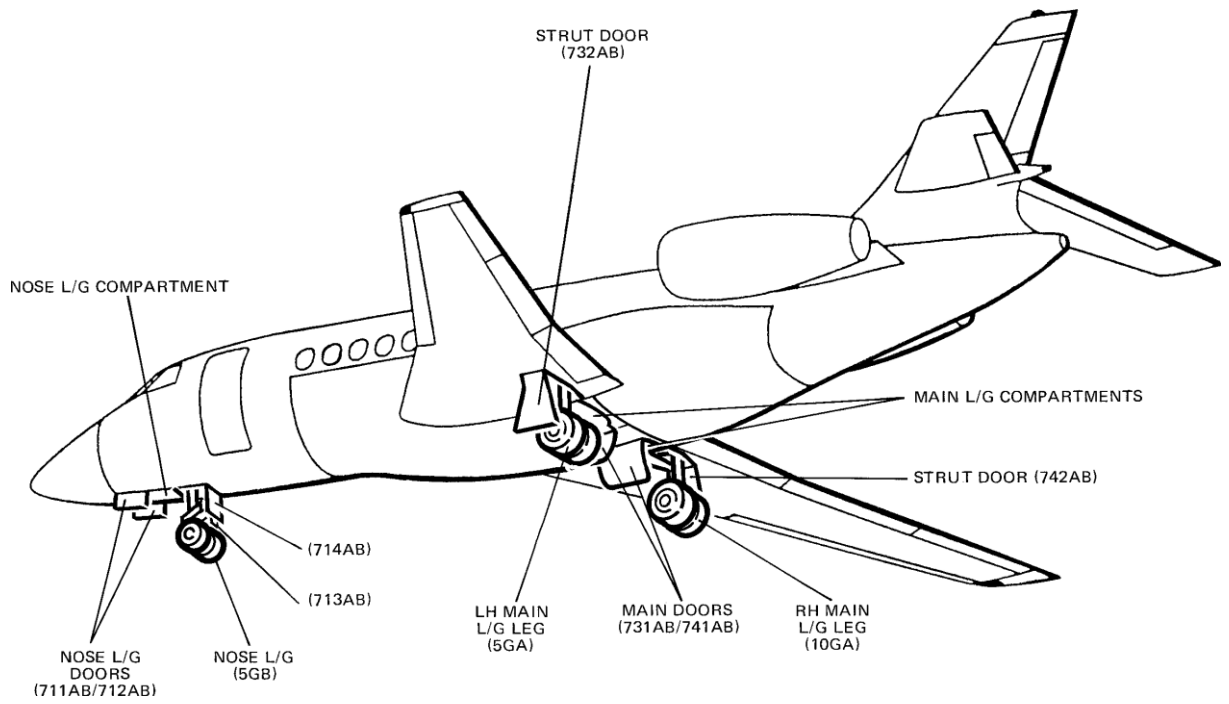


Figure 1. L/G general view.

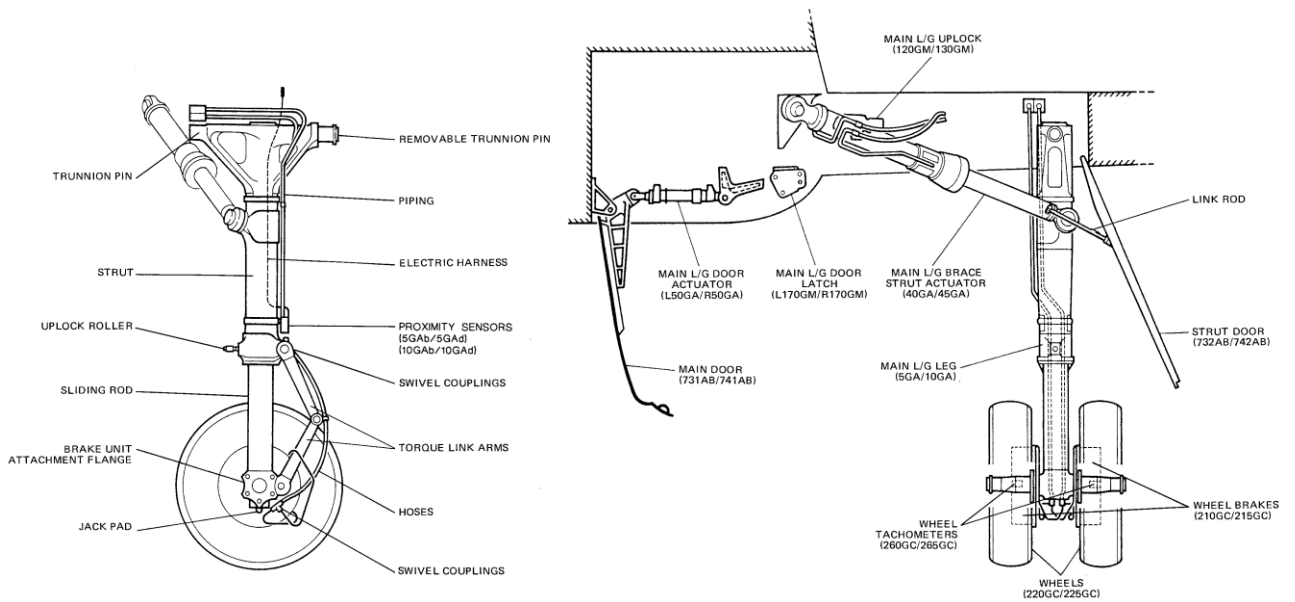


Figure 2. Main L/G and its components.

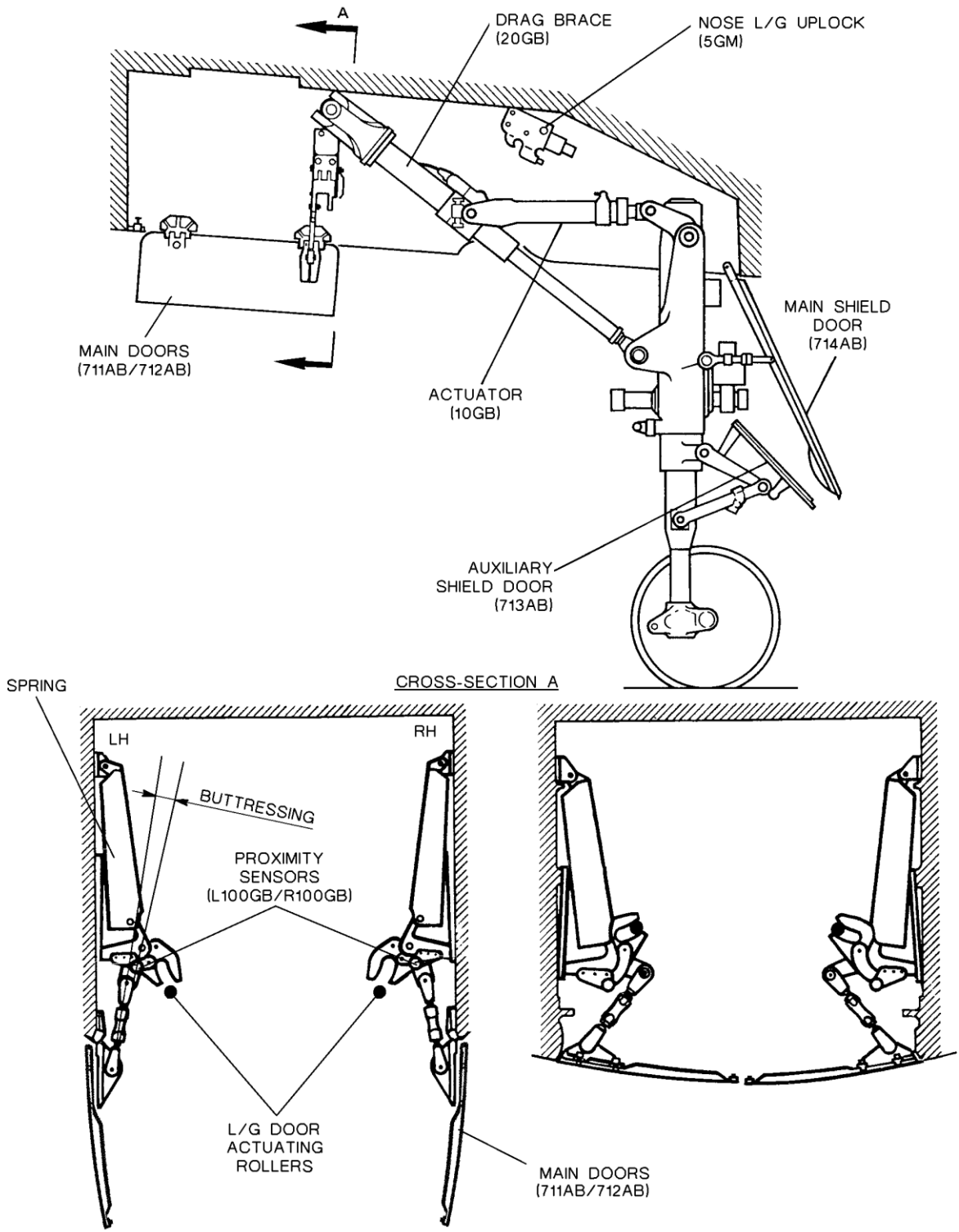


Figure 3. Nose L/G and doors.

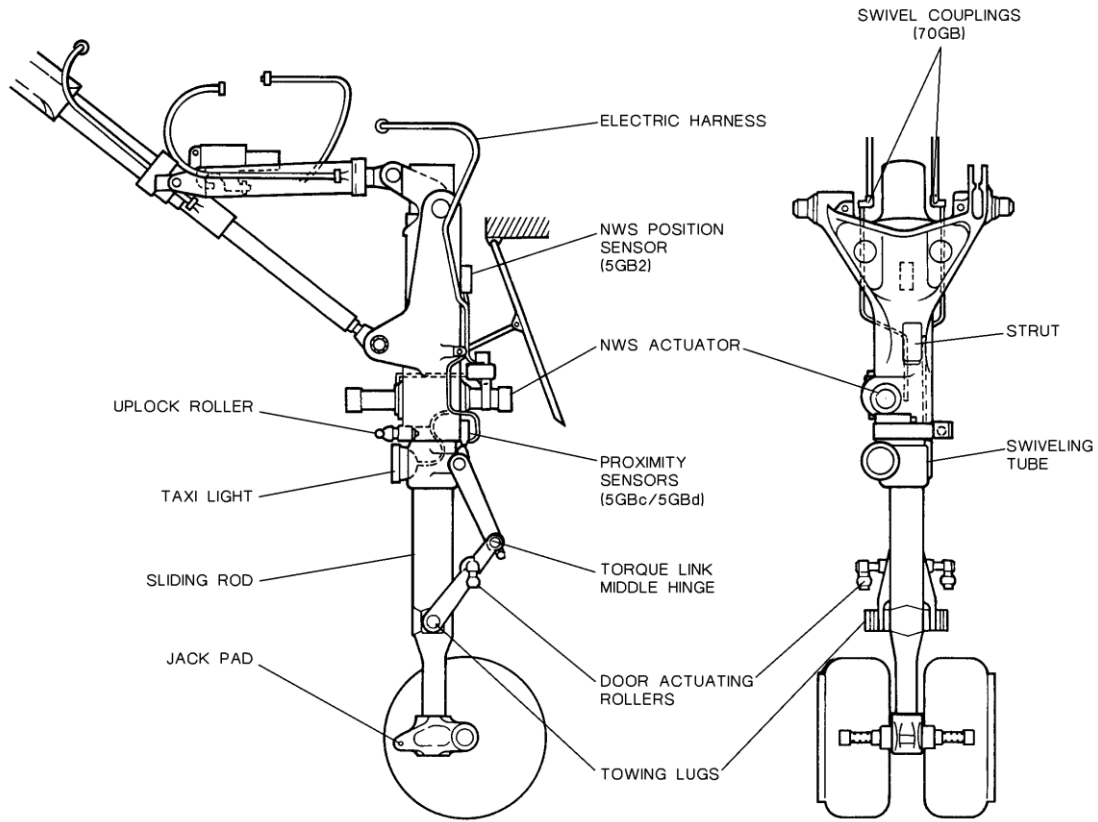


Figure 4. Stand of the nose L/G.

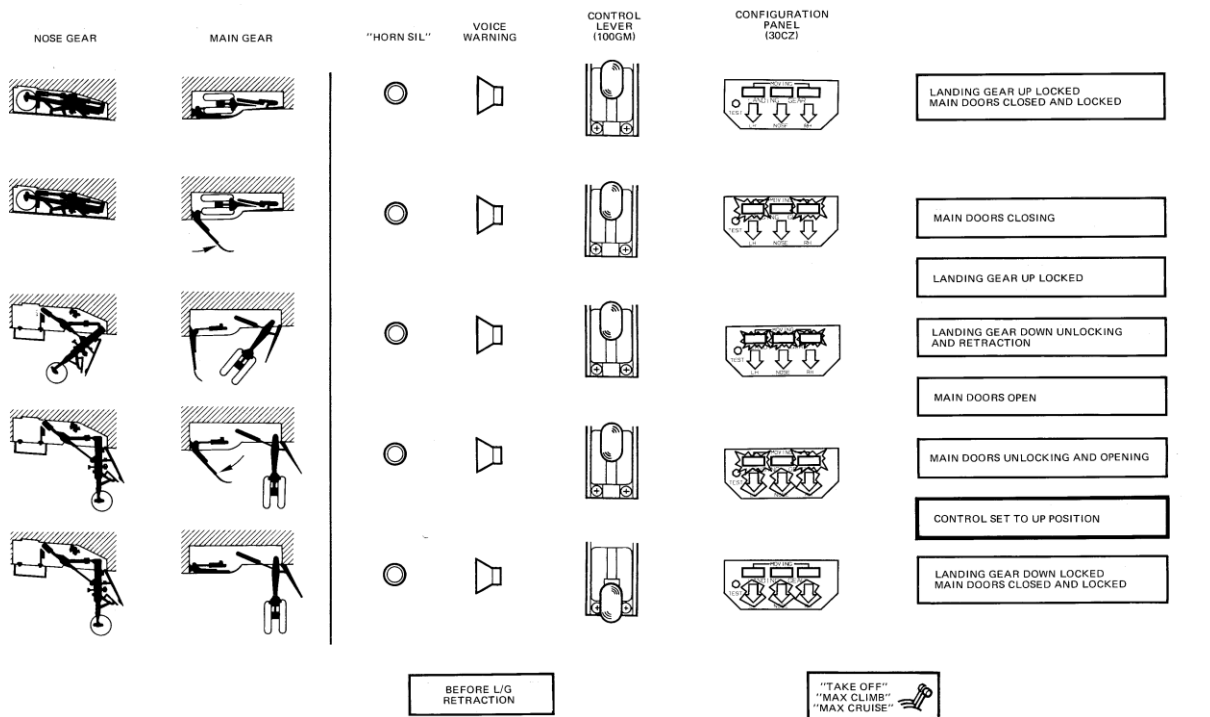


Figure 5. Sequence of L/G retraction.

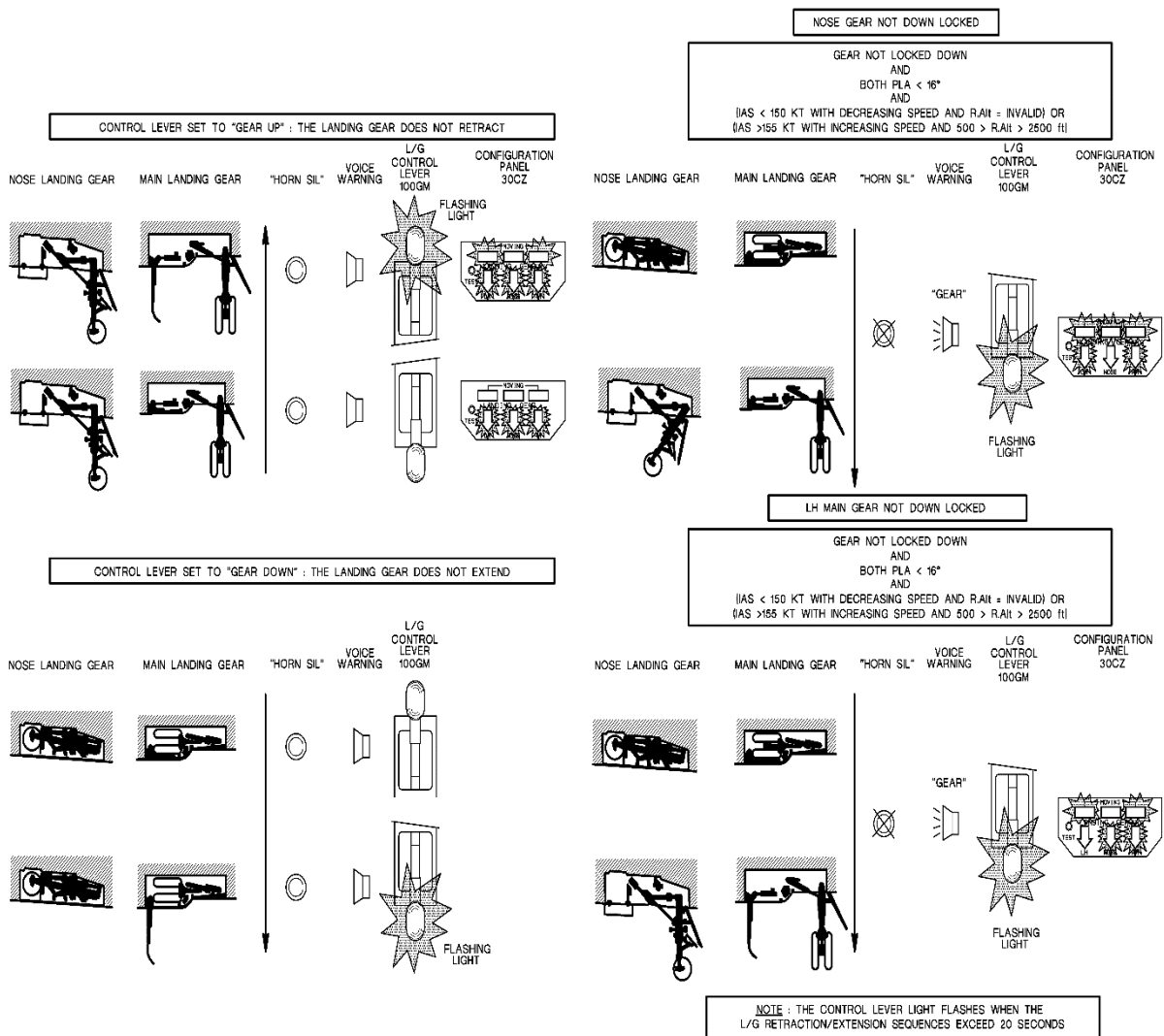


Figure 6. Obstruction of the normal functioning upon L/G retraction and drop-down.



Figure 7. The aircraft at Sofia Airport on 12.02.2015.



Figure 8. The aircraft with retracted L/G upon tests on 13.02.2015.



Figure 9. Preparation of the aircraft for L/G functional tests on 31.08.2015 at Sofia Airport.



Figure 10. Signaling on the configuration panel for L/G down position.



Figure 11. The lever is in “retracted” position, the doors of the main L/G remain in “down” position.



Figure 12. The lever is in “retracted” position, the nose stand is not closed in “retracted” position.



Figure 13. On the configuration panel, three red lights are illuminating.



Figure 14. The failed lock of the nose L/G.