

FINAL REPORT

on

investigation of a serious incident realized on 29.01.2008 after take off from Lajes Airport, Azores, with Tu-154M aircraft, registration No LZ-BTZ, property of Aviodetachment 28 Air Operator, conducting flight BULG-001 on route Sofia - Lajes - Bermuda - Mexico City.



2008

CONTENTS

1. Introduction	5
2. Factual Information	5
2.1 History of Flight	5
2.1.1 Flight Number	5
2.1.2 Preparation and description of the flight	5
2.1.3 Location of the Occurrence	6
2.2 Injuries to Persons	7
2.3 Damages to Aircraft	7
2.4 Other Damages	7
2.5 Personnel Information	7
2.5.1. Aircraft Commander	7
2.5.2. Copilot	7
2.5.3. Flight engineer	8
2.5.3. Flight radio operator	8
2.5.3. Senior cabin attendant	9
2.5.6. Cabin attendant	9
2.5.7. Cabin attendant	9
2.5.8 Cabin attendant	10
2.5.9 Cabin attendant	10
2.5.3. Technical Person	11
2.5.11 Official	11
2.5.12 Official	11
2.5.3. Flight Dispatcher	11
2.6. Aircraft information	11
2.6.1. Airworthiness information	11
2.6.2. Airplane performance	13
2.6.3 Fuel	14
2.7. Meteorological information	14
2.8. Aids to navigation	15
2.9. Communications	15
2.10 Airport	15
2.11. Flight data recorders	15
2.11.1. Data from the information carriers taken from flight data recorders	15
2.11.2. Date from the analysis of MSRP-64 information	15
2.12 Wreckage and impact information	17
2.13 Medical and pathological information	17
2.14 Fire	17
2.15 Survival aspects	17
2.16 Tests and research	17
2.16.1 Inspection of the condition of the nose landing gear, the niche for retraction of the gear and valves and switches for landing gear control in the cockpit	17
2.16.2 Tests of the function of landing gear retraction and extension system	18
2.16.3 Tests of the function of nose landing gear control system;	18
2.16.4 Check of the quantity of hydraulic liquid in the systems, check of the filters of hydraulic systems and laboratory analysis of hydraulic liquid of first hydraulic system	19
2.16.5 Check of gas pressure in the nose landing gear shock-absorber and nose landing gear castor	19

2.16.6 Tests of the locking of the nose landing gear with deviated nose wheel from the aircraft axis.....	19
2.16.7 Non-destruction control of assemblies of the nose landing gear structure	20
2.16.8 Test of hermiticity of nose landing gear castor	20
2.16.9 Decoding and analysis of the information from flight data recorders.....	21
2.16.10 Investigation of aircraft operational documentation and air operator operational documentation.....	21
2.16.11 Technical flight test after elimination of the failures discovered.....	21
2.16.12 Logical and probabilistic analyses of the possible causes for the air occurrence	22
3. Analysis.....	22
4. Conclusions	24
5. Safety recommendations:	24

LIST OF ABBREVIATIONS

AO	- Air operator;
AC	- Aircraft;
MD CAA	- Main Directorate of Civil Aviation Authority;
ACr	- Aircraft crew;
CAA	- Civil Aviation Act;
ACC	- Aircraft commander;
ARP	- Airport reference point;
MT	- Ministry of Transport;
SN	- Since new;
MO	- Maintenance organization;
RWY	- Runway;
TWY	- Taxi way;
SM	- Scheduled maintenance;
ATC	- Air Traffic Control;
AOM	- Aircraft Operation Manual;
FCO	- Flight control officer;
MAC	- Mean aerodynamic chord;
AAIU	- Air Accident Investigation Unit
ATC	- Air Traffic Control;
ATC	- Air Traffic Control;
ATIS	- Automatic terminal information service;
CAVOK	- Ceiling and visibility OK
CRM	- Crew resources management;
CVR	- Cockpit voice recorder;
DME	- Distance measuring equipment;
ILS	- Instrument landing system;
FDR	- Flight data recorder;
FOM	- Aircraft Operation Manual;
KIAS	- Knots indicated airspeed;
LDA	- Landing distance available;
METAR	- Information on regular weather observation;
NOTAM	- Notice to airmen.
RA	- Radio height;
TODA	- Take-off distance available;
UTC	- Coordinated universal time.
VOR	- VHF omnidirectional radio range.

1. Introduction.

On the 29.01.2008 the crew of Tu-154M, reg. No LZ-BTZ, property of Aviodetachment 28 AO was conducting State Flight for transport of passengers on route Sofia - Lajes (Terceira Island, Azores) - Bermuda - Mexico City under flight number BULG-001.

After takeoff from Lajes Airport the nose landing gear did not retract. The crew informed ATC and after execution of the respective procedures, foreseen in AOM and a flight in a holding area for burn off the fuel landed normally at the Lajes Airport.

No consequences for the crew and aircraft.

Notified: Air Accident Investigation Unit (AAIU) and General Directorate of Civil Aviation Authority at the Ministry of Transport of Republic of Bulgaria, Interstate Aviation Committee of Commonwealth of Independent States (CIS), International Civil Aviation Organization (ICAO) and Air Accident Investigation Board, Portugal.

On the base of Article 9, Para. 1. Rev. - SG, No 83 of 2004, addition, No 77 of 2005) and in accordance with Para.3, p. 1 (б) of additional provisions of Regulation No 13 (last rev. and additions 16.01.2007) of 27.01.1999 of the MT, the air occurrence has been classified by AAIU as a serious incident. The materials on the aviation occurrence are classified under state file number No 02/29.01.2008 in the archives of AAIU.

On the base of Article 142, Para. 2, of CAA of Republic of Bulgaria of 01.12.1972 (last rev. and additions SG No 10 of 30.01.2007) and Art. 10, Para.1 (Rev. - SG No 83 of 2004), in relation with Art. 2, Para. 3 of Regulation No13 of MT of 27.01.1999 on investigation of air occurrences with an order RD-08-42/ 04.02.2008 of the Minister of Transport a commission for investigation of the serious incident was appointed.

After the landing of the aircraft at Sofia Airport the commission performed an inspection, conducted interviews and took written explanations from the aircraft crew and persons in charge for aircraft maintenance. Written explanations were taken and interviews were conducted with the officials, related with the realized serious incident. Functional tests of the landing gear retraction system and nose wheel steering system have been made. The castoring mechanism of the nose gear was investigated and a laboratory analysis of the hydraulic liquid was conducted.

The difference between the local time at Lajes Airport, Terceira Island and UTC is -1 hour.

2. Factual Information

2.1 History of Flight

The flight mission was tasked by an Order No RD-16-3/25.01.2008 of the Director General of Aviodetachment 28 to two crews consisting of: two commanders/instructors, two copilots, two flight engineers, flight radio operator, six female attendants, four male attendants, two technical persons and a flight dispatcher.

2.1.1 Flight Number

The flight was conducted under number BULG - 001.

2.1.2. Preparation and description of the flight

By an order No RD-16-3/25.01.2008 of the Aviodetachment 28 Director General a crew for test flight before the flight on 29.01.2008 was appointed. The crew consisted of: two

commanders/instructors, flight engineer-instructor, flight engineer, flight radio operator, senior cabin attendant, five cabin attendants and technical person. The test flight was performed on 28.01.2008 and no technical problems or remarks were registered in the technical log book No 000159 by the crew.

By Flight Mission of 29.01.2008, which number wasn't shown, for the route sector Sofia (LBSF) – Lajes (LPLA) AO General Director appointed a crew consisting of: commander/instructor, copilot, flight engineer, five cabin attendants, three technical persons and a flight dispatcher. By a separate flight mission, which number wasn't shown, for the route sector Lajes - Navigation Point NAT1 the same crew was appointed with addition of a flight radio operator.

The pre-flight preparation was reflected in a pre-flight sheet and the crew received in full the necessary en route weather information, weather information along the route and alternates, the necessary NOTAM information for the en route flight, the required additional information, related with the aerodrome services and refueling at intermediate airports.

On 29.01.2008 Tu-154M aircraft, reg. No LZ-BTZ, took-off for the flight BULG-001 at 12:10UTC from Sofia Airport to Lajes Airport on Terceira Island, Azores. The take-off, en-route flight, approach and landing at Lajes Airport passed without peculiarities. The landing at Lajes Airport was at 18:00 UTC.

After refueling of the necessary fuel according to the preliminary calculation the aircraft took-off from RWY33 at 19:10 UTC in conditions of moderate turbulence and pulsating wind with side component reaching 29 kn. After take-off for the flight en-route Lajes (LPLA) - Bermuda (TXKF) and switching over the lever of the retracting and extending of the landing gear in retracted position the crew noticed, that the red lamp for non-locked (intermediate) position of the nose gear continued to glow. The readings of the hydraulic system and the noise from the fore part of the aircraft confirmed that the nose landing gear wasn't retracted. The crew discontinued the climb at FL120 and made several attempts to retract the landing gear (according to the flight data recorder - two), but they didn't give a result and after that they made the decision after overflying the RWY of Lajes Airport for review of the landing gear from the ground. After conducting of the review by Lajes Control Tower and the confirmation that the nose landing gear wasn't retracted, the crew decided to terminate the flight and to land at the Lajes Airport. After a flight in the holding area for burning off fuel for achievement of the maximum allowable landing mass the crew performed landing on RWY33 at Lajes airport at 22:40 UTC.

After the landing the technical persons made an inspection of the end switches for extended and retracted position of the nose landing gear, for fractures and deformations. An inspection of casings and control rods of the end switches was made. An examination of the cable plans of the gears and the nose landing gear bay was made for presence of signs of abrasions, breaks and insulation faults. A check of the signalization of the nose landing gear position separately from the flight engineer console and pilot's console was made. Both signalizations worked normally and after execution of maintenance form „BC + A2”, the crew decided to cancel the next part of the flight.

No consequences for the passengers, crew, aircraft and third persons.

2.1.3 Location of the Occurrence

The serious incident originated at 19:12 UTC on 29.01.2008 after take-off from Lajes Airport for the flight BULG-001 en-route LPLA-TXKF.

2.2 Injuries to Persons

No injuries to crew and passengers.

2.3. Damages to Aircraft

After the landing on the 29.01.2008 at Lajes Airport no damages have been found out.

During the assessment of the technical condition of the aircraft performed after the landing at Sofia Airport on 01.02.2008 no damages and deviations of the technical requirements were established excluding the lack of pressure in the gas area of air castor 154.80.4208.100 of the nose landing gear.

In Enclosure 1 of Fig. the aircraft is shown at the parking stand at Sofia Airport after its landing on 01.02.2008 r. and on the Fig. 2 the air castor of the nose landing gear is shown.

2.4. Other Damages

No other damages.

2.5 Personnel Information

2.5.1. Aircraft Commander – aged 55 .

License ATPL(A), line pilot – 1-st class, No BG ATPA-0111-10163, date of first issuance 27.02.1998, date of issuance 16.03.2006, valid till 05.10.2009.

Medical fitness certificate from CAA No MED BG - 72149 - 10163-9, Class -1, date of first issuance 10.08.1976, date of issuance 20.09.2007 and valid till 20.03.2008.

Type ratings and permissions:

Commander of Tu-154 aircraft since 30.04.2002 with validity till 09.07.2008 and instructor grade since 26.05.2004 and valid till 09.07.2008.

Last checks:

– Full check on Tu-154 simulator at Training Center No 21 of OAO Vnukovo Airport on 21.01.2008;

- flight proficiency check and in-flight emergency procedures for Tu-154 aircraft, 24.06.2007.

Flight experience:

Total flying hours: 8225:44 hrs;

On the type of aircraft, on which the air occurrence was realized: 2164:09 hrs, from which 1262:12 hrs as commander and 273:45 hrs as commander/instructor.

Information about duty time:

Flying hours:

– for the last 24 h: 10:40 hrs on TU-154 M;

– for the last 30 days: 17:35 hrs on Tu-154 M;

– for the last 90 days: 60:15 h on Tu-154 M;

- rest time: 12 hrs.

2.5.2. Copilot – aged 58.

License: ATPL(A), No BG ATPA-0101-10157, date of first issuance 19.02.1998, date of issuance 28.01.2005, valid till 10.10.2009.

Medical fitness certificate from CAA No MED BG - 72166 - 10157-9, Class -1, date of first issuance 10.08.1972, date of issuance 25.09.2007 and valid till 20.03.2008.

Type ratings and permissions:

Copilot of Tu-154 aircraft (COP) since 06.08.1996 and validity till 27.07.2008.

Last checks:

- check on Tu-154M simulator – 23.10.2007;
- flight proficiency and navigation check and in-flight emergency procedures: 27.07.2007.

Flight experience:

Total flying hours: 9437:10 hrs;
On the type of aircraft: 2408:42 hrs.

Information about duty time:

Flying hours:

- for the last 24 h: 09:25 hrs;
- for the last 30 days: 16:20 hrs;
- for the last 90 days: 36:55 hrs.
- rest time: 12 hrs.

2.5.3. Flight engineer – aged 55.

License: F/EL № BG FE – 0032 -20062, date of first issuance 24.06.2004, valid till 09.06.2009.

Medical fitness certificate from CAA No MED BG - 72192 - 20062-8, Class -1, date of first issuance 12.08.1986, date of issuance 26.09.2007 and valid till 26.03.2008.

Type ratings and permissions:

Flight engineer of Tu-154M since 28.01.1992 with validity till 09.04.2008.

Last checks:

- in-flight proficiency check in line conditions on 14.03.2007 and 15.03.2007.
- check on Tu-154M simulator on 30.10.2007;

Flight experience:

Total flying hours: 7082:29 hrs;
On the type of aircraft: 5019:24 hrs.

Information about duty time:

Flying hours:

- for the last 24 h: 09:25 hrs;
- for the last 30 days: 09:25 hrs;
- for the last 90 days: 31:30 hrs.
- rest time: 12 hrs.

2.5.3. Flight radio operator – aged 54.

License: F/ROL № BG FRO – 0032 -20050, date of first issuance 26.08.1983, date of issuance 21.10.2004, valid till 21.10.2009.

Medical fitness certificate from CAA No MED BG 72430 – 20050 - 8, клас-1, date of first issuance 07.10. 1981 г., issued on 23.10.2007 and valid till 23.10.2008.

Type ratings and permissions:

Flight radio operator of Tu-154M since 16.01.1991 with rating F/ROL and validity till 23.01.2009.

Last checks:

- in-flight proficiency check in line conditions on 23.01.2008.
- check on Tu-154M simulator on 30.10.2007 without any remarks and recommendation by the simulator instructor.

Flight experience:

Total flying hours: 6837:20 hrs;
On the type of aircraft: 2825:09 hrs.

Information about duty time:

Flying hours:

- for the last 24 h: 04:50 hrs;
- for the last 30 days: 11:45 hrs;
- for the last 90 days: 51:30 hrs.
- rest time: 12 hrs.

2.5.3. Senior cabin attendant – aged 47.

License: C/AL, No BG CA - 00450 - 30341, date of first issuance 26.05.1982, date of 18.05.2007, valid till 6.07.2009.

Medical fitness certificate from CAA No MED BG 70637-30341-4, Class -4, date of first issuance 02.06.1982, date of issuance 07.03.2007 and valid till 07.03.2008.

Type ratings Senior cabin attendant (SEN/CAL) of Tu-154, since 26.05.1982 and valid till 04.06.2008.

Last checks:

- annual check on 21.05.2007 and 22.05.2007.
- training at Air Transport Institute on normal and emergency procedures of Tu-154M aircraft on 28.09.2007

Flight experience:

Total flying hours: 10740:48 hrs;

On the type of aircraft: 6605:13 hrs.

Information about duty time:

Flying hours:

- for the last 24 h: 09:25 hrs;
- for the last 30 days: 16:20 hrs;
- for the last 90 days: 46:10 hrs;
- rest time: 12 hours.

2.5.6.Cabin attendant – aged 34.

License: C/AL, No BG CA - 00505 - 30396, date of first issuance 13.07.2000, date of issuance 08.01.2008, valid till 18.08.2009.

Medical fitness certificate from CAA No MED BG 70488-30396-4, Class-4, date of first issuance 04.04.2000, date of issuance 28.02.2007 and valid till 27.02.2008.

Type ratings and permissions: Ty-154 cabin attendant since 30.08.2005 with confirmed validity till 09.07.2008.

Last checks:

- annual check on 08.07.2007 and 09.07.2007.
- training at Air Transport Institute on normal and emergency procedures of Tu-154M aircraft on 28.09.2007.

Flight experience:

Total flying hours: 2715:05 hrs;

On the type of aircraft: 1299:00 hrs.

Information about duty time:

Flying hours:

- for the last 24 h: 09:25 hrs;
- for the last 30 days: 16:20 hrs;
- for the last 90 days: 47:40 hrs.
- rest time: 12 hours.

2.5.7.Cabin attendant – aged 43.

License: C/AL, No BG CA - 00226 - 30086, date of first issuance 24.06.2004, date of issuance 25.10.2007, valid till 03.05.2009.

Medical fitness certificate from CAA No MED BG 70579-30086-4, Class-4, date of first issuance 12.08.1992, date of issuance 06.03.2007 and valid till 06.03.2008.

Type ratings and permissions: Ty-154 cabin attendant since 25.06.1987 with confirmed validity till 25.06.2008.

Last checks:

- annual check on 25.06.2007.
- training at Air Transport Institute on normal and emergency procedures of Tu-154M aircraft on 28.09.2007.

Flight experience:

Total flying hours: 8387:04 hrs;
On the type of aircraft: 8378:54 hrs;

Information about duty time:

Flying hours:

- for the last 24 h: 09:25 hrs;
- for the last 30 days: 10:40 hrs;
- for the last 90 days: 18:15 hrs;
- rest time: 12 hrs.

2.5.8 Cabin attendant – aged 40.

License: C/AL, No BG CA - 00307- 30141, date of first issuance 14.03.1989, date of issuance 29.05.2006, valid till 11.05.2009.

Medical fitness certificate from CAA No MED BG 70561-30141-4, Class -4, date of first issuance 16.11.1988 r., date of issuance 06.03.2007 r. and valid till 05.03.2008 r.

Type ratings and permissions: instructor rating for Ty-154 since 29.05.2006 with confirmed validity till 25.03.2008.

Last checks:

- annual check on 25.03.2007.
- training at Air Transport Institute on normal and emergency procedures of Tu-154M aircraft on 28.09.2007.

Flight experience:

Total flying hours: 7322:39 hrs;
On the type of aircraft: 3924:05 hrs.

Information about duty time:

Flying hours:

- for the last 24 h: 10:40 hrs;
- for the last 30 days: 17:35 hrs;
- for the last 90 days: 57:20 hrs.
- rest time: 12 hrs.

2.5.9 Cabin attendant – aged 40.

License: C/AL, No BG CA - 00199- 30017, date of first issuance 11.08.1992, date of issuance 21.08.2007, valid till 22.04.2009.

Medical fitness certificate from CAA No MED BG 72843-30017-4 Class-4 date of first issuance 10.02.2004, date of issuance 11.12.2007 and valid till 11.12.2008 r.

Type ratings and permissions: Ty-154 cabin attendant since 25.06.1987 with confirmed validity till 25.06.2008.

Last checks:

- annual check on 09.12.2007.
- training at Air Transport Institute on normal and emergency procedures of Tu-154M aircraft on 28.09.2007.

Flight experience:

Total flying hours: 7358:30 hrs;
On the type of aircraft: 1443:50 hrs.

Information about duty time:

Flying hours:

- for the last 24 h: 09:25 hrs;
- for the last 30 days: 10:40 hrs;
- for the last 90 days: 28:20 hrs.
- rest time: 12 hrs.

2.5.3. Technical Person – aged 49.

Aircraft maintenance certificate: AM No BG – AM 0029-50018, date of first issuance 11.07.1985, date of issuance 29.10.2004, valid till 29.10.2009 Tu-154 M - airframe and engine.

Qualification/ subqualification classes for the type of aircraft and/or engines:

For Tu-154, „B1.1”, „C” with validity till 25.03.2011.

Information about duty time:

- rest time: 12 hrs.

2.5.11 Official – aged 37.

Aircraft maintenance certificate: AM № BG – AM 0035-50039, date of first issuance 27.01.2000, date of issuance 29.10.2004, valid till 29.10.2009, Tu-154M.

Qualification/ subqualification classes: For Tu-154, „B2” with validity till 28.11.2008.

Information about duty time:

- rest time: 12 hrs.

2.5.12 Official – aged 37.

Aircraft maintenance certificate: AM No BG – AM 0373-50031, date of first issuance 06.06.2000 г., date of issuance 23.03.2005 г., valid till 3.03.2010 г. Tu-154M.

Qualification/ subqualification classes for the type of aircraft: „B2” with validity till 27.05.2008.

Information about duty time:

- rest time: 12 hrs.

2.5.3. Flight Dispatcher – aged 51.

License: F/DL No BG FD 0085-20016, date of first issuance 30.01.2007, date of issuance 30.01.2007, valid till 30.01.2012.

Qualification classes: not marked

- registration on 30.07.2007 with validity till 30.01.2010.

Information about duty time:

- - rest time: 12 hrs.

2.6. Aircraft information**2.6.1. Airworthiness information**

Tu-154M aircraft, reg. No LZ-BTZ, has been manufactured on the 31.10. 1988 by the Ministry of Aviation Industry of USSR. The aircraft possesses Certificate for Registration No 1723/14.01.2003. The aircraft is owned by AVIODETACHMENT 28 with address Sofia Airport. The air operator is AVIODETACHMENT 28 with address Sofia Airport. The

Certificate for Airworthiness under No 1723 was issued on 14.01.2003 with the last verification on 01.12.2007 and validity till 31.10.2008. Since new (SN) till 27.01.2008 the aircraft has accumulated 5758 flight hours and 3262 cycles. The total life time of the aircraft is 30000 flying hours, 15000 cycles and calendar time of operation 20 years with last phased life-time prolongation till 31.10.2008. Life-between-overhauls is 7500 flying hours and 3000 cycles. On 04.05.1999 an overhaul of the aircraft was certified at OAO VARZ – 400, Moscow. After the overhaul the aircraft has flown 3814 flying hours and 2114 cycles.

As to the moment of the occurrence the aircraft had the following residual life time:

- total life time 24242 flying hours and 11738 cycles;
- life time between overhauls 3686 flying hours and 886 cycles;
- calendar time of operation 9 months and 2 days.

From the above mentioned follows, that as to the moment of the conducting of the flight during the occurrence happened the aircraft was secured from life-time point of view.

The power plant of the aircraft consists of 3 D-30 QU-154 bypass turbofan engines with total life time of 18000 hrs and time-between-overhauls 5000 hrs and an auxiliary power plant TA-6A.

The engine at position No 1 is with serial number 59238912434, manufactured on 18.09.1989 and last certified overhaul on 17.04.2007. The engine has accumulated SN 8615 hrs and 115 hrs after overhaul.

The engine at position No 2 is with serial number 59148812446, manufactured on 31.12.1988 and last certified overhaul on 01.06.2006. The engine has accumulated SN 6609 hrs and 468 hrs after overhaul.

The engine at position No 3 is with serial number 59238812406, manufactured on 31.07.1988 and last certified overhaul on 10.02.1999. The engine has accumulated SN 6234 hrs and 891 hrs after overhaul.

The auxiliary power unit TA-6A is with serial No 4436A281P, manufactured on 28.12.1984 and last certified overhaul on 26.05.2006. The plant has:

- total life time – 3400 hrs; 5000 starts;
- life time between overhauls 1000 hours and 1800 starts;
- operating time since new 2271 hrs; 3552 starts;
- operational time after overhaul – 279 hrs; 538 starts;

During the flight when the occurrence was realized there were no remarks related with the operation of the power plant.

The aircraft maintenance is performed on the ground of approved by CAA Maintenance Program of Tu-154M aircraft of AO AVIODETACHMENT 28. The program is based on the obligatory requirement of the Maintenance Schedule of Tu-154M aircraft with periodical execution of form F-2 (600 hrs), approved by the Chief Designer of OAO TUPOLEV, additions to it and bulletins, developed by the type certificate holders of the aircraft, engines and auxiliary power plant.

In execution of this program, on 08.11.2007 a base maintenance Form 2 (F-2)+ airframe life time prolongation was certified and as to this moment the aircraft has flown 5722 hrs since new and 3778 hrs after the overhaul and has conducted 3233 cycles since new and 2085 cycles after the overhaul. The maintenance was certified at VARZ-400, Moscow, holder of certificate of competence No SA-23/0705. For the maintenance made a certificate for releasing for flights was issued with term of validity till 06.11.2008 or till 6022±30 flying hours. The certificate was without sequence number. Copy of this certificate was contained on board. After the base maintenance performed the aircraft has flown 36 hrs and 29 cycles.

In relation with the forthcoming special flight on 28.01.2008 at 09:00 the line maintenance of the aircraft was certified by Form A₂+YκNoAT-01-15+OB” at Sofia Airport. The maintenance was registered in a technical logbook No 000159 and no defects were established and eliminated during the works. At 09:15 the aircraft took-off for the trial flight for testing of the operation of engines, systems and equipment, during which two landings were

performed at Sofia Airport. The trial flight has been documented by a statement from 28.01.2008, signed by 7-member commission presided by the aircraft commander, who is also Director General of Aviodetachment 28. The normal operation of the aircraft, engines, systems and equipment is stated in this document. The same conclusion is written also in the technical logbook for the flight under No 000160, prepared for the flight. After the flight line maintenance was performed Form BC+A₂+OB, registered in the technical log book No № 000160. During the maintenance no defects were established and eliminated. On 29.01.2008, before take-off for Lajes Airport, at 10:00 line maintenance of the aircraft was certified Form „OB”, registered in technical logbook No №000161. A pre-flight inspection was also conducted by the crew. During the maintenance no defects were established and eliminated. In the technical logbook No 000162, completed on 29.01.2008 for the flight from Sofia Airport to Lajes Airport is written "normally". After the landing for refueling at Lajes Airport the following forms for line maintenance were certified: BC+A₁+OB. The record was made in the technical logbook No 000162 under number 1 in column „Damages, malfunctions, defects, transit maintenance”. During the maintenance no defects were determined and eliminated. The next record, under number 2, is as follows: "After take-off from TER Airport the nose landing gear didn't retract. Red lamp was glowing." Against this record in the column for measures taken is written: „An inspection was performed according t.k. 032.00.00B. No damages. Possible cause for the malfunction is failure of actuating device for extension and retraction of the nose landing gear.”

Having in mind the above mentioned the conclusion could be made that as to the moment of take-off from Lajes Airport the aircraft was kept in condition of airworthiness.

2.6.2. Airplane performance

In accordance with Book I, Section 2 of the Aircraft Operation Manual of Tu-154M, serial No 88A781, approved by CAA on 08.12.2000 and Flight Operation Manual, Part B, Tu-154 LZ-BTZ, from 15.01.2007, the limitation of aircraft masses are as follows:

- (1) Maximum taxiing mass 104,5 t;
- (2) Maximum take-off mass 104 t;
- (3) Maximum landing mass 80 t;
- (4) Maximum dry mass 74 t;
- (5) Maximum fuel quantity 39,75 t.

Limitations of maximum speed and M-number are as follows:

- (1) Maximum operational speed and M-number,
with centering 32% MAC or less:

- at altitudes from 0 to 7000m 600 km/h;
- at altitudes of 7000 m and above 575 km/h;
- M number M=0,86,

With centering more than 32% of BAC at all altitudes 525 km/h.

- (2) Design maximum speed and M-number:

- at altitudes from 0 to 7000m 650 km/h;
- at altitudes from 7000m up to 10300m 625 km/h;
- at altitudes from 10300m and above M=0,95

- (3) Maximum speed with flaps at:

- 15° 420 km/h;
- 28° 360 km/h;
- 36° 330 mi/h;
- 45° 300 km/h;

- (4) Maximum speed at landing gear retraction and extension – 400 km/h.

- (5) Maximum speed at:

- nose wheel lift off 315 km/h;
- aircraft lift-off speed 325 km/h;

- touch down on main landing gear 280 km/h;
 - touch down on nose landing gear 270 km/h.
- Wind component at take-off and landing:
- headwind component 30 m/s;
 - downwind component 10 m/s;
 - crosswind at angle 90° to the RWY:
 - in normal conditions 17 m/s;
 - with failure of two hydraulic systems at landing 10 m/s.

According to the record in technical logbook No 000379 the maximum take-off from Lajes Airport the aircraft mass was 101 tons, and at landing after termination of the flight it was 76 tons. The aircraft centering was in allowable bounds during the flights. The aircraft has flown 3 h 25 min for fuel burn.

Short description of Tu-154M aircraft landing gear retraction and extension system according to the Aircraft Operation Manual, Section 032.

The landing gear of this aircraft is tricycle with castored nose wheels for steering the movement on ground. On figure 1 in Enclosure 1 the general view of the landing gear is shown, and on fig. 3 the scheme of the nose landing gear is shown.

- The landing gear is retractable in niches by hydraulic liquid under pressure, given by the first hydraulic system to hydro cylinders after a command from the cockpit.
- The landing gear extension is with triple redundancy by separate control through three hydraulic systems.
- The signalization of the landing gear is with double redundancy. The light the of green lamps signalize extended and locked landing gear. When landing gear is retracted, the green lamps are not alight, and red lamps signalize intermediate and not-locked position of the landing gear.
- Taxi and damping cylinder, installed on the nose landing gear, ensure pivot turn of the wheels for turning the aircraft on ground, fig. 4, Enclosure 1. After take-off the switches on the landing gears block the wheel spinning in the niche.
- There is a castor mechanism to the taxi- and damping cylinder, which consists of orienting hydro-pneumatic cylinder, fig.5, Enclosure 1. This castor mechanism should fix the nose wheels at 0 degrees in respect to the aircraft axis after take-off and prepare the nose landing gear for retraction (ensuring its direction to the lock for retracted position).
- The above mentioned castor mechanism consist of two separate chambers. One of the chambers is charged with nitrogen under pressure of 90 kg/cm² for keeping the wheels at 0 degrees and the other one is designed to change the fixed direction of 0° by hydraulic liquid under pressure for the aircraft control during the movement on ground.

2.6.3 Fuel

In accordance with the written in technical logbook No 000379 at take-off from Lajes Airport the aircraft had 36000 kg fuel JET-A1 and after a flight with duration of 3 hrs 25 min landed with 11000 kg of fuel. In the technical logbook No № 000162 in the column „Aircraft ready for flight and refueled” the fuel quantity wasn't registered.

The quality and condition of the fuel is not related with the air occurrence.

2.7. Meteorological information

According to the METAR data the take-off was performed during the night, the wind was from 080° with a speed between 9 and 22 kts, variable between 040° and 160°. The visibility was over 10 km, broken clouds (5-7/8) at 1800 ft and (3-4/8) at a height of 3000 ft. Air temperature was 14°C and dew point was 11°C, at QNH 1032. To the message

broadcasted there was a note that a crosswind was expected from 040° with variable speed from 18 to 29 kn, which might be leading to moderate turbulence and wind with peak speed of 34 kn from 030°.

There is no record of the current weather parameters (wind, air temperature) just before the take-off.

2.8. Aids to navigation

Standard aids for Tu-154M aircraft.

During the take-off and landing at Lajes the crew used the following navigation aids for RWY33: NDB, DME and ILS. The crew had no information if other aids for navigation had been working at that time.

2.9. Communications

Communication equipment for Tu-154M aircraft.

During the take-off and landing the radio exchange with ATC air controllers at Lajes Airport was performed by the flight radio operator. No radio exchange was reported to the commission, but it wasn't related with the clarification of the cause for the serious incident.

The radio exchange by the flight radio operator with ATC air controllers at Lajes Airport was conducted at the following frequencies:

- Lajes Ground - 121.9 MHz;
- Lajes Tower - 122.1 MHz;
- Lajes Approach - 135.0 MHz.

2.10 Airport

Lajes Airport (ICAO code: LPLA) is situated on Terceira Island from the group of Azores, Portugal. The airport is air military base and possesses a RWY 150/330° (marked as RWY15/33). Geographical coordinates of the threshold of RWY33 are: N 38° 46' 33.43" , W 027° 06' 19.98". Elevation is 55 m. The take-off distance available (TODA) is 3630m, and landing distance available (LDA) is 3313m. Runway surface is asphalted.

According to the warnings, during the period from October to May strong headwinds and crosswinds are possible and there is a possibility of wind shear at the final approach phase.

2.11. Flight data recorders

2.11.1. Data from the information carriers taken from flight data recorders

After the flight BULG 001 en-route TER-TER (Lajes -Lajes) a cassette KC-13 No 491046 was taken from MSRP-64, on which the flights en-route SOF-TER and TER-TER performed on 29.01.2008 were recorded. Cassette KC-13 No 491046 of MSRP-64, removed on 01.02.2008, contains the records of flights BGF 101 en-route TER-BCN (Lajes - Barcelona) and BCN-SOF (Barcelona -Sofia), conducted on 31.01 and 01.02.2008.

The tape of the registering instrument K3-63 No10286 and MLP-14-5 No. 80423 from MSRP-64 was also taken. MLP-14-5 wasn't used because the quality of recorders of KC-13 were of good quality.

2.11.2. Data from the analysis of MSRP-64 information.

The following is the results of analysis of the data from the MSRP-64 record from the flight BULG 001 en-route TER-TER (return to the departure airport Lajes after take-off because of failure of nose landing gear to retract) of the LZ-BTZ aircraft, conducted on 29.01.2008.

Engines start up ended at 19:06:24. The aircraft started off from the stand at 19:07:38 and lined up for take-off on RWY33 at TER at 19:11:39.

The red light alarm signal NOT READY FOR TAKE-OFF went out at 19:11:03 and after 36 seconds the engines were set at take-off regime at total aircraft weight of 101 t (according the technical logbook) with available fuel of 36500 kg (according the record of MSRP-64).

The take-off run started at 19:11:43 with flaps at 28° and slats extended. At 19:12:12 at indicated airspeed $V_{is} = 273$ km/h and deviation of the pedals $\delta_{ped} = -25$ mm (minus = left-hand pedal to forward) the control column was deflected for pitching.

The nose wheel lift-off was at 19:12:14 at $V_{is} = 283$ km/h and deflection of pedals of $\delta_{ped} = -51$ mm. Just after that (0,5 s) the radio height increased to 4,3 m, when it could be considered that the signalization "landing gear loaded" of the main landing gears gave signal for switch-off the steering of nose landing gear. At that moment a deflection of pedals $\delta_{ped} = -48$ mm was registered, which is equal to rotation of the nose landing gear at $4,1^0$ to the left (according the additional tests performed).

At a radio height of $H = 13$ m, $V_{is} = 317$ km/h and $\delta_{ped} = -25$ mm, at 19:12:20 a command for retraction of the landing gear was given. At 19:12:42 at $H = 225$ m and $V_{is} = 333$ km/h the pedals were shifted in zero position ($\delta_{ped} = 0$ mm). The retracting of flaps from 28° and slats started at 19:22:44 at $V_{is} = 333$ km/h at $H = 261$ m and ended at 19:13:11 at $V_{is} = 380$ km/h at $H = 530$ m.

Because of the failure of the landing gear to be retracted a command for its extension was given. At 19:14:04 at barometric height of $H_b = 1057$ m and speed $V_{is} = 393$ km/h according MSRP-64 was registered that the landing gear was extended and locked.

At 19:15:07 at $V_{is} = 398$ km/h and $H_b = 1837$ m a second command for retraction of the landing gear was given. Because of the failure of the landing gear to retract a second command for extension of the landing gear and at 19:20:02 $H_b = 3629$ m and $V_{is} = 383$ km/h it was registered that the landing gear was extended and locked.

Next, third command for retraction of the landing gear was given at 19:21:59 at $H = 3629$ m and $V_{is} = 386$ km/h. After that according to the information from the crew a decision for termination of the flight was made and return to the departure airport for descending and observation of the landing gear condition from the ground.

The descending from $H_b = 3629$ m started at 19:41:57. At 19:53:44 the aircraft overflies the RWY33 TER with $V_{is} = 349$ km/h and high-lift device at 28°. The minimal height of overflying was $H = 60$ m.

After that started a climb to the holding area for fuel burn at $H_b = 3500$ m. During the climb at $H_b = 2675$ m at $V_{is} = 411$ km/h a third command was given for extension of the landing gear and at 20:02:21 the landing gear was locked at extended position. 14 circling were conducted with landing gear extended in the holding area.

The descending for landing started at 22:16:53. The landing was at 22:32:41 on RWY33 TER with flaps at 45° and speed at touch down $V_{is} = 250$ km/h. The registered remaining fuel after landing was 10775 kg. The overload at landing, measured by K-3-63, was $N_y = 1,20$ g.

During the flight no decrease of the pressure in the first, second and third hydraulic system was registered.

Note 1: The digital signal „NOT READY FOR TAKE-OFF” disappears, when the aircraft is in take-off configuration and the nose wheel is switched in a small angle of control regime and at that the aircraft is controlled by both the lever of nose wheel steering and pedals for control of the rudder.

Note 2: The digital signal „Landing gears extended and locked” appears when all three landing gears are locked in extended position and disappears when at least one of the

three landing gears is not locked at extended position. No other information is provided to be registered in the records of MSRP-64.

2.12 Wreckage and impact information

The aircraft landed on RWY 33. No destructions and failures were discovered.

2.13 Medical and pathological information

Because of the nature of the air occurrence no medical and pathological examinations were performed.

2.14 Fire

No fire appeared.

2.15 Survival aspects

The air occurrence has not lead to damages of the aircraft, injuries of passengers and use of emergency equipment by passengers and aircraft crew.

2.16 Tests and research

For the purposes of the technical investigation the following was accomplished:

- inspection of the condition of the nose landing gear, the niche for retraction of the gear and valves and switcher for landing gear control in the cockpit;
 - test of the functionality of the landing gear retraction and extension system;
 - test of the functionality of nose landing gear retraction and extension system;
 - check of the quantity of hydraulic liquid in the systems;
 - laboratory analysis of the hydraulic liquid of first hydraulic system;
 - check of the filters of hydraulic systems;
 - check of the pressure of the gas in the nose landing gear shock-absorber.
 - check of the pressure of the gas in the nose landing gear castor;
 - checks of the locking of the nose landing gear with deviated nose wheel from the aircraft axis;
 - non-destruction control of assemblies of the nose landing gear structure;
 - test of the hermeticity of nose landing gear castor;
 - decoding and analysis of the information from the flight data recorders;
 - examination of the records in the aircraft operational documentation;
 - examination of the documentation of preparation of the flight;
 - examination of the operational documentation of the air operator;
 - technical flight test after elimination of the failures discovered.
 - logical and probabilistic analyses of the possible causes for the air occurrence;
- The materials and results of the tests and researches are enclosed to the deed of air occurrence investigation.

2.16.1 Inspection of the condition of the nose landing gear, the niche for retraction of the gear and valves and switches for landing gear control in the cockpit

During the inspection of the condition of the nose landing gear, the niche for retraction of the gear and valves and switches for landing gear control in the cockpit the following ascertainment were made:

- the nose landing gear castor hasn't oriented the nose wheels to zero angle to the aircraft axis (the roller of the caster control was outside the socket of taxi and damping cylinder), fig. 6, Enclosure 1;

- seals of orifices for charging the castor with gas and sealing lubricant were on their places, fig. 6, Enclosure 1;
- presence of bruises on the guiding roll of the lock, fig. 7, Enclosure 1;
- presence of bruises and scratches on the guiding channels of the rollers of the lock, Figure 8 and Figure 9, Enclosure 1.

2.16.2 Test of the function of landing gear retraction and extension system

For a test of the function of landing gear retraction and extension system on the ground it is necessary to lift the aircraft on jacks. The commission found out that AO Aviodetachment 28 doesn't possess jacks for the lifting of Tu-154M aircraft. Such jacks are absent also at base aerodrome of the operator - Sofia Airport. The jacks were supplied from Plovdiv Airport.

The test of functioning of the landing gear retraction and extension system was performed at two phases. During the first stage the configuration of the nose landing gear system aggregates was without any changes. The works at this phase are shown in Operational Card No 1, which is enclosed to deed of investigation of the occurrence. The card was compiled on the base of Aircraft Technical Operation Manual, section 032, Landing Gear, and it was performed on 02.02.2008 by certified personnel of AO Aviodetachment 28 monitored by the members of investigation commission. During the execution of the operations included in the card the following ascertainments were made:

- the super pressure measured in the castor of the nose landing gear was $P_{изм.}=0$ kg/cm² (pressure of charging 90^{+2} kg/cm²), fig. 2, Enclosure 1, recharged with nitrogen up to 90 kg/cm²;
- the super pressure in the shock-absorber of the nose landing gear was $P_{изм.}=67$ kg/cm² – in admissible norms;
- landing gear retraction and extension system worked without deviations from the technical requirements.

During the second phase the nose landing castor was replaced. The works at this phase are shown in Operational Card No 6, which is enclosed to deed of investigation of the occurrence and performed on 11.02.2008. During the execution of the operations included in the card the following ascertainments were made:

- the super pressure measured in the castor of the nose landing gear was $P_{изм.}=87$ kg/cm², at $t_H=0^0$ C;
- the roller of the rod of taxi&damping mechanism entered into the socket and than the direction of the nose wheel was at 0^0 , fig. 10, Enclosure 1;
- the retraction and extension of the landing gear was conducted five times;
- the landing gear retraction and extension system worked without deviations from the technical requirements, fig. 12, Enclosure 1.

2.16.3 Tests of the function of nose landing gear control system;

The works during the tests of the functionality of the nose landing gear control system are shown in Operational Card No 2, which is enclosed to deed of investigation of the occurrence and compiled on the base of Tu-154 Aircraft Technical Operation Manual, section 032, Landing Gear, and it was performed on 04.02.2008. During the execution of the operations included in the card the following ascertainments were made:

- The nose landing gear control system at big angles of deviation worked without deviations from the technical requirements;
- The nose landing gear control system at small angles of deviation (up to 10^0) and when charged with nitrogen worked without deviations from the technical requirements;

-The nose landing gear control system at small angles of deviation (up to 10^0) and discharged of nitrogen from the castor of the nose landing gear ($P_{meas.}=0 \text{ kg/cm}^2$) didn't fix the nose wheel at position of 0^0 , after its deviation to the left or to the right. fig. 11, Enclosure 1;

- caliber pin with a length of $L=43 \text{ mm}$ entered to the end in the control orifice for sealing lubricant of the nose landing gear castor.

A lubrication of the assemblies and joints of the nose landing gear was performed in accordance with the Operational Card No 4, enclosed to deed of investigation of the occurrence.

2.16.4 Check of the quantity of hydraulic liquid in the systems, check of the filters of hydraulic systems and laboratory analysis of hydraulic liquid of first hydraulic system

On figure 13, Enclosure 1, the readings of level gauges for the level of liquid in hydraulic systems are visible. No deviations of admissible norms.

The works during the check of the filters of hydraulic systems are shown in Operational Card No 3, which is enclosed to deed of investigation of the occurrence and compiled on the base of Tu-154 Aircraft Technical Operation Manual, section 029, Hydraulic System, and it was performed on 04.02.2008. During the execution of the operations included in the card the following ascertainments were made:

- no filter clogging on filtering elements of 1-st hydraulic system was observed; fig. 14, Enclosure 1. After the removal the filters were replaced with new ones;

- the indicators for filtering elements of 2-nd and 3-rd hydraulic systems didn't gave indications for clogging.

The examination of the aircraft documentation has shown the hydraulic oil in the aircraft hydraulic systems was changed on 29.10.2005 during the base maintenance under Form F2 at MO of AO Hemus Air, for which a Release to Operation Certificate No 51/28.10.2005 was issued. The aircraft was recharged with hydraulic oil FH 15. After the landing at Sofia Airport on 01.02.2008 from the 1-st hydraulic system two bottles by 1litre with hydraulic oil were drawn and sealed. It was given for examination to Aviation Research Base of Air Force (unit 24530). The Executive Report of the examination under No 8/III of 07.02.2008 enclosed to the deed of investigation of the air occurrence. The following conclusion was made in this report:

„During the comparative analysis between the admissible values of fresh (new) oil and the results received from the analysis of the oil from the aircraft we have established that the values are in allowable limits. No mechanical impurities and metal particles of magnetic nature were found. "The minimal deviation of the cinematic viscosity from the admissible values for fresh oils is specific for oils in operation and it was into the margins of quality for this indicator."

2.16.5 Check of gas pressure in the nose landing gear shock-absorber and nose landing gear castor

In Para.2.16.5 the gas pressure measured in the nose landing gear shock-absorber and nose landing gear castor is given.

2.16.6 Tests of the locking of the nose landing gear with deviated nose wheel from the aircraft axis.

A test for evaluation of the ability to lock the nose landing gear in retracted position in the presence of deviation of the nose wheels from the aircraft axis was made. For the goals of the test the aircraft was jacked and the nose landing gear was unlocked in extended position

by hydraulic system; the undercarriage control cock was moved in "retracted" position and immediately after the unlock of the nose landing gear was moved in "neutral" position. The retraction of the nose landing gear was further performed by lifting by a motorcar with lifter as it was shown on Fig. 15 in Enclosure 1.

At first the nose wheels were deviated from the axis at a relatively small angle of -2° . During the lifting of the nose landing gear the rollers of the hook of the lock for retracted position approached to the coulisse for control of the aft doors in a way showing a possibility for their sliding in the grooves of the coulisse and possible locking of the lock. The lifting of the nose landing gear was ceased at this stage because of risk of damages in the well of the landing gear.

After that the nose wheels were deviated to an angle of -4° from the aircraft axis. During the lifting of the nose landing gear the rolls of the hook of the lock for retracted position approached in a way showing impossibility for their sliding into the grooves of the coulisse and locking of the lock. The lifting of the nose landing gear was ceased at this stage because of risk of damages in the niche of the landing gear. A conclusion was made that at such angle of nose wheel deviation or bigger one the nose landing gear wouldn't be retracted in full in the well and to lock in retracted position.

Pictures of the tests are shown on figures from 16 to 18 in Enclosure 1.

During the measurements performed it was determined that deviation of the nose landing gear from the aircraft axis from $4^\circ \dots 4^\circ 30''$ is equal to deviation of 48...53mm of the rudder control pedals, figure from 19 to 22 in Enclosure 1.

2.16.7 Non-destruction control of assemblies of the nose landing gear structure

Because of the risk of damages on the elements of the nose landing gear structure as a result of its non-retracting a nondestructive testing (magnetic and eddy current) of assemblies of the nose landing gear structure. The works for non-destructive control are shown in Operational Card No 5, which is enclosed to deed of investigation of the air occurrence.

No damages were established of the assemblies of the nose landing gear as a result of non-destruction control.

2.16.8 Test of hermiticity of nose landing gear castor

After establishing of lack of nitrogen pressure in the castor 154.80.4208.100, serial No 8818 it was dismantled from the aircraft and replaced with a castor serial № 9358. The replacement was registered in Technical logbook No 000169, drawn up on 11.02.2008. The dismantled castor was examined by the commission for determination the cause for its non-hermeticity. The test results were given in two reports, drawn up by the investigation commission members and air operator representatives. The reports are enclosed to the deed on investigation.

On 15.02.2008 after a thorough inspection of outer condition of the castor during which no damages were established, it was charged with nitrogen with pressure of 91 kg/cm^2 . Triple measurement of this pressure was made with the recharging device used. It was made in order to establish the loss of pressure in the castor during the measurement because of some capacity of the tubes of recharging device. Arithmetic middling of these losses was $4,66 \text{ kg/cm}^2$. After that the castor was recharged up to pressure of 92 kg/cm^2 at ambient air temperature of 10° C . The nipples and contact surfaces of the elements of the castor were coated with cleaning agent foam in order to check for loss of nitrogen. During the next inspection the following was established:

1. No visible leak of nitrogen from the nipples.

2. Appearance of air bubbles on the ring-shaped surface between the rod and aggregate housing, fig. 24, Enclosure 1;

A decision was made to leave the castor charged with nitrogen during no less than 14 days and after that to measure the pressure in it.

On 04.03.2008 (after 18 days) a new measurement of the nitrogen pressure in the castor was made. At ambient air temperature of 19°C the pressure measured was 91 kg/cm², Fig. 25, Enclosure 1. The reduced pressure to the air temperature of 10° C (the temperature of the first measurement) it corresponds to a pressure of $P_{red.} = 88,2 \text{ kg/cm}^2$. The difference between the pressure of recharging on 5.02 and the pressure measured on 04.03 (eighteen days later) was 3,8 kg/cm² and might be explained with the capacity of the tubes of recharging device. The recharging device is shown on figure 26, Enclosure 1;

The results of the examination performed permit to conclude that the gas camera of the castor serial No 8818 was hermetic.

2.16.9 Decoding and analysis of the information from flight data recorders

The results of decoding and analysis of flight data recorders information is shown in Para.2.11.

2.16.10 Investigation of aircraft operational documentation and air operator operational documentation.

The results of the investigation of aircraft operational documentation and air operator operational documentation, related with aircraft maintenance are shown in Para.2.6.1 & 2.6.2.

During the examination of Air Accident Prevention and Flight Safety Program of Aviodetachment 28 AO the commission made the following ascertainments:

1. The obligations of the nominated post holders regarding the flight safety are not given.

2. No methods for evaluation of hazard factors and their management are given in the program.

3. In Para.11.3.1.2. Air occurrence investigation at Aviodetachment 28 is written: "Accidents and Incidents investigation should be performed by a commission, appointed by an order of Aviodetachment 28 Director General, if unforeseen circumstances don't impose something else." This record is in conflict with Article 2, Para. of the Civil Aviation Act.

4. The Program doesn't take into account the need of reporting of occurrences shown in Enclosure 8 or Regulation No 13/27.01.1999 on investigating of air accidents.

5. The Program doesn't include training of AO personnel performing activities related with flight safety and creation of culture of safety.

2.16.11 Technical flight test after elimination of the failures discovered

After the replacement of the nose landing gear castor and the control retracting and extending of the landing gear on the ground mentioned in Para.2.16.2 an aircraft technical flight test was conducted in order to check the work of the undercarriage systems. The test flight was performed on the ground of an order of Aviodetachment 28 according an approved by its program in the presence of the investigation commission representatives. Three extensions and three retractions of the undercarriage were made during the flight. No deviations from technical requirements in functioning of undercarriage systems were

established. A Test Flight Report was written down where the results of the test flight were given. The documents from the flight test were enclosed to the investigation deed.

The Chief Designer of Tupolev OAO was informed about the results of the examinations performed, the results of them and the actions undertaken. The actions prescribed by him for putting the aircraft in operation coincided with the actions performed during the investigation of the cause for origin of the air occurrence.

2.16.12 Logical and probabilistic analyses of the possible causes for the air occurrence

It is made in the next section.

3. Analysis

As it is clear from the above mentioned, the cause of cessation of the flight and the precautionary landing at Lajes Airport is the failure to retract the nose landing gear after take-off. The crew made three attempts for retraction and after that took decision for cessation of flight and landing after fuel burn off to allowable landing mass of the aircraft.

During the process of searching of the cause for nose landing gear failure to retract, during the tests of landing gear retracting and extending system a decreasing of the nitrogen pressure in the nose landing gear castor down to the atmospheric was ascertained. This aggregate is an element of the nose landing gear control system and it is not directly related with its retracting and extending. That's why after aircraft lifting by jacks at Sofia Airport the aircraft undercarriage was retracted without any restoration works on the retraction and extension system.

The function of the castor, as it is shown in Para.2.6.2 is to line the nose wheels at 0 degree to the aircraft axis after take-off in order to prepare the nose landing gear for retraction. When the nose wheels are not deviated from the aircraft axis, it is not necessary for the castor to act (i.e. to operate by gas pressure from the gas camera) in order to perform normal retraction and extension of the nose landing gear. The situation is different when the nose wheels for some reasons are deviated from the aircraft axis. The tests carried out as in Para.2.16.6 have shown that in case of wheel deviation from the aircraft wheels and especially if this deviation is about 4 degrees or more, the nose landing gear would not be retracted in full in the well and locked in retracted position. After putting the undercarriage control cock into neutral position the nose landing gear drops because of its own dead-weight and then on the undercarriage indicator in the cockpit a red lamp continues to light for nose landing gear position.

Decoding and analysis of MSRP-64 record has shown that at the moment of lift-off of the main landing gear there is a pedal deviation of $\delta_{ped} = - 48$ mm (minus denotes deviation to the left). Having in mind the weather reference in Para.2.7, this deviation might be explained with the side component of the wind, which should be compensated during the take-off run.

In accordance with the computation performed this deviation means a nose landing gear turn to $4,1^0$ to the left. The tests performed given in Para.2.16.6 confirmed this value.

The absence of nitrogen pressure in the landing gear castor after the main landing gear lift-off (before this moment the nose wheels position is controlled by pedals), did not allow the castor to return the nose wheel to 0^0 position and the nose landing gear failed to lock in retracted position and after moving the undercarriage control cock in neutral position it drops because of its own dead-weight.

After putting the undercarriage control cock in extended position, the undercarriage system functions normally and it locks in extended position.

The stated above has shown that the cause for the retracting failure of the undercarriage after taking-off from Lajes Airport is loss of nitrogen pressure in the nose landing gear castor.

During the take-off and after determining the cause of the malfunction shown in point 4, Para 8.9.3. Malfunctions, Subsection 8.9, Undercarriage, in Book II of Aircraft Operation Manual of Tu-154 aircraft, the crew did not follow strictly the required action described in this point and made two attempts to retract the undercarriage. It didn't lead to additional complication of situation.

An inquiry was sent to the Chief Designer of Tupolev OAO regarding the presence of additional procedures to the given in point 4, Para 8.9.3. Malfunctions, Subsection 8.9, Undercarriage, in Book II of Aircraft Operation Manual of Tu-154 aircraft, he answered by a fax No 42.11/190 from 14.02.2008 that there were no other procedures and it was not necessary to have such procedures.

After cessation of the flight and landing at Lajes Airport at 22:35 UTC the technical persons performed inspection of the nose landing gear and have made the following record in the Technical Logbook No 000162: „Inspection performed according t.k. 032.00.00B. No damages. Possible cause for the malfunction is failure of the actuating device for extension and retraction of the nose landing gear.” In the same technical logbook a line maintenance is certified by Form „BC+A₂”. On the ground of this record and the prescribed in point 4, Para 8.9.3. Malfunctions, Subsection 8.9, Undercarriage, in Book II of Aircraft Operation Manual of Tu-154 a decision for technical flight with undercarriage extended to the base aerodrome for investigation and elimination of the malfunction should be made.

In the explanation given by the technical person who performed the inspection at Lajes Airport is written that during the inspection of the castor the roller of the cradle was in the groove of the profile cam of the rotor of taxi and damping cylinder. After the landing of the aircraft at Sofia Airport a representative of the investigating commission has made a photo, on which is visible that the roller of the cradle isn't in the groove of the profile cam of the rotor of taxi and damping cylinder. The photo is shown on Fig. 23, Enclosure 1. Since there are no works prescribed for checking of the position of the roller of the cradle of the nose landing gear castor in technology card 032.00.00B and in the Form A₂ for line maintenance, which has been carried out in Lajes, maybe the technical person has been mistaken himself, and because of the lack of jacks at Lajes Airport no aircraft lifting and control retraction of the undercarriage has been performed for establishing of the real cause for failure of nose landing gear retracting.

Taking into account the tests performed shown in Para.2.16.8 and the fact established after landing at Sofia Airport that the seals of the recharging nipples for gas and sealing lubricant were at their places, the following hypotheses might be considered for the lack of nitrogen pressure in the gas camera of the castor serial No 8818:

1. The loss of pressure in the gas camera of the nose landing gear castor during the operation since the last base maintenance Form 2 (certified on 08.11.2007) till the date of occurrence 29.01.2007 because of cripple of hermeticity of contact surfaces;
2. Loss of pressure in the gas camera of the nose landing gear castor because of violation of recharging procedures or failures emerged in the recharging nipple during recharging.

According to the data in the passport, the castor was manufactured in 1988, overhauled in 1999 and its lifetime was equal to the aircraft airframe lifetime. Castor's gas camera should be charged with technical nitrogen up to 90^{+2} kg/cm². In the operational cards from the base maintenance Form 2, carried out at OAO VARZ-400 in Moscow there is written and certified point 143 with the following content:

„Check the nose landing gear castor:

- charging with sealing lubricant.
- charging with working gas (nitrogen).”

After the recharging, the nipples were sealed which was also certified by a signature in operational cards of above mentioned base maintenance. The seals of nipples were removed in the presence of investigation commission members and were stored with materials of the investigation. Having in mind the stated and the tests performed shown in Para.2.16.8, the commission considered the first hypothesis as improbable.

The nose landing gear castor is placed in upper left-hand part of the landing gear niche. The access to it is limited and it makes difficult the works related to its recharging and checking the pressure in the gas camera. Because of the small volume of the camera and certain capacity of the tubing of the recharging device there exists a risk of not full recharging, even of discharge of pressure from the camera during the removal of recharging device. Possible cause for the loss of pressure might be also a jamming of recharging nipple valve at removal of recharging device because of different causes, including a hard particle clogging, which might be blown during the next recharging. Having in mind the stated and the results of the tests performed shown in Para.2.16. 8, the commission accepted as probable the second hypothesis.

4. Conclusions

On the grounds of above stated the Investigation Commission indicates as

A main cause for serious incident origination: Loss of pressure in the gas camera of the nose landing gear castor down to 0 kg/cm² because of violation of the recharging procedures or failures emerged in the recharging nipple during the recharging of the base maintenance at OAO VARZ-400.

Immediate cause for serious incident origination: Failure of retracting of the nose landing gear after take-off from Lajes Airport because of malfunction of nose landing gear castor.

During the investigation the commission revealed also the following deficiencies:

1. The Certificate for Release for flights from the base maintenance certified on 08.11.2007 is without sequence number.
2. In the technical logbook No 000162, completed on 29.01.2008, the fuel quantity for refueling wasn't registered.
3. AO Aviodetachment 28 doesn't possess jacks for lifting of Tu-154M aircraft at its base aerodrome in Sofia.
4. The provision for inspection of the position of the roller of the cradle of the nose landing gear castor in technology card 032.00.00B of Aircraft Maintenance Manual of Tu-154 aircraft is not included.
5. During the take-off after establishing of the cause of malfunction shown in point 4, Para 8.9.3. Malfunctions, Subsection 8.9, Undercarriage, in Book II of Aircraft Operation Manual of Tu-154 aircraft, the crew haven't followed strictly the required action described in this point.
6. There is no record of current weather parameters (wind, air temperature) just before the take-off.

5. Safety recommendations:

During the process of investigation the Commission proposed by a letter No 10-01-25/15.02.2008 to the Main Director of CAA the following measures for flight safety to be carried out:

1. In the Aircraft Maintenance Program of Ty-154M of AO AVIODETACHMENT 28 activities for checking of castor 154.80.4208.100 of the nose landing gear control system should be included in Form A2 for line maintenance at the base aerodrome.

2. A working card for this check should be elaborated by AO AVIODETACHMENT 28 and it should be approved by CAA.

Due date for the safety measures above - 2 weeks from the date of sending of the letter.

Having in mind the causes for the serious incident realized and the deficiencies revealed during the investigation, the commission recommended the following measures to be carried out in addition to the above:

1. Air Operator Aviodetachment 28 to conduct an analysis before the personnel engaged in the flight safety for consideration of circumstances related with the occurrence, main ascertainment and conclusions of the report, the reasons and safety measures recommended.

Due date for execution - 1 week after handing in the report, person in charge - Director General of Aviodetachment 28.

2. Aviodetachment 28 to revise the Air Accident Prevention and Flight Safety Program and to eliminate the deficiencies cited in Para.2.16.10.

Due date for execution - 2 months after handing in the report, person in charge - Head of Flight Safety Directorate of Aviodetachment 28.

3. Air Operator Aviodetachment 28 to revise its Quality Assurance Program in order to ensure reliable keeping of technical and flight documentation without deficiencies similar to the these shown in points 1, 2&6 of deficiencies revealed.

Due date for execution - 2 weeks after handing in the report, person in charge - Director General of Aviodetachment 28.

The Commission avail itself the opportunity to remind all organizations to which safety measures are sent, that on the ground of Article 19, Para. 7 of Regulation No 13 of 27.01.1999 on air accident investigation are obliged to inform AAIU and CAA regarding the status and terms of implementation of flight safety.