

## No. 13

Bulgarian Airline, TABSO, Ilyushin IL-18, LZ-BEN, accident near Bratislava, Czechoslovakia, on 24 November 1966. Summary of report released by the State Aviation Inspection of the Czechoslovak Socialist Republic on 23 October 1967.

1. - Investigation1.1 History of the flight

Flight 12<sup>o</sup> LZ 101 scheduled international air service Sofia - Budapest - Prague - Berlin. Last point of departure: Budapest at 1046 hours, 24 November 1966. Point of intended landing: Prague. Times quoted are GMT throughout.

## Description of the flight:

Meteorological conditions at Prague Airport deteriorated. Due to this fact, the flight landed at Bratislava International Airport at 1158 hours. About 1450 hours the pilot-in-command of the aircraft decided to resume his flight to Prague. He took off from Bratislava Airport at 1528:30; after take-off he made a turn to starboard according to the flight clearance with the instruction to perform a right turn on to the OKR Beacon, to climb only to 300 m and then to climb on to the NI beacon up to the flight level of 5 100 m. At 1530:20 hours the flight was requested to change to the ATC approach service frequency, 120.9Mc/s. The crew confirmed reception of this message, but they did not carry-out the retuning. Shortly afterwards the aircraft crashed into wooded ground in the mountains. The accident occurred 8 km away from the 31 runway threshold of Bratislava Airport (17<sup>o</sup> 09' 47" E. Long, and 48<sup>o</sup> 14' 34" N. Lat.), at the altitude of 420 m above MSL, i.e. 288 m above the airport level.

The accident happened at dusk.

1.2 Injuries to persons

| Injuries  | Crew | Passengers | Others |
|-----------|------|------------|--------|
| Fatal     | 8    | 74         |        |
| Non-fatal |      |            |        |
| None      |      |            |        |

1.3 Damage to aircraft

The aircraft was completely destroyed.

#### 1.4 Other damage

The aircraft cut a swath 340 m long and 10 - 30 m wide in a mountainous wood.

#### 1.5 Crew information

The crew comprised pilot-in-command, co-pilot, navigator, radio operator, flight engineer and three stewardesses. The pilot-in-command, aged 41, held the following valid licences; airline transport pilot valid till 1 May 1967 with meteorological minima rating: QBA 1 000 m and QBB 100 m day and night. He had his flying technique checked on 22 November 1966 with excellent results. He logged a total of 11 959 flying hours, of which 2 002 hours were on IL-18, including 339 hours of night flying. During the last three months prior to the accident he had flown 197 hours.

The co-pilot, aged 36, held a second-class commercial transport pilot's licence and was qualified for day and night flights on the IL-18. He had his flying technique checked on 23 November 1966 with very good results. He had flown a total of 5 979 hours, of which 768 hours were on IL-18. During the last three months he had flown a total of 179 hours.

The navigator, radio operator and flight engineer had also considerable flying experience and valid licences. The three stewardesses were also in possession of valid licences.

#### 1.6 Aircraft information

The IL-18 aircraft was operated since January 1966, with 78 per cent of its T.B.O. expired, the engines T.B.O. being 98 per cent expired and the propellers being from 4 to 48 per cent time expired. The aircraft had a valid Certificate of Airworthiness. Having examined the documentation, it may be concluded that the aircraft maintenance was performed in compliance with approved maintenance schedules and procedures, with the following exception: there was no evidence of the laboratory checks of the gyro horizons having been performed after 1 000 hours as required.

The take-off weight of the aircraft was approximately 49 960 kp this being much less than the specified maximum take-off weight. The centre of gravity of the aircraft was not shown in the loadsheet and could not be reliably ascertained.

The aircraft cargo comprised a consignment of radio-active iodine. The containers were destroyed and the radio-active substance contaminated the area of accident.

The fuel used was the PL-4 aviation kerosene.

#### 1.7 Meteorological information

At the time of take-off, Bratislava Airport was behind an undulated cold front which was moving eastward. Due to a depression over Hungary, a north-west and west wind was strengthening and also the flow of cold air was increasing.

At 1500 hours at the Bratislava Airport the wind was 310°, 7 m/s, maximum gusts 13 m/s, visibility 7 km, overcast, continuous drizzling rain, 5/8 St at 360 m, 8/8 Ns at 900 m. At 1530 hours: wind 320°, 6 m/s, visibility 7 km, overcast, moderate continuous rain, 6/8 St in 360 m, 8/8 Ns in 900 m.

From 1530 hours until 1540 hours the Bratislava Airport registered two gusts of 15 m/s. At a distance of 5 km in the take-off direction of the aircraft, moderate turbulence of chaotic character up to the altitude of 500 m was observed.

The meteorologist on duty drew the crew's attention to the possibility of encountering moderate or severe turbulence in the Little Carpathian's area. The crew received a written flight forecast in Slovak language, although nobody did express this demand.

Sunset at Bratislava on 24 November 1966 was at 1459 hours. At the time of the accident there was twilight.

#### 1.8 Aids to navigation

The aircraft was equipped for take-off and departure with two ARK-11 airborne automatic direction-finders, an airborne weather and obstructions avoidance radar and a marker receiver. Nothing has been ascertained to indicate any failure of these instruments. It has been established that at the time of impact the airborne weather and obstructions avoidance radar was not switched on.

Ground based radio navigation facilities available to the crew were a 75 Mc/s departure marker beacon of the runway 31, 725 m distant from its stop end, and the OKR non-directional radio beacon. By subsequent investigation it has been established that these aids were functioning properly.

The airport surveillance radar, with respect to its technical parameters, cannot be used for aircraft guidance and tracking in RW 31 sector.

#### 1.9 Communications

There were three VHF radiocommunication sets on board. There were no failures ascertained in the functioning of the airborne VHF communication set used for maintaining communication with the ATC services.

#### 1.10 Aerodrome and ground facilities

The runway 31 on which the aircraft took off has a geographical course of 314°, a length of 2 150 m, width of 60 m, and a zero slope. The airport reference point altitude AMSL is 132 m. At the time of take-off the runway was wet. At a distance of 5 km from the threshold of the runway 31, the flat country rises to reach at 8 km from the runway threshold a mean altitude of 430 - 440 m AMSL. (i.e. an elevation of about 300 m above the airport level). For the 31 RW a type A ICAO chart (operational limits) has been issued in the Czechoslovak AIP.

#### 1.11 Fire

After the impact of the aircraft, the wreckage burnt out and the fire was probably initiated by an electric arc or by engine hot sections.

## 2. - Analysis and Conclusions

### 2.1 Evaluation of Technical Investigations

From the evaluation of the wreckage and from the technical investigations it follows that:

- no aircraft part separated before the aircraft contacted the obstructions;
- the aircraft was in flight configuration, the flaps and the undercarriage were retracted, the locking mechanisms of aircraft controls were in unlocked position;
- all engines were running in the last phase of flight at nearly nominal power rating;
- the communication and navigation equipment was in order;
- the fuel was faultless.

The radio-active substances carried on board had no influence on the functioning of instruments and the health condition of crew members.

A failure of one of the rate gyro switches and failures of electrolytic vertical reference gyro switches have been ascertained.

For the purpose of establishing the accident causes, the following has been evaluated:

- health condition of crew members;
- the flight path;
- influence of failure of the rate gyro switch on proper functioning of the gyro horizon;
- possibility of errors in the gyro horizon indications;
- possibility of turbulence and its effect on the aircraft;
- evaluation of weather conditions by officials of the meteorological service;
- decisions of the air traffic controllers;
- evaluation of geographical and meteorological conditions in the Bratislava Airport control area by the aircraft crew;
- activities of the crew in flight.



### 2.1.1 Health Condition of Crew Members

By forensic medical investigation no signs of any of the five flight crew members having taken alcohol or medicaments have been ascertained. Nor has it been established that any of the crew members inhaled combustion products prior to death.

By biochemical investigation an extraordinary mental load of the crew prior to death has been established, which was particularly heavy in the case of the flight radio operator and slightest in the case of the second pilot. The established mental load (with the exception of the flight radio operator) corresponds to data established in cases of other aircraft accidents of similar character. Causes of extraordinary mental load of the flight radio operator could, however, not be explained.

On the co-pilot no injuries typical for the hand position on the controls have been established. This fact, together with the increased muscular effort ascertained on the pilot-in-command and with the knowledge of the practice introduced by the airline, leads to the conclusion that immediately before the crash the aircraft was controlled by the pilot-in-command. Neither on the territory of Bulgaria, nor at Budapest or Bratislava Airports have data been established on violations of the rest, alimentation and work load regulations, from which it could be inferred that the efficiency of any member of the crew was reduced or defective.

### 2.1.2 Flight Path

In respect of the flight path the Commission endeavoured, first of all, to ascertain the true flight path. In this respect, the Commission's work was made rather difficult by the fact that the aircraft was not equipped with a flight data recorder which could furnish objective information on the flight course, from initiation of the take-off procedure to the collision with obstructions. The true flight path could not therefore be definitely established. The probable flight path was plotted on the basis of established facts, eyewitnesses' evidence and assumptions based on aircraft operation documents. In this respect the eyewitnesses' testimonies contain no discrepancies. The probable flight path plotting can be seen in the diagram.\* As regards the flight altitude, it can be concluded that the 300 m height was maintained. The first impact with wooded ground occurred at a height of 281 m above the airport level. The 19-metre deviation below the 300 level is well within technical tolerances of the altimeters used and of admissible errors due to flying technique.

The possibility has also been examined whether under prevailing conditions the IL-18 aircraft could have taken off from the runway 31 and flown onto the OKR beacon by performing a turn to starboard at an altitude of 300 m in such a manner that obstructions would not be contacted by the aircraft, while maintaining exactly the Directives on Aircraft Operation ("Rukovodstvo") and with exclusion of any delay in initiating the turn. At the same time, the performance of a turn with 15° bank was taken into consideration, which would correspond to piloting conditions in turbulence.

\*Note of the Secretariat: The diagram was not appended to the summary of the report.

The flight path has been established taking into account the following basic conditions:

- take-off from runway 31 initiated at a distance of 50 m from its threshold after the engines have reached full performance and with flaps set at  $15^{\circ}$ ;
- unstick performed at a speed of 215 km/h, retracting the undercarriage at a speed of 250 km/h at an altitude of 5 m, retracting the flaps at a speed of 300 km/h at an altitude of 50 m, the engine power being set at "nominal" at the altitude of 100 m;
- performing of a straight-line climb up to the altitude of 200 m, at a velocity of 380 - 390 km/h;
- initiating of a turn at an altitude of 200 m and a continuous transition to  $15^{\circ}$  bank in a turn and maintaining this bank value;
- climbing up to 300 m, passing to level flight at 100 m and continuing in level turn with  $15^{\circ}$  bank and velocity of 400 km/h;
- mean values of wind vector: direction -  $310^{\circ}$ , velocity 8 m/s.

The computation and the graphic evaluation of the ground configuration show that with this flight path a vertical clearance of 97 m above the highest obstructions could be maintained and collision with obstructions could have been avoided. However, a comparison of the horizontal projection of the probable flight path with the projection of the plotted flight path (hereafter called proper flight path) shows that the aircraft deviated to the left by 1 450 m (measured along the normal to the proper flight path from the point of impact of the aircraft) in the direction of the obstructions, which in this direction and distance were higher than the altitude at which the aircraft was flying and consequently the impact of the aircraft with obstructions occurred.

### 2.1.3 Effect of Rate Gyro Switch Failure on Functioning of Gyro Horizon

In examining the rate gyro switches, it has been established in the case of one instrument that the time delay system was attached to the instrument casing by a single screw, while the other three screws and their washers were freely moving in the case of the instrument. These freely moving parts could therefore be locking the transmission mechanism of the instrument and thus interfering with its correct functioning, switching off the correction of gyroscopic instruments or breaking circuits of other instruments when turns or manoeuvres were being performed.

Because the VK-53 RB rate gyro switch controls also the switching off of the AGB-2 horizon ~~transverse~~ correction, the effect of non-switching the correction on indications of these horizons was examined, especially on bank indications. By plotting by graphical means, using realistic simplification, maximum errors for the given case have been established for bank and pitch, and it has been ascertained that they do not exceed  $2.5^{\circ}$ , the sense of error being such that the gyro horizon shows a smaller bank or pitch than the true one. If, therefore, the aircraft was performing a flight according to gyro horizon indication having this defect, the pilot would perform a turn with a greater bank than the indicated one.

The Commission is therefore satisfied that, although it was not possible to ascertain whether the faulty rate gyro switch was functioning correctly, its failure could not have led to performing the turn with a smaller bank than intended by the pilot.

#### 2.1.4 Possibility of Errors in Gyro Horizon Indications

In examining documents applicable to life-timed components it has been ascertained that the 1 000-hour periodic check on AGB-2 gyro horizons was not certified, although similar checks of other instruments were duly certified. From this fact, it can be inferred that the periodic check applicable to gyro horizons was not performed.

This possibility, together with the established fact that the aircraft, although performing a turn to starboard, struck the ground with a slight bank to the left, without evidence of any other circumstances accounting for it, has led to the assumption that the indication of gyro horizons was not correct.

Investigations have shown that the gyros of gyroscopic instruments were running and, in view of other evidence on normal functioning of the aircraft electrical system (radiocommunications; ampere meter pointer imprint against value corresponding to normal conditions in flight), an eventual drop of the gyro speed cannot be assumed.

In investigating defects which are encountered in AGB-2 gyro horizon service it has been ascertained that, due to irreversible electrolysis in the electrical level which this gyro horizon type provides for maintaining vertical spin axis of the gyro, separated copper forms deposits on an annulus insulating functional contacts of the level. Following gradual deterioration of the insulation resistance may result in bridging the functional contacts.

By the effect of this process the gyrospin axis will not be maintained in its proper position and an indication of error follows.

From the AGB-2 horizons of the IL-18 (LZ-BEN) aircraft only one considerably damaged case and one gyroscope with its inner gimbal without level have been recovered. In spite of intensive searching, the horizon levels have not been recovered and their service condition cannot, therefore, be ascertained. In order that at least their possible state could be taken into consideration, vertical reference gyro levels have been examined, which are of identical principle and analogous construction. By this expert examination, on one vertical reference gyro a level has been ascertained on which cross contacts one contact was fully short-circuited; on another vertical reference gyro a level with reduced values of insulation resistance at contacts has been established. These findings support the assumption that the horizon could have incorrect indications.

In view of this evidence, the Commission is of the opinion that a wrong indication of the AGB-2 horizons cannot be dismissed as a contributory cause of the accident.

#### 2.1.5 Possible occurrence of turbulence and its effect on the aircraft

In establishing the causes of the flight path deviation towards the obstructions and in evaluating the last phase of flight, especially the fact that while performing the turn to starboard the aircraft collided with obstructions in a bank to the left, the Commission concentrated its attention mainly on clarifying the questions of a possible occurrence of turbulence and its effect on the aircraft. In this respect the work of the Commission was made particularly difficult because of the fact that the experts' advice

which was requested for this purpose from competent organizations and meteorological services has given no definite explanation of this meteorological phenomenon in relation to the accident.

Relatively concurring opinions have been expressed in evaluating the conditions of turbulence origin and its effect on aircraft. The experts' advice is definite in pointing out that conditions originating turbulence were present and that turbulence could cause considerable bumping of the aircraft. This is corroborated also by practical knowledge of experienced pilots who say that in north-west winds aircraft control in close vicinity of the Carpathian Mountains is made difficult and effects on aircraft are strong.

In respect of a precise classification of turbulence corresponding to the prevailing circumstances in the area of Little Carpathians, the experts' conclusions are not definite. This is no doubt partly due to the fact that the problem of objective measurement of turbulence and its forecast has not yet been solved by world meteorology.

The Commission could not, therefore, decide whether the information on turbulence, as furnished by experts of the Hydrometeorological Service, corresponded with the actual turbulence at the time and place of accident. Besides, it was not possible to evaluate objectively the effects of the prevailing turbulence on the specific type of aircraft.

The Commission considers, however, that in the vicinity of the Little Carpathians the aircraft moved in an environment where the aircraft control, especially equal maintaining of bank in performing a turn, was made difficult and where the environmental effects could contribute to make the aircraft deviate towards more elevated ground and to cause its collision with obstructions in a left-bank position.

#### 2.1.6 Evaluation of Weather Conditions by Officials of Meteorological Service

The Commission has also examined the question of whether the meteorological situation, especially from the standpoint of turbulence, was correctly evaluated.

The flight forecast prepared on 24 November 1966 at 1410 hours, which was received by the crew, envisaged a slight to moderate turbulence without any more specification in respect of space.

The meteorologist on duty, who was briefing the crew, admitted the possibility of moderate to severe turbulence in the area of Little Carpathians, drawing the crew's attention to this circumstance.

The concept of "slight, moderate and severe turbulence" has not yet been exactly defined and there are no exact criteria for its consistent determination and forecast.

As regards severe turbulence, only in 1967 the World Meteorological Organization in a letter dated 17 March 1967 (Circular letter CAeM No. IV-20, "First report of the CAeM Working Group on Definition and Classification of Aeronautical Meteorological Terms") ~~proposed~~ a definition of severe turbulence, but this has not yet been generally adopted.

For the Bratislava Airport control zone, where the meteorological situation as it occurred on the day of accident is the most frequent (47 per cent of all measurements in Bratislava indicate the wind direction in the west to north quadrant), no detailed methods have been so far developed which would allow the officials of the Meteorological Service to give more reliable forecasts of severe turbulence and to determine it objectively.

The evaluation of possibilities of occurrence of severe turbulence, which is a dangerous phenomenon, depends therefore on personal consideration and experience of individual officials of the Meteorological Service.

In briefing the crew, the meteorologist proceeded in accordance with regulations of the Hydrometeorological Institute which supposes that the purpose of briefing is to explain the meteorological situation, the expected developments on which the flight forecast is based, or any other phenomena with a small probability of occurrence.

The Commission considers that the information received by the crew cannot be classified as anticipation of severe turbulence which would account for issuing a warning of dangerous meteorological phenomenon.

#### 2.1.7 Decisions of Air Traffic Controllers

The ATC flight clearance contained also the instruction to perform a turn to the right and to climb only up to 300 m.

The ATC rules of Bratislava Airport control zone permit in taking off from runway 31, to make a turn to starboard or to port. Both these turns ensure a continuous departure on to the NI (Nitra) radio beacon.

In the prevailing situation a turn to port after taking-off of the IL-18 aircraft would not require an altitude limitation.

It was not wrong to decide on a turn to starboard but, in view of the fact that 5 min prior to the take-off of the IL-18 (LZ-BEN) aircraft a slower IL-14 aircraft took off, which, after passing the OKR beacon at 1526:30 hours was performing a turn to port in order to proceed toward Breclav, it was necessary to ensure an altitude separation between the two aircraft. At the time when the senior controller of the approach control service was issuing the flight clearance, a temporary altitude limitation for the LZ-BEN aircraft taking off was mandatory.

In order to give a correct evaluation of the second part of the flight clearance, i.e. the altitude limitation to 300 m, it is necessary to explain how far the air traffic controller must or can, in taking his decision, expressed in ATC flight clearance, evaluate the effect of the configuration of ground on the safety of flight.

The Air Traffic Control Rules provide that the Air Traffic Control Services must, among other things, "control the air traffic in such a manner that collisions between aircraft in flight with obstructions on the ground are prevented on all IFR flights". Further, Article 2.8.2.5 provides that "on IFR flights the Air Traffic Control Services are responsible for the ensuring of adequate altitude separation between aircraft and the allocation of safe flight level".

It has been established that the senior controller of the ATC approach service, in issuing the flight clearance for take-off with temporary altitude limitation to 300 m for the IL-18 (LZ-BEN) aircraft, based his considerations on the prevailing traffic conditions and the necessity of ensuring a safe altitude separation between the LZ-BEN aircraft and the slower IL-14 aircraft, as well as on the assumptions that according to the actual traffic situation he would permit the aircraft to proceed in climbing and that the aircraft would initiate the turn immediately after passing above the marker. The air traffic controllers cannot with full responsibility judge the flight characteristics of all aircraft



types and know all operation limits prescribed by flight manuals. Therefore, in exceptions to Air Traffic Control Rules, Doc 4444-RAC/501-8, Part II, Section 1, Note 2 provides: "The Air Traffic Control Service has also the task of preventing aircraft collisions with the ground on IFR flights". This provision does not, however, relieve pilots of their duty to make sure that the flight clearance issued by Air Traffic Control Service is safe in this respect (see AIP CSSR, Part RAC-1). Besides, the provisions of Articles 3.3.4.1, 3.3.4.2 and 3.3.5 of the Rules of the Air make the operator responsible for determining the safe minimum height and for determining the take-off procedures and meteorological minima. The Commission considers that, at the time when the airport controller was issuing to the LZ-BEN aircraft the flight operation clearance for the flight in the airport control zone and the take-off clearance, it was already possible to fix a higher limit of temporary altitude restriction before the aircraft passing over the OKR beacon.

#### 2.1.8 Evaluation of Geographical and Meteorological Conditions by the Aircraft Crew

In accordance with Czechoslovak regulations the flight preparation must comprise study and analysis of planned flight conditions, including evaluation of traffic situation. There is no doubt that flight conditions include also the actual geographical situation.

The aircraft crew had at Bratislava Airport all necessary documents at their disposal in order to evaluate the geographical situation.

On the "Bratislava-Ivánka Airport Control Zone Chart RAC 4-3", as well as on all RW 31 (LKIB 6/65, 7/65, 7/65, 8/65 and 9/65) approach charts, the terrain relief and artificial obstructions in take-off direction are quite clearly marked. On the LKIB 6/65, 8/65 and 9/65 charts, a cross-section of the terrain relief in the RW 31 direction is also graphically indicated. Besides, for RW 31 of Bratislava Airport the "Aerodrome Environment Chart - ICAO" (LKIB 2/63) has been published. All these charts form part of the Aeronautical Information Publication of ČSSR, which the crew had at their disposal for flight preparation. The crew had thus the possibility of thoroughly evaluating the ground relief and had also time enough for it. Since the crew had not used their right of asking for flight clearance modification, it is justified to assume that they considered the received flight clearance as appropriate. From this it can be inferred that the crew either did not sufficiently evaluate the ground relief or was unable to apply the acquired knowledge to the required manoeuvre after taking off. Causality between these circumstances and the dangerous approach to the ground can be assumed.

Flight preparation must also include the acquisition of data on meteorological situation and of forecasts for the airport of departure.

There can be no doubt that the crew received all available basic information on the weather situation and its development at Prague, Berlin, Budapest and Bratislava Airports. However, it can be assumed that the crew's attention was concentrated more on weather conditions at Prague, Berlin and Budapest Airports than at the airport of departure.

The Commission assumes that information on possible occurrence of moderate to severe turbulence above the Little Carpathians was not taken by the crew sufficiently into account, because otherwise the crew would have chosen RW 04 or performed the required manoeuvre after take-off in such a manner that they would not have flown over the Little Carpathians, if no other circumstances occurred to prevent the crew from realizing this second possibility.

It has not been ascertained that the operator had issued special instructions for taking off from various runways.

The Commission considers that by issuing such instructions for taking off the free decision of crews would be restricted in the interest of increased safety.

The Commission believes that an insufficient evaluation of the terrain relief and of the weather conditions or an inadequate application of necessary conclusions drawn from this evaluation in performing the flight had a causal connexion with the accident.

#### 2.1.9 Crew's Activities in Flight

In the course of investigation, the Commission has not established any circumstances which from the viewpoint of aircraft control and navigation would definitely and evidently explain the causes of aircraft deviation from the proper flight path and, by inference, the collision of the aircraft with ground obstructions.

From the magnetic tape record of air-ground correspondence of the aircraft, it cannot be inferred that a technical failure or another circumstance occurred on board, by which the aircraft control would become difficult for the crew.

The aircraft deviation could have been caused by non-observation of proper speed and proper bank and by delayed initiation of the turn.

As regards velocities, these have not been definitely ascertained. It can, however, be assumed that in climbing the speed of 380-390 km/h and in level flight the speed of approximately 400 km/h were maintained, though a higher velocity than 400 km/h in level flight cannot be excluded. In this respect the "Rukovodstvo", valid from 14 March 1964, in Chapter IV, Article 4.1.3, para. 2 admits the speed of 360 km/h as minimum velocity under turbulence conditions.

The Commission has not succeeded in determining at what altitude the turn was initiated. From witnesses' testimonies it can, however, be inferred that the pilot did not initiate the turn before reaching the height of 200 m and that also, in initiating it, no substantial delay occurred. On the basis of facts ascertained at the crash site and from witnesses' testimonies it can, however, be concluded that the turn was being performed with a mean bank of less than 15°.

It has not been ascertained that in making their preparation on the ground at Bratislava Airport the crew would have paid special attention to the study of obstructions in the airport area. This circumstance could have, according to the Commission's opinion, played a negative role in controlling and navigating the aircraft in the course of take-off.

The flight radio operator who conducted the air-ground correspondence was not fully proficient in English phraseology, as has appeared from the analysis of magnetic tape records. The Commission considers that this circumstance complicated the process of making decisions by the pilot-in-command. Besides, some of the immediate replies to messages from the ground raise certain doubts whether sufficient and concentrated attention was given on board by the whole crew to their evaluation in taking decisions.

These findings are not irrelevant in view of the conditions which arose by accepting the flight clearance and under which a safe performance of flight along the proper flight path at an altitude of 300 m required precise actions of the whole crew and put higher demands on the aircraft control and navigation.

The Commission considers therefore that the aircraft's deviation from the proper flight path could be partly due to the aircraft control and navigation in performing the turn, especially in maintaining a bank smaller than 15° and a speed higher than that which is allowed by the "Rukovodstvo".

The Commission considers also that the crew's activities were not adapted to flight conditions, to begin with reception of information and instructions, their evaluation, taking decisions by the pilot-in-command and, at last, with aircraft control and navigation. In view of the established facts, their causal connexion with the aircraft accident must be assumed.

## 2.2 Conclusions

### Findings

No deficiencies in the crew's qualification and medical fitness, which would raise doubts about the crew's capability of performing the flight safely, have been ascertained.

The execution of take-off of the IL-18 (LZ-BEN) aircraft from RW 31 of Bratislava Airport on 24 November 1966 in accordance with ATC flight clearance (turn to starboard on to the OKR beacon and climbing only to 300 m) was possible without impact with obstructions occurring. This manoeuvre was possible without doing anything by the crew in contradiction with "Rukovodstvo".

Whereas the required height of 300 m was maintained, the aircraft deviated from the proper flight path in such a direction and to such an extent that an impact with obstructions occurred. The deviation could have been caused by a smaller than 15° mean bank or by a higher speed, but most probably by a combined effect of both.

In view of the fact that mandatory laboratory checks of gyro horizons had evidently not been carried out and that failures of electrolytic levels of vertical reference gyros have been ascertained, serious doubts about correct indications of bank as furnished by the gyro horizon have arisen. Their causal connexion with the aircraft deviation from the proper flight path cannot be excluded.

In view of the actual flight conditions, the negative influence of turbulence created in the Little Carpathian Mountains area, causing difficulties in maintaining constant aircraft bank, could probably multiply the effects of a possible incorrect indication of bank by the gyro horizon, and cannot be excluded.

Officials of the Meteorological Service gave the crew sufficient information necessary for evaluating the weather situation and for the pilot-in-command to take correct decisions.

The flight clearance given to the crew by Bratislava Airport air traffic controllers may not have been the only possible solution of the actual traffic situation, but it ensured safety of flight of the IL-18 aircraft against other aircraft in the airport control zone and did not by itself create for the IL-18 aircraft an emergency situation. The situation became dangerous only when the crew did not comply with the accepted flight clearance in performing the take-off manoeuvre, or when in the course of the manoeuvre unexpected circumstances occurred which the crew did not know of or could not cope with.



There are serious reasons to doubt whether the crew thoroughly evaluated the geographical and meteorological situation and drew from this evaluation the necessary conclusions in choosing the take-off runway, in accepting the flight clearance and in performing the take-off and the departure by making a turn to the starboard on to the OKR beacon.

The possibility must be admitted that the non-maintenance of the 15° bank and the 400 km/h speed (or the lowest possible limit of 360 km/h), which non-maintenance had a causal connexion with the accident, could be partly due also to errors in controlling and navigating the aircraft.

Cause or  
Probable cause(s)

The Commission could not definitely establish the cause of accident of the IL-18 (LZ-BEN) aircraft.

The Commission assumed that the most probable cause of the accident was insufficient evaluation of terrain relief and weather conditions in the Bratislava Airport control zone by the aircraft crew and lack of adaptation of the flight to these conditions.

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