No. 5

Aeroflot, Tu-154, CCCP-85023, accident at Praha/Ruzyne, Czechoslovak Socialist Republic, on 19 February 1973. Report not dated, released by the Federal Ministry of Transport of the Czechoslovak Socialist Republic.

1.- Investigation

1.1 History of the flight

The aircraft took off at 0650 GMT on a scheduled flight Moscow - Prague. Over the territory of the USSR the flight proceeded at 10 000 m, and this altitude was increased over the Romanian People's Republic to 10 650 m. Over Warsaw the aircraft was cleared to descend to 9 400 m, and near the Czechoslovak frontier it was cleared again to 8 850. The frontier was crossed at 6 700 m, the crew complying with all instructions. At 0854 GMT the aircraft reported overhead OKX that it had descended from 7 200 m to 6 700 m. Prague ACC cleared it to continue descent to 2 450 m and tune to Rodnice (RCE) VOR. At 0856 GMT the aircraft was instructed to maintain a track which would keep it in the middle of the airway. At 0900 GMT the aircraft reported overhead Rodnice at 2 450 m and was instructed to change over to the approach frequency 121.4 MHz.

The aircraft at once contacted approach control and was cleared to fly via EHO until it intercepted the approach beacon, then to descend to 1 200 m and report when crossing 1 500 m. The crew complied with these instructions. At 0902 GMT the aircraft reported descending through 1 500 m on a 135° heading and was instructed to change over to the ATC radar frequency.

On this frequency it was cleared to continue flying to the ILS approach beacon, was given priority to land on Runway 25 and instructed to descend to 500 m on QFE 730.1 mm. At 0904 GMT the aircraft was cleared to descend to 350 m on QFE and was informed that it was 2 km off the course line. After 40 seconds the radar controller informed the aircraft that it was correctly aligned and 15 km from the aerodrome, and at 0905 GMT he instructed the aircraft to switch over to the TWR frequency. After changeover the aircraft reported to TWR that it was approaching to land. TWR cleared it to land on Runway 25 and reported a change in the wind direction and speed to 250° - 4 m/s. At 0906 GMT, at its own request, the aircraft was given runway braking coefficient 5 and again cleared to land. This data was acknowledged by the aircraft at 0906.30 GMT, and this was the last contact with it.

The aircraft flew the correct heights and headings and did not report any defects or trouble on the ATC frequencies. The descent to land proceeded normally along the ILS glide path up to the vicinity of the "L" marker.

Near this aid the aircraft suddenly ducked under the glide path, continued to descend at an average angle of 4.62° to the glide path and struck the ground with the nose-wheel at a point 467 m before the threshold of Runway 25.

Calculations showed that in its descent to the ground the aircraft's attitude was:

- flight path angle = -4.12^{o}
- longitudinal inclination of the aircraft = -3.5^{o}
- tilt of the aircraft to the right = 3.6^{o}
- angle of attack = 3.62^{o}

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	4	62	-
Non-fatal	3	15	-
None	6	10	

1.3 Damage to aircraft

The aircraft was completely destroyed.

1.4 Other damage

Approach lights to Runway 25.

1.5 Crew information

Pilot-in-command, age 41, First Class Pilot's Licence No. UI R 0301, valid till 13 March 1973, annual medical check 16 March 1972, last quarterly medical check 21 December 1972, pre-flight medical check at 0820 hours on 19 February 1973.

Total flight time 12 650 hours, including 236 hours on Tu-154, 48 of these at night. Was off duty the day before flight and slept 7 hours 45 minutes before the flight. Last pilotage check on Tu-154 on 16 February 1973, at night in aerodrome conditions. Previous accidents: None.

Co-pilot, age 44, Second Class Pilot's Licence No. 1X P 3361, valid until 23 February 1973, annual medical examination 23 February 1972, last quarterly medical examination 23 November 1972, pre-flight medical check 19 February 1973 at 0820 hours.

Total flight time 14 650 hours, including 247 hours on Tu-154, of which 53 hours at night. Was off duty the day before the accident, pre-flight rest (sleep) 9 hours. Last pilotage check 2 January 1973. Previous accidents: None.

Navigator instructor, age 35, First Class Navigator Licence No. Xl SH 0396, valid until 24 March 1973, annual medical check 24 March 1972, last quarterly medical check 4 January 1973, pre-flight medical check 19 February 1973 at 0831 hours.

Total flight time 7 280 hours, including 310 hours on Tu-154 of which 60 hours at night. Was on a flight to Rome on 18 February 1973. Returned at 1640 hours. Total time of the flight 6 hours 35 minutes. Pre-flight rest (sleep) 10.40 hours. Last in-flight proficiency check 8 June 1972.

Trainee navigator, age 47, First Class Navigator Licence No. 11 SH 1026, valid until 15 December 1973, annual medical check 15 December 1972, last quarterly medical check (date missing), pre-flight medical check on 19 February 1973 at 0752 hours.

Total flight time 4 630 hours, including 124 on Tu-154, of which 25 hours at night. Was off duty the day before the flight, pre-flight rest (sleep) 9 hours.

Flight Engineer Instructor, age 47, First Class Flight Engineer Licence No. 4 BM 0498, valid until 19 December 1973. Annual medical check 19 February 1972, pre-flight medical check 19 February 1973 at 0750 hours.

Total flight time 9 515 hours, including 674 on Tu-154 and 230 at night. On 18 February he flew to Rome and returned at 1 640 hours. Total time of the flight 6 hours 35 minutes. Pre-flight rest (sleep) 8 hours.

Flight Engineer, age 34, Flight Engineer Licence First Class No. UP BM 2923 valid until 13 September 1973. Annual medical check 13 September 1972, pre-flight medical check on 19 February 1973 at 0742 hours.

Total flight time 3 710 hours, including 957 on Tu-154 of which 323 at night. Was off duty the day before the flight, pre-flight rest (sleep) 8 hours.

Flight Radio Operator Instructor, age 44, First Class Flight Radio Operator Licence No. PBR 0035 valid until 6 February 1974, annual medical check 6 February 1973, pre-flight medical check on 19 February 1973 at 0846 hours.

Total flight time 9 987 hours, including 602 on Tu-154 of which 156 hours at night. Was off duty on the day before the flight, pre-flight rest (sleep) 8 hours.

Radio Operator Trainee, age 42, Flight Radio Operator Licence First Class No. PBR 0084 valid until 24 March 1973. Annual medical check 24 March 1972, pre-flight medical check on 19 February 1973 at 0825 hours.

Total flight time 10 460, including two hours as trainee on Tu-154. Was off duty on the day before the flight, pre-flight rest (sleep) 8 hours.

1.6 Aircraft information

a) Airworthiness and maintenance

The Tu-154, serial No. 72A023, was manufactured by the Ministry of the Aviation Industry of the USSR in September 1972. The owner of the aircraft was Aeroflot, Moscow, USSR.

The aircraft carried a valid Certificate of Airworthiness No. 2806, issued on 30 October 1972 by the USSR Ministry of Civil Aviation, valid until 19 September 1973.

The aircraft was entered in the USSR Aeronautical Register under No. 10135 with effect from 30 October 1972 and carried the identification mark "CCCP - 85023".

At the time of the accident the airframe had flown:

since manufacture: 459.10 hours

since last overhaul: 4.10 hours

number of landings since entry into service: 261

The aircraft was fitted with series 1 HK-8-2 engines as follows:

left - serial No. A8214044

central - serial No. A8214038

right - serial No. A8214040

Engine No. A8214044 had flown 472.53 hours since manufacture

Engine No. A8214038 had flown 472.49 hours since manufacture

Engine No. A8214040 had flown 472.49 hours since manufacture

According to the documents produced, the aircraft had been maintained in conformity with the instruction and technology applicable to the Tu-154.

No modifications were made either to the aircraft or its powerplant during its period of operation. Only defects of a more serious character, and the replacement of major components of the aircraft, have been extracted from the aircraft's repair log book for the last month of operation. No defects in radio navigation equipment were reported.

Date	Nature of defect	Remedial action taken
19.1.73	Tires of forward part of the landing gear severely worn	Replace wheels
	Excessive play in the fuel supply control system and No. 3 thrust reverser	Tighten linkages
4.2.73	Crack in No. 1 engine casing	Lap-joint applied
	Right outboard section of flap making contact with the wing	Flap adjusted
	Gap in rod linkage on No. 3 thrust reverser	Tightened up
	Excessive play in the No. 1 engine thrust reverse latch control	Tightened up
7.2.73	Faulty starting in No. 1 engine	Replace starter
	No. 1 engine "heavy vibration" warning light comes on during descent and thrust reduction	Replace block B7-8

Date	Nature of defect	Remedial action taken
9.2.73	No. 3 engine fails to start	Replace starter
	Forward part of landing gear retracts slowly during take-off	Grease retracted position limit switch
11.2.73	Faulty operation of the 514 air-conditioning unit	Replace 514 unit
14.2.73	MSRP-12 not working	Replace unit
	Excessive play in No. 3 engine thrust reverser linkage	Tighten up
	Track in skin covering round V aft suspension of No. 1 thrust reverser flaps	Lap-jointed

All faults were rectified in the proper manner during operation. The faults indicated could not, following the remedial action taken, have caused the accident.

b) Weight and centre of gravity

According to the weight and balance sheets for Tu-154, Registration CCCP 85023, flight CU-141 of 19 February, the load was as follows:

Weight empty	42 274 kg
Crew weight	640 kg
Weight of galley and stewardesses	800 kg
Take-off fuel weight	27 000 kg
Aircraft operating weight	75 714 kg
Maximum gross take-off weight	90 000 kg
Maximum permitted load	14 286 kg

According to passengers' declarations and the combined load sheet the aircraft was carrying the following load:

85 adult passengers, 1 child under 12 years, 1 infant under 2 years, total weight	6 420 kg
112 pieces of baggage	1 202 kg
Special baggage	155 kg
Handbaggage	192 kg
Cargo (358 pieces)	2 223 kg
Mail (45 pieces)	410 kg
Total load:	10 602 kg
Actual take-off weight	86 316 kg
Landing weight, including 12 tonnes of residual fuel	71 316 kg

According to the load and trim sheet the passengers and cargo were distributed as follows:

Flight deck:		6 crew members
Forward cabin	row 1	2 passengers + 2 crew members
	row 2	4 passengers
	row 5	6 passengers
	row 6	6 passengers
	row 7	6 passengers
	row 8	6 passengers
	row 9	6 passengers
Aft cabin	rows 10 - 11	12 passengers
	rows 12 - 13	12 passengers
	rows 14 - 15	12 passengers
	rows 16 - 17	14 passengers
Forward service bay:		2 crew members (cabin staff)
Middle service bay:		3 crew members (cabin staff)
No. 1 baggage hold:		compartment 1 -
		compartment 2 - 500 kg
		compartment 3A - 500 kg
		compartment 4 - 1 223 kg
No. 2 baggage hold:		compartment 5 - 1 000 + 410 kg
		compartment 6 - 500 kg
		compartment 7 - 702 kg

Based on the above load distribution, the centre of gravity of the aircraft minus fuel was 20.3 per cent MAC, which is within the permissible limits of 16.5 - 28 per cent MAC with the permitted -5.5^{o} maximum stabilizer deflexion on landing, and 28 - 32 per cent MAC with the smaller -3^{o} deflexion of the stabilizer.

An imprecision appears in the documents inasmuch as the declarations of the passengers and the combined load sheet give a total weight of baggage, cargo and mail amounting to 3 835 kg, to which must be added the weight of the special cargo (155 kg), i.e. the correct figure should be 3 990 kg, whereas on the load and trim sheet the total weight of baggage, cargo and mail is shown as 4 735 kg, i.e. 745 kg more then on the combined load sheet. Although it could not be established from the documents which entry was correct, this circumstance could not have influenced the safety of the flight. Neither the take-off, nor the landing weights were exceeded. The most adverse centre of gravity changes produced by the weight differential of 745 kg were investigated, but in each case the aircraft's centre of gravity remained within permissible limits. Its value could fluctuate from the 20.3 per cent MAC to 19.3 - 22 per cent MAC, which are still within permissible tolerances. The centre of gravity displacement due to fuel consumption also remains within permissible limits.

c) Type of fuel used

The fuel used was of the approved type and was not linked to the cause of the accident.

1.7 Meteorological information

1. Weather situation

The eastern edge of a high-pressure wave over western Europe was located above Czechoslovakia.

2. Meteorological conditions between the Frydlant and Roudnice beacons

Wind and temperature in the upper air:

300 mb 9 000 m STD : 100° 20 m/sec -50°C

500 mb 5 500 m STD : 070° 15 m/sec -25°C

700 mb 3 000 m STD : 030° 7 m/sec -10°C

Cloud cover:

4-7/8 Ac, As 2 700-3 500 m STD, 3-5/8 Sc 1 400-1 600 m STD

Precipitation:

Brief snowfalls in different places.

No hazardous meteorological phenomena - turbulence or icing - were forecast or reported by aircraft

3. Meteorological conditions during approach

Wind and temperature in the upper air:

850 mb 1 500 m STD : 300° 6 m/sec -8°C

1 000 m STD : 300° 6 m/sec -5°C

500 m STD : 260° 6 m/sec 0°C

Cloud cover:

The flight was conducted under the lower limit of the cloud base.

No hazardous meteorological phenomenon - turbulence - was forecast or reported by aircraft

Temperature gradient: about 0.67°C/100 m

Vertical wind shear: very small (1 m/sec)

Precipitation: brief local falls of snow

4. Meteorological conditions at the accident site at approximately 0907GMT

Wind 260° 6-8 m/sec; between 0900 and 0915 GMT maximum measured wind speed 11 m/sec

Visibility: 5 km

Precipitation: brief snowfall

Cloud cover: 3/8 Sc 1 200 m SOL 7/8 Ac 2 700 m SOL

Temperature: 0°C

Dew point: -2°C

Air pressure: QFE on Runway 25: 973.0 mb 28.75 in, 730.1 mm Hg (torr), QNH: 1 015 mb

5. Present weather at Prague/Ruzine airport

a) TAF valid 0900-1800 GMT

230° 7 m/sec 5 km snowfall GRADU 1000-1300 GMT

wet snow 6/8 Sc 600 m TEMPO 09/12 GMT

PROB 30% 1 200 m snowfall 6/8 St 150 m

b) Trend-type landing forecast, valid 0830 to 1030 GMT

Visibility: 3.5 km, at times (TEMPO) 1 800 m

Cloud cover: cloud base above 450 m SOL
valid 0900 - 1100 GMT

Visibility: 5 km, at times (TEMPO) 1 800 m

Cloud cover: cloud base above 450 m SOL

6. Transmitted meteorological data

ATIS 112.6 MHz and VOLMET Prague 128.6 MHz concord with the values contained in the regular Prague airport meteorological reports between 0730 and 0900 GMT on 19 February 1973.

The wind and temperature gradient values in the atmospheric layer up to 100 m above the surface did not preclude the possibility of turbulence in the approach zone to Runway 25 on the morning of 19 February 1973.

1.8 Aids to navigation

Immediately following the accident a ground check was made of all navigational aids which the crew might have utilized in its approach to Runway 25, i.e. ILS LOC, ILS GP, NDB "PR", MKR "OM", L "L", MKR "MM".

Between 1500 and 1600 GMT a special flight check was made of all the above radio aids. Up to the time of the accident on 19 February 1973 the navigational facilities for landing on Runway 25 were functioning normally.

During the ground flight checks all the facilities were in operation and their parameters complied with order L-10 and the technical specifications of the manufacturer.

1.9 Air traffic control and communications

Throughout its flight over the territory of the Czechoslovak Socialist Republic the aircraft maintained the prescribed routes and flight levels and did not report any anomalies on the ATC frequencies. Communications between the aircraft and the ATC units were normal. The aircraft clearly acknowledged all communications from the ATC units on the territory of the Czechoslovak Socialist Republic.

1.10 Aerodrome and ground facilities

Runway 25, 3 100 m long and 45 m wide, was clean and dry at the time of the accident and could be utilized over its entire length and width. In view of the favourable meteorological and daylight conditions the approach and landing lighting systems were not switched on.

1.11 Flight recorders

The aircraft carried three flight recorders, of which two were damaged:

a) a MSRP-12 flight data recorder

b) a MS-61 cockpit voice recorder.

The third, a K3-63, flight recorder was not recovered.

1. The recording part of the MSRP-12, in its crash-proof case, was recovered from the fairing of the rudder. The recording part was extracted and sent for expert analysis. No fire damage was found; one holder was broken and the surface of the casing was damaged in several places.

2. The MS-61 cockpit voice recorder was recovered from the front part of the wreckage, behind the flight deck. The recording part in its crash-proof container was extracted and sent for expert analysis. The surface of the recording part was severely damaged by fire.

1.12 Wreckage

Initial contact with the ground was made by the nose of the fuselage at a point 467 m before the threshold lights of Runway 25. The nose part of the gear was destroyed on impact; thereafter the right gear was also destroyed, after which the lower part of the forward fuselage and the right wing struck the ground.

The first fragments of the aircraft were found at the point where the nose of the fuselage and the right wing struck the ground, i.e. at a distance of 320 m before the threshold lights of Runway 25. These were parts of the nose gear, the outer part of the stabilizer and part of the wing flap.

In the ensuing phase the right wing and right landing gear became completely detached from the fuselage; they were found at a distance of 257 m before the threshold lights of Runway 25. At this moment the fuel, which had escaped from the burst right wing tanks, was ignited. Most of the aircraft became enveloped in flames.

The fuselage continued to move forward, rotating to the right, and the tail unit and right engine became detached. The right engine turned upside down, along the left wing, and came to rest at a point 50 m before the threshold lights of Runway 25 and 75 m to the right of its centre line.

The fuselage was destroyed by fire, which consumed the entire length of the passenger cabins and flight deck.

Parts of the instruments and radio navigation equipment, together with the electrical equipment, were wholly or partially destroyed in the crash and fire.

1.13 Medical and pathological information

Thirty-four persons - 25 passengers and 9 crew - survived the accident. Eighteen persons sustained different degrees of injuries, and 16 were unharmed.

Sixty-six persons died. Thirteen bodies were found outside the wreckage and 53 inside. In 51 cases the cause of death was fire; the other 15 died of multiple injuries that were not survivable.

1.14 Fire

It was clear from the wreckage, the ground traces and witnesses' testimony that the integral tanks burst at impact of the right wing with the ground at 0907 GMT, fuel spillage occurred and fire broke out.

After the cabin turned over, the fuel began to penetrate the wrecked passenger compartments and spread through the whole of the passenger cabin. The fire increased during the movement of the wreckage along the ground. The intensity of the fire during this movement is evident from the distribution of charred pieces of the aeroplane.

At 0909 GMT the entire aft part of the fuselage, from the mid-wing section to the engines was enveloped in flames on both the inside and outside. The windows in this part of the fuselage had already splintered in the fire.

At 0914 GMT the fire spread along the whole left side of the fuselage and engulfed all parts of the cabin. Compressed air cylinders began to explode in the forward part.

At 0920 GMT the fire was localized, but by this time the entire length of the passenger cabin had been consumed as a consequence of fuel leakage.

1.15 Survival aspects

Immediately after the crash, at 0907 GMT, the duty officer in charge of technical, fire fighting and rescue services, who had watched the aircraft's approach, sounded the alarm. Ten seconds later the TWR also sounded the alarm. Twenty seconds after the crash the fire fighting service set out and covered the 1.5 km to the aeroplane in 90 seconds. At 0909 GMT the fire vehicles reached the scene of the accident and commenced

rescue operations. By this time, however, the state of the fire was such that there was no hope of finding any surviving passengers in the aft part of the fuselage, i.e. from the mid-wing section to the engines. Efforts were therefore directed to rescuing the passengers in the forward part of the fuselage where, judging by the scale of damage and intensity of the fire, there was still some hope of saving occupants. Fire fighting was complicated by the fact that the aircraft turned over and escaping fuel penetrated the interior of the fuselage. As a result a fierce fire raged, not only outside, but also inside the fuselage where it was constantly fed by fuel escaping from the tanks.

In the first 3-4 minutes of operations 34 persons were successfully extricated, i.e. part of the passengers and the crew, partly with the assistance of survivors, but mainly by members of the fire fighting and rescue service, members of the crew and aerodrome personnel.

At 0914 GMT it was no longer possible to continue rescue work in the forward part of the fuselage due to the fact that the compressed air cylinders had begun to explode, metal alloys were burning, the fuel was entering the forward part of the fuselage in large quantities, the temperature was extremely high and, despite a blanket of foam applied to the area, the fire enveloped the opening through which passengers were being pulled clear. At 0917 GMT reinforcements from fire fighting units outside the aerodrome were sent to the accident.

The fire was brought partly under control at 0920 GMT and was completely and finally subdued, both in the wreckage of the aircraft and on the aerodrome surface, by 0945 GMT. The equipment of the fire fighting and rescue service complied with Instruction VP-3 of the Czechoslovak Ministry of Transport, developed in conformity with ICAO requirements. The fire fighting equipment used greatly surpassed these standards.

1.16 Tests and research

The following units and instruments were bench-tested:

- stabilizer trim mechanism
- stabilizer servo-control mechanism
- stabilizer position indicator
- auto-pilot control
- aircraft control components
- flight altitude control instruments
- flight speed control instruments
- climb (descent) speed control instruments
- flap position indicator

There was no evidence of defect or failure in the units and instruments tested which might have caused the accident.

2.- Analysis and Conclusions

2.1 Analysis

- Pre-flight preparation of the crew and aeroplane was conducted in accordance with applicable standards. No defects were discovered on the aircraft. The flight took place along the prescribed routes and at the prescribed heights up to the vicinity of the "L" beacon. During the flight the crew did not report any anomalies or difficulties.

- In the crash itself 66 persons died, 18 were injured and 16 escaped unhurt. Except for four stewardesses, the crew survived the accident.

- The aircraft was completely destroyed.

- Approach lights to Runway 25 were damaged.

- All crew members possessed the requisite qualifications, held valid licences and were in good health.

- The aircraft carried a valid Certificate of Airworthiness and had been maintained in accordance with applicable instructions and technology. The aircraft had not undergone any modifications during its operating life and all reported defects had been corrected.

- Neither the take-off nor landing weights were exceeded. The centre of gravity was within permitted limits.

- Fuel of the approved type was used.

- No dangerous meteorological phenomena were forecast or reported by aircraft during the flight and approach to land. Prior to landing, the flight was conducted in visual meteorological conditions. The wind and temperature gradient values in the atmospheric layer up to 100 m above the ground did not preclude the possibility of turbulence in the final approach area.

- The radio aids to navigation on the air route and at the aerodrome were working normally.

- Contact between the aircraft and ATC units were normal.

- No failure of radio aids occurred at the aerodrome during the aircraft's flight and approach. All facilities were operating normally within prescribed tolerances.

- The flight recorders were operating and were sent for expertise after the accident.

- No part of the aircraft became detached prior to impact with the ground. Fragments of the aeroplane were scattered over a distance of 320 m ahead of the runway threshold.

- Fire broke out immediately after the right wing struck the ground; it was extremely fierce and spread rapidly. After the aircraft turned over, the fuel began to enter the fuselage and fed the fire inside and outside the fuselage. Rescue and fire fighting operations commenced immediately (120 seconds) after the crash.

- During rescue operations 34 persons were extricated from the wreckage. According to passengers' statements, the work of rescue and evacuation was complicated by the design of the seat belt locking mechanism.

2.2 Conclusions

a) Findings

The following can be ruled out as probable causes of the accident:

- preparation of the crew and aircraft for the flight

- qualifications and medical fitness of the crew

- the technical condition of the aircraft, its weight and centre of gravity, and the fuel used

- the en-route meteorological conditions during the flight

- the radio aids and technical facilities en route and on the aerodrome, and the work of the ATC units

- external interference.

b) Cause or Probable cause(s)

Owing to the high degree of destruction and total disintegration of the aircraft in the crash and ensuing fire it was not possible to establish the precise cause of the accident. The influence of unexpected atmospheric turbulence during the aircraft's final approach cannot be entirely ruled out.

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