REPORT ON THE CATASTROPHY OF AVIOGENEX AIRCRAFT

TU - 134 A, YU-AHZ

AIRPORT "RIJEKA", YUGOSLAVIA

23 May 1971

DIRECTORATE GENERAL OF CIVIL AERONAUTICS

Commission for investigation the causes of accidents in the Yugoslav Civil Aviation

11000 B E O G R A D, Brankova str. No. 25

A V I O G E N E X

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SKETCH No. 1

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1. INVESTIGATION

1.1 History of the flight

On 23 May 1971, the aircraft TU-134A, registration marks YU-AHZ took off from Gatwick Airport near London at 1633 GMT on a charter flight "JJ 130" (Aviogenex) directly to Rijeka. The purpose of the flight was transportation of British tourists who were going on holiday. The flight proceeded normally although the meteorological situation over Europe was unstable, with thunderstorms and rain. Before entering into the airspace of the SFR of Yugoslavia the crew had established contact with Regional Air Traffic Control "Zagreb" who passed to the crew the necessary instructions for continuation of the flight to "Rijeka" airport.

Sometime later the crew established contact with the Air Traffic Control at "Rijeka". The air traffic controller on duty, passed to the crew meteorological data and other information necessary for the approach to the airport. The controller has warned the crew that there was a cumulonimbus above Učka. Using their airborne radar, the crew flew around the cumulonimbus. As the aircraft was too high to start an ILS procedure the aircraft flew over the airport and then returned back over the "Breza" NDB. Afterwards the captain followed the ILS glide path and localizer normally. The co-pilot maintained radio communications with the air traffic control and the radio communications were good without interruptions though there were the disturbances due to lighting. In the landing configuration, the aircraft approached the airport normally passing through dense clouds. When it came out of clouds it was rather dark, because of the heavy overcast. However, up to that time everything was within the limits of safe flying.

The crew followed the ILS with the flight director system in operation and with a slightly increased speed.

Suddenly, 4 km away from the runway threshold, at a height of approximately 300 m above the sea level, the aircraft entered into torrents of rain. The crew immediately activated the windscreen wipers. During the flight through rain slight turbulence was felt and 50 seconds before touchdown the aircraft was carried upwards and rolled to the right. Due to the height and speed at which the aircraft was then flying and the degree to which it had been deflected from its normal approach path the crew could not return to an ILS Approach. Through rain which had reduced the visibility from the cockpit, the crew endeavoured to align the aircraft directly with the extended runway centre line and succeeded in doing so. However, the aircraft was above the glide path even though the crew was endeavouring to reduce height by applying down elevator and by reducing power.

During the change from IMC to VMC conditions with an approach being made with conditions of dusk, rain and water on the runway, as it was the case at Rijeka, false perceptions (illusions) about the position and altitude of the aircraft in relation to the runway, are possible.

Just at that moment (flight recorder, 18 sec. before impact) engine power was increased and up elevator was applied. According to the captain's statement for a very short time he considered discontinuing the approach. But after three seconds he decided to land; power was reduced to flight idle and down elevator applied at the moment when the aircraft was at a distance of 800 m from the runway threshold, at a height of over 60 m in relation to the threshold.

The subsequent flightpath of the aircraft was characterized by the reduction of speed and a steeper and steeper angle of descent (Figure No. 1)

this was to be expected with the reduced power and due to the aerodynamic features of the aircraft. From the statements of the crew it was apparent that due to an optical illusion they thought that they were closer to the runway and at a greater height above it than was in fact the case.

The aircraft touched the runway at a speed of 260 km/h and afterwards the right wing broke, the aircraft turned over and the fire broke out (Figure No. 2). In the ensuing fire, the aircraft burned out together with the passengers.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	3	75	
Non-fatal			
None	4	1	

1.3 Damage to aircraft

The aircraft was completely destroyed due to rupture of the right wing during landing and due to ensuing fire.

Baggage of the passengers and crew members, documents and aircraft logbooks were burned in the fire.

1.4 Other damage

During the crash sequence some parts of the aircraft and the ensuing fire slightly damaged the runway.

1.5 Crew information

The pilot-in-command, Miloš Markićević, aged 41, held an airline transport pilot's licence No. 90/2194 valid until 18 June 1971, with IFR rating and special rating for long ranged flights. He passed his last medical examination on 26 November 1970. He had flown a total of 87 flights totalling 138 hours and 50 minutes on the TU-134A aircraft. On all other types of aircraft he had flown, until 23 May 1971 a total of 9. 230 flights or 6. 987 hours respectively.

The co-pilot, Stevan Mandić, aged 34, held a senior commercial pilot's licence No 263/3799 with a rating for co-pilot on board the aircraft TU-134 A, valid until 20 November 1971. He also held an IFR rating. He passed his last medical examination on 19 May 1971.

As a co-pilot and as a holder of commercial pilot's licence he had flown 899 hours on TU-134 and TU-134A. Until the accident he had flown a total of 2563 flights or 2400 hours respectively.

The flight engineer, Viktor Tomić, aged 45 embarked on flight JJ-130 as a trainee and a candidate for examination on TU-134 A.

During the training for TU-134A, he had flown 99 hours.

He occupied the flight engineer's seat and was performing all duties under the supervision of the instructor, Ivan Čavajda, who was standing behind him.

The flight engineer, Ivan Čavajda, aged 39, instructor had held a licence since 30 May 1958 and had flown a total of 7. 500 hours of which 1. 373 hours on TU-134. On this flight he was the responsible flight engineer.

The stewardess, Alma Svoboda, aged 29, had her first flight on 2 May 1970. She had flown a total of 656 hours.

The stewardess, Mira Miše, aged 22, had her first flight on 15 May 1971. She had flown a total of 29 hours.

The stewardess, Mirjana Janković, aged 20, had her first flight on 30 April 1971. She had flown a total of 45 hours.

All crew members held appropriate and valid licences for the TU-134A type of aircraft.

No medical limitations were imposed for flying of both pilots, flight engineers or cabin attendents.

That day and previous days as well, the crew had not violated the prescribed flight time limitations.

1.6 Aircraft information

The TU-134A aircraft has been designed in accordance with the USSR regulations. The aircraft represented a modified series aircraft of TU-134 made with the aim to improve the operational characteristics, increase the number of seats and to ensure autonomy during ground maintenance. For that purpose the fuselage of TU-134 has been extended for 2.322 m. MTOW has been increased to 47 tons and LW has been increased from 40 to 43 tons while forward position of the center of gravity has been moved from 26% to 21% MAC. New engines D30 series II, have been installed with thrust reverse and auxiliary power unit (APU).

The TU-134A aircraft serial number 1205 was bought and imported as a new one on 23 April 1971. Main inspection was performed on 27 April 1971. Certificate of Airworthiness was issued with validity until 27 April 1972. During manufacturer's tests the aircraft had flown 4 flights or 9 hours and during airline operation it had flown 102 hours in 43 flights. Checking the documentation it was

noted that during operation the aircraft had not experienced any significant failures or damage. On the basis of crew members statements, tape recordings of air traffic control and the inspection of aircraft wreckage it was noted that during the flight the aircraft had been in good technical condition. On the basis of weight and balance (loadsheet and calculations), at the moment of accident center of gravity was 29% MAC with landing weight of aircraft LW= 39. 290 kg including approximately 4. 000 kg of fuel.

1. 7 Information about meteorological conditions

On 23 May 1971 the region of Kvarner bay was under the influence of a low air pressure area. Center of area of low altitude of the pressure surface extended to the North-West part of the Adriatic Sea. The 1004 mb isobar was over "Rijeka" airport. Horizontal gradient of the air pressure was 1 mb/111 km.

From 1600 hours the sky became fully clouded and ground wind changed its direction from southwest to southeast with a speed of 10 knots.

At 1905 hours a Cb of 2/8 with the ceiling at 900 m appeared from the southwest of the airport.

At 1920 the sky above the airport was completely covered with clouds. Thunder and rain started (4/8 Cb at 600 m and 4/8 CuSc at 600 m). Horizontal visibility, which was 15 km until then, reduced to 10 km. Ground wind from 130^{o} increased its speed in gusts to 15 knots. Air temperature was 17^{o}C, dew point was 15^{o}C and QNH was 1004 mb. The Cb whose base was at 600 m, was above northwest portion of the airport and was extending in the direction of outer marker "KO", towards Rijeka, 2-3 km from the threshold of the runway 14. From there to Rijeka there were CuSc with ceiling

of approximately 700 m. Shower zone extended 3 km from the airport in the direction of Rijeka.

1.8 Aids to navigation

The aids to navigation (cf. AIP - Yugoslavia) were in operational condition and are not relevant to this accident.

1.9 Communications

Radio facilities were in operational condition and are not relevant to this accident.

1.10 Airport, airport services, installations and equipment

Rijeka airport was opened to public air traffic on 1 May 1970, and belongs to Class A according to the ICAO Annex 14. The airport is provided with all necessary services for the airports of Chategory I in Civil Aviation. Detailed information are contained in the AIP - Yugoslavia (Section AGA 2- 11).

1.11 Flight recorder

The TU-134A aircraft of Soviet manufacture are provided with flight recorder equipment which is of "MSRP-12" type. This equipment records on magnetic tape 12 (twelve) flight parameters whose decoding is performed on the ground by the device DUMS.

The equipment MSRP-12 records: pitch and roll values, elevator rudder and aileron position; position of the power lever of left and right engine; indicated speed and altitude; rotation per minute of left and right engines and roll rate.

Magnetic tape recordings of the coded signals and the time basis of parameters for last 30 min. of the flight are retained.

Basic technical data about MSRP-12

- Number of measuring channels of analogue parameters is 12.
- Frequency response per each channel is $^{+10}_{-5}$ per second.
- The system has been evaluated for the work with potentiometers and corresponding installation of output voltage which changes from 0 to 6, 3 voltes.
- Constant operation lasts 30 hours. Flight recordings are made by continuous wiping off the registered signals so that information about last 30 minutes of the flight always remain on the tape.
- Error of the recordings and its decoding (by ground device DUMS) does not exceed $\pm$ 3% in total (excluding the transducer error).
- The recordings are made on magnetic tape which is 6, 25 mm wide.
- In order to check the system, tension is checked on the entrance of each channel each 35 seconds.
- Time recordings is made once in a second on channel 13.
- The mechanism of the magnetic tape is closed and protected in a box which protects it from damage during shock loads to 100 g, static load of 1000 kg and thermal shock of 1000°C for a duration of 10 minutes.

On 24 May 1971 the Commission disassembled the box with the flight recorder tape and found out the following:

- there was no mechanical damage to the box,
- the tape with recordings was saved without any damage,
- both halves of the box were filled with water in accordance with the maintenance instruction.

1.12 Aircraft remains

A survey of the accident site is presented on Figure 3. The survey has been made on the basis of stereophotogrametric photography.

The wreckage of the right wing and the wreckage and deformation on other parts of the aircraft were re-constructed during the investigation and photography, and the following was found out:

- the initial failure occured in the right wing between the sixth and seventh rib because of the combined loads on the attachment point of the landing gear to the wing.
- deformation - bending and traces of scraping the runway were found on the root of the right wing the remains of which bent over and blocked the access to the emergency exits.
- damage to fin and detachment of the horizontal stabilizer.
- traces of scraping and deformation of the right engine nacelle,
- traces of scraping of the right side of rudder and twisting of the tail cone for 90^{o},
- damage to tail cone at the section of freight hold and the occurrence of a hole on the airframe,
- traces of scraping, bending and partial damage of the left wing on the outer third of the span,
- intensive traces of scraping of the upper surface of fuselage, Figure No. 5,
- the fuselage nearly completely burned in the fire while the engines and the left wing remained together with the right landing gear assembly.

The following position of the aircraft and engines controls was noted:

- horizontal stabilizer (- 1, 5^{o}) "backward",
- horizontal tail trim - "backward",
- flaps, fully extended (38^{o})
- aerodynamic brake - retracted,
- spoilers - retracted,
- landing gear extended and locked,
- power lever - "on idle"

In respect of the powerplant the following was noted:

- The side of right engine nacelle was deformed with traces of scraping. The engines were without major mechanical damage with typical signs of the effect of the fire-fighting system. Auxiliary power unit (APU) in the tail cone was undamaged with traces of fire-fighting system's effect.

Analysing the parts of the landing gear it was found out that:

- Nose wheel leg nearly completely burned in the fire. Right main leg with traces of intensive fire and a hole on a shock absorber resulted from the explosion due to heated air and lubricant.
- Left wheel mechanically undamaged with complete wheel tires,
- Pistons on both shock absorbers on the left and right main landing gear slightly damaged due to extremely high compression forces.
- The left wheel leg tires were damaged due to maximum tire deflection.

1.13 Medical and pathological information

After the inspection of aircraft remains, the group of experts started with the identification of corpses of passengers and crew members. Major items of this report are:

- 78 corpses were found nearly completely carbonized,
- 70 passengers and 3 stewardesses were identified,
- none of passengers had suffered traumatic injuries,
- 30% of passengers remained fastened to the seats with the seat belts until they died,
- other passengers tried to find the exits. One group went towards the nose of the aircraft and the other one toward the tail,

- the three stewardesses were in the front part of the aircraft,
- great concentration of carbon monoxide was present,
- the passengers and crew members fainted in several minutes due to carbon monoxide poisoning,
- the death resulted from carbon monoxide poisoning and burning in the fire,
- mean temperature during the fire was between 660° and 1000°C.

1.14 Fire

Fire broke out 0, 45 sec after the first touchdown of the right leg, at the moment when inner portion of the right wing flap touched the runway. The Figure No. 2 depicts the wreckage of the right wing, wreckage of tail surface and turning over of the aircraft. Fuel leaked out of the broken right wing onto the runway and was immediately set on fire by sparks which resulted from the contact of the flaps with the runway. At the same moment the fire-fighting system was automaticaly activated. The system carried out its function and prevented fire in both engines as well as on the APU in the tail cone. Besides extinguishing the fire, the system also disconnected the electrical power supply from main power supply source and closed the ventilation of the generators.

When the aircraft turned over and the tail broke because of the torque, tail cone twisted and partly broke. That torque and damage caused the braking of electrical cables which connected the cabin with the tail cone which contained a battery for emergency supply and for the lighting of passenger cabin. Immediately after the aircraft turned over the engines stopped and the lights in the passenger cabin and the cockpit switched off.

The aircraft turned upside-down at a speed of over 200 km/h. Followed by the broken wing, tail and minor parts covered with flame and sparks it slid down the runway for a distance of approximately 700 m.

The detached wing in a very intensive fire stopped on the runway just before the turn towards the terminal apron. In the vicinity of the wing there was the horizontal stabilizer in fire of less intensity. The fuselage with the left wing had diverged from the runway to the right and passing from runway asphalt to soft ground it turned through 180° and came to rest inverted with the tail in the direction of landing. After an analysis of the facts and from statements of crew members, fire-fighting team and other participants in the rescue it has been deduced that the fire spread in the following chronological sequence.

- In the first minute after the aircraft had stopped, the fire broke out under and around the left wing and with less intensity in the tail, behind the right engine and in the remaining parts of the right wing (Figure No. 4).
- In the second minute, the first fire brigade appliance arrived,
- Fire-fighting team extinguished the fire on the left wing,
- Three minutes after the aircraft had stopped, the fire-fighting team extinguished the fire in the aircraft tail and in the remaining parts of the right wing.
- Five minutes after the aircraft had stopped it seemed that the fire around the aircraft was extinguished but signs of fire inside the fuselage were more and more prominent. Thick smoke emerged from the hole on the tail and the holes in the windows of the passenger cabin which were made by the strokes of the axe.
- Eight minutes after the aircraft had stopped, the fires in the left and right wings started again. Between the wings and the engines the fire was observed inside the cabin.

- Ten minutes after the aircraft had stopped the inside fire caught the whole cabin while fire on the left and right side of the fuselage, in the center wing, has intensified. Firemen and all participants in the rescue withdraw to the safe distance because of possible explosions.

- Twelve minutes after the aircraft had stopped, the inside fire caught the oxygen equipment in the front section of the aircraft which caused the explosion and disintegration of the front section of the fuselage between the doors and center wing area.

- In the minutes that followed everything was destroyed by the fire.

1.15 Survival aspects

After the impact, breakup and ground slide the aircraft stopped on the right side of the runway near the terminal building on its back and with the tail in the direction of landing, Figure No. 4.

The crew from the cockpit tried to get into the passenger cabin but did not manage to do so because the door between the cockpit and the galley was jammed in closed position due to deformation of the upper part of the fuselage, Figure No. 5. The crew left the cockpit through the undamaged right pilot's window. The co-pilot and two flight engineers immediately tried to open the front cabin exit door from the outside. The only surviving passenger escaped through a hole in a freight hold on the side of the aircraft's rear fuselage. At the moment when the aircraft stopped, heavy smoke had already appeared in the passenger cabin. The endeavours of the crew members and other participants who were trying to rescue the passengers were in first 3-5 minutes concentrated on the opening of main and service doors, at first by hand and afterwards using axes and a hand motor saw. In the 5th minute the service door was partially opened only for 20-30 cm (these are sliding doors). At that moment the passengers showed no signs of life and heavy smoke was coming out through the hole. The attempt to cut the

fuselage with a motor saw was abandoned because the fan belt on the saw had torn off.

Fire-fighting team of the airport enterprise consisted of 9 firemen and managed in the first minutes to extinguish the outer fire around the aircraft while, in the meantime, the other participants in the rescue (3 crew members, two flight engineers, "Aviogenex" Station Manager and JAT's mechanics) were trying to open the doors and to break several windows with axes. Heavy torrents of rain hindered the rescue and washed away the powder and foam which were used for fire extinguishing which resulted in the reactivation of the fire and quick consumption of fire extinguishing agents. The wind from a direction of 150° from tail to nose of the aircraft brought large amount of heavy smoke what reduced the visibility even more, and slowed down the work of the rescuers. Four emergency exits were not opened. If it is taken into account that one to two minutes after the aircraft had stopped the passenger cabin was full of thick and toxic smoke and that 30% of passengers did not manage to unfasten the seat belts, the absence of passengers' and stewardesses' activity is clear. The passengers who were sitting in the center of the aircraft managed to unfasten the seat belts and proceeded towards nose and tail, running away from the place where the emergency exits were located, which is in accordance with the statements of the rescuers who have stated that the first signs of fire were noticed in the section of the center of the aircraft.

While the aircraft was sliding along the runway, the root portion of the broken wing, heated by fire, produced a lot of smoke and completely obscured the access to emergency exits on the right side.

The main passenger door on the left side of the fuselage and service door on the right side of the fuselage resisted to all attempts of the rescuers to open them. As for the passenger door which opens

"inward", it is realistic to suppose that by confusion, in panic and darkness the door was locked from the inside. Besides main lever, there is also a lever for locking. Because of the aircraft position on the back, the main lever should have been pushed upwards. Being impossible to open the door by pushing the main lever "downward", a normal reaction would be to change the position of the locking lever.

However, the service door was opened for 20-30 cm at the time when the aircraft was full of smoke. Hot and heavy smoke prevented the rescuers from getting into the cabin. The flight engineer, Viktor Tomić, tried, by re-entering into the cockpit, to reach the passengers but did not manage to break down the door between the cockpit and the galley.

Breakage of windows made of very tough plastic did not give any results except that penetration of air through the holes expedited the spreading of fire inside the cabin. Finally the reactivated exterior fires and intensive inside fire associated with explosions forced the rescuers to move to a safe distance from the burning aircraft.

1.16 Tests and research

In connection with the accident the following tasks were carried out:

- Analysis of technical aspects of structural wreckage and testing of the material of the aircraft TU-134A, YU-AHZ, (Report V4 - 641 Aviation Institute "Žarkovo") ;
- Data processing of the flight YU-AHZ, recorded on the recorder MSRP-12 No. 00354 ;
  (Report 740 - Aviation Test Center) ;
- Analysis of fuel used on the flight JJ-130
  Chemical Inspectorate Harefield, Middlesex
  (Test Report No. CR/700/f/7059) ;

- Some observations of the airline AVIOGENEX in connection with the accident of the aircraft TU-134A, S/N 1205 Design Bureau - Tupolev, Moscow ;
- Report on the flight tests of TU-134A with simulated situation which preceded the accident of YU-AHZ Design Bureau Tupolev - Moscow ;
- Analysis of the accident of TU-134A with respect to the strength of aircraft Design Bureau Tupolev - Moscow ;
- Analysis of YU-AHZ flying on short final on the basis of flight recorder evidence. Design Bureau Tupolev - Moscow ;
- Report and opinion of the experts from Great Britain, Messrs. G. C. Wilkinson and J. Goulding Accident Investigation Branch ;
- In flight tests on TU-134A Working Group of the Accident Investigation Commission of the Directorate General of Civil Aeronautics ;
- Possible occurrences in intensive rain, Accident Investigation Commission of the Directorate General of Civil Aeronautics, Dipl. ing. Ž. Nikolić

The above expert opinion and tests were used during the compilation of this report but due to their volume have not been attached hereto.

All mentioned material is available at the Accident Investigation Commission of the Directorate Gneral of Civil Aeronautics of Yugoslavia.

1.17 Other information

Landing of the TU-134A aircraft YU-AHZ was performed under heavy shower conditions which in the Commission's opinion created the conditions for false perceptions - illusions for the pilots.

Illusion about the runway position

During the flight through the rain curtain, the refraction of light on the cockpit windshield creates the illusion that the runway is closer than it actually is. This error may reach 5^{o}, so that during the approach for landing, at a distance of one mile, the runway seems 200 feet (approximately 60 m) lower than it actually is. According to known experience, the greatest potential danger appears in the approach or final approach for landing after coming out of cloud.

Perspective from the air

In connection with the size and linear perspective, the pilots estimate the distance from the objects by their clarity : more brilliant lights and sharp terrain contours seem closer while dim lights and obscure terrain contours seem more distant. For example, clear deser air is good light conductor and for that reason a lighted runway seems closer than it actually is. Such a situation may prevail even on the airports located on islands and demands extreme caution.

The opposite situation is under the conditions of heavy rain and bad visibility through the cockpit windshield.

A change of angle of attack is possible, i. e. lift and resistance because of vertical effect of rain curtain, as well as the disturbed circulation around the airfoil what also may result in the change of lift and drag. For example, with the DC-3 aircraft which flies with en route speed and encounters the rain with density of 50 gr/M, a pilot must increase the power for approximately 470 h. p. in order to surmount the additional drag and to maintain the speed by power correction. According to calculations for the TU-134A in order to maintain a constant speed without adding the power it is necessary to descend at an angle of 4^{o}.

2. Analysis and conclusions

2.1 Analysis

The character of the right wing separation and damage on the aircraft YU-AHZ has been reconstructed by inspection and analysis. The traces at the touchdown point revealed that it was a hard landing on the right leg of the landing gear with the aircraft banked to the right. Immediately afterwards there was an even harder contact of the left leg of the landing gear with the runway and a structural failure of the right wing immediately adjacent to the attachment point of landing gear to the wing. The landing gear strut destroyed the forward spar by a force of approximately 70 tons while in the shock absorber of the main landing gear a force of approximately 100 tons broke the aft spar. There is a possibility that the right leg of the main landing gear was not in the correct position for landing but it was in forward position. However it has not been possible to establish this point.

It is deduced from the evidence that the place and character of the structural damage corresponds to the calculated loadings.

The D30, series II, engine should accelerate from the idle regime to the maximum power regime (P=6. 800 kp) in 7 sec., and from the regime 88% r. p. m. in 3 sec. (These data are according to the Flight Manual, but could not be achieved in practice).

Emergency equipment of the TU-134A aircraft, oxygen bottles and connections are located in the front part of the aircraft in the galley immediately next to the seat of the aircraft hostess, and in the aft part of the aircraft on the right wall. In the cockpit, besides three oxygen masks there is fire-fighting equipment and an axe. Lighting in case of emergency is provided through the supply of an aircraft battery which is located in the tail of the aircraft. Size and shape of the emergency exits correspond to BCAR.

METEOROLOGICAL SITUATION

Analysis of the meteorological situation and conclusions about weather are based upon the report of a group of meteorologists.

At "Rijeka" airport there is a Meteorological Center Class II provided with observation and weather forecast services.

At the moment and on the date of accident all meteorological instruments and equipment were in operational condition except for the telemeter (instrument for measuring the ceiling of cloud) which did not operate due to a failure.

The Observer on duty had 20 years of experience. On 23 May 1971 at 1905 LT he reported a regular QAM report (all details are presented in the Appendix which contains the interrogation of the meteorological observer).

At 1920 LT the Meteorological Center, due to rain shower and thunder issued a "SPECI" report which read:

- QAN 130/11 KTS
- QNT 15 KTS
- QBA 10 km
- QNY 95 TS
- QBB 4 Cb 600 m 4 Cu Sc 600 m
- QMU 17/14
- QNH 1004 mb

At 2000 LT the Meteorological Center issued a METAR report which read:

METAR 23 1900 LYRI 130/11/15 9999 95 TS
4 Cb 20+4 CuSc 20 17/15 1004.

Meteorological reports QAM, "SPECI" and "METAR" did not contain the QFE which is reported only upon the request of the crew.

The meteorological minima for "Rijeka" airport runway 14 are as follows:
QBB - vertical visibility or ceiling 100 m, relative heights (THR) QBA or horizontal meteorological visibility 2000 m.

- maximum allowed cross wind velocity for landing is according to the Flight Manual.
- Time of landing and the accident coincide with the dusk for geographical longitude at "Rijeka" airport.
- Turbulence during the last minute of the approach of aircraft, according to the flight recorder was 0, 2 - 0, 25 n, which according to the accepted international scale represents weak or mild turbulence.
- Visibility ground - aircraft, besides the shower, was not significantly reduced (statements of witnesses).
- Visibility aircraft - ground, when passing through rain, depends upon the cockpit construction, efficiency of wipers, speed of aircraft and refraction of light on the wet cockpit windows. It is possible that under the conditions obtaining visibility was reduced significantly.

Therefore, weather (meteorological situation) at the time of accident to the TU-134A was within the limits of approved standards though landing conditions were difficult due to rain, wind and dusk.

LAST MINUTE OF THE FLIGHT

The analysis of the last minute of the flight are based upon the tape recording of the flight recorder with its 12 parameters, and the statements of the crew.

Penetration of clouds, according to the crew statement, coincided with the arrival of the aircraft above the outer marker LOM-KO. The crew navigated the aircraft by ILS using the flight director. That phase of approach (between LOM and the last minute of the flight) was characterized by the following:

- approximate speed Vi = 300 km/h
- column position 5^{o} (up elevator)
- r. p. m. 86-88%
- frequent heading corrections, tendency to turn to the right
- slight bank to the right

The disturbance of the established flightpath by moderate turbulence began 70 sec. before the touchdown on the runway. It was manifested by the negative loading of 0. 2 n and in the 64th second by the reduction of speed Vi by 16 km/h. The change of speed and loading was not caused either by change of thrust or by the application of elevator, so it could only be interpreted by the change of air density i. e. by a rain shower. Therefore it could be said that at a distance of 4 km. from the runway threshold, at a height of 300 m above sea level, the aircraft entered into a shower of rain.

After 12 seconds flying through rain and 52 seconds before the touchdown, the established regime was again disturbed by positive loading of 0, 2 - 0, 25 n, increased speed Vi by 16 km/h and by rolling - right bank. This disturbance may be explained by a moderate gust - change of wind velocity and by theaircraft coming out of the zone of the heavy rain shower. The crew reacted in an attempt to return the aircraft to its previous position by increasing the engine thrust from 87% to 91%. The aircraft came above the glide slope and out to the right of the localizer centre line.

In the period from 52 to 19 seconds before touchdown the change of flight regime was noted from "column forward" to "column backward" what resulted in increased speed Vi to 310 km/h. In the 32nd second the thrust was reduced by 7% r. p. m. In the same period the heading was corrected to the left side by full left deflection of rudder associated with a significant bank of the aircraft to the left.

In the 18th second the aircraft overflew the middle marker, still being above the glide slope and to the right of centre line of the runway. This was in accordance with the statements of the crew members about their intention to discontinue the approach.

The decision was changed after three seconds, the power was reduced to flight idle and down elevator applied at the time when the aircraft was 800 m from the runway threshold at a height of over 60 m in relation to the runway. At the same moment intensive correction of heading to the right was made followed by the return of the rudder to the neutral position.

The latter part of the aircraft's flightpath was associated with a reduction in speed and aprogressively steepening angle of descent (Figure No. 1). This was the natural result of a large reduction in power and the application of down elevator.

Analysing the statements of the crew it was apparent that at that moment they experienced an illusion regarding their proximity to the runway and their height above the runway. The aircraft touched the runway with a speed of Vi - 260 km/h. Vertical loading coefficient was recorded as n_y = + 4,15 and side loading to the right n_z = + 1,46.

About the work of airport services

During the approach of the aircraft and at the moment of accident, all necessary services at "Rijeka" airport were in a state of readiness.

Zagreb ACC released the aircraft on time to the Approach Control at "Rijeka" which maintained the communications with the aircraft until 40 seconds before the touchdown.

The Meteorological Center, Class II had passed to Air Traffic Control the necessary information and reports.

Fire-fighting and rescue team started the action in good time considerably helped by the fact that the distance between the terminal building and the aircraft was only 200 m.

The activity of all participants can be divided into the attempts to extinguish the fires and the attempts to rescue the passengers and crew.

Fire extinguishing had been performed by 14 members of which 9 members of the team were at the site from the first moment while another 5 members joined later. The team had at its disposal three vehicles and other tools and equipment. However, in spite of all endeavours of the team, the rescue and evacuation of passengers and crew members from the passenger cabin was not successful and was prevented by rapid spreading of carbon monoxide and fire which engulfed the entire aircraft.

2. 2 CONCLUSION

a) Findings

1) The crew were properly certificated.
2) The aircraft was certificated and maintained in accordance with the existing regulations.
3) The crew planned a flight from London (Gatwick) England to Rijeka - Yugoslavia.
4) All over Europe the weather situation was unstable with thunderstorms.
5) Radio communications with Air Traffic Control were maintained all the time and were good except for minor disturbances

due to rain.

6) Air Traffic Control provided all necessary information including the meteorological information for the approach of the aircraft to the "Rijeka" airport.

7) At "Rijeka" airport the pilot started the ILS approach normally, with the flight director system on.

8) Four kilometres from the runway threshold, at a height of 300 m (sea level) the aircraft entered into a heavy rain shower. The crew immediately activated the wipers and during the flight through rain slight turbulence was felt.

9) Fifty seconds before the touchdown the aircraft was carried upwards and rolled to the right which interupted the ILS approach.

10) Until the middle marker, the crew, flying through rain, was endeavouring to align the aircraft with the runway centre line and succeded in doing so.

11) The aircraft was above the glide path though the crew endeavoured to reduce the height by applying down elevator and reducing the power.

12) The latter part of the flightpath was associated with a reduction in speed and a steep angle of descent.

13) It is concluded that during the entire approach in the intense rain, and due to the refraction of light, the pilot had an optical illusion that he was closer to the runway and at a greater height above it than was in fact the case.

14) The aircraft touched down on the runway at a speed of 260 km/h.

15) After the heavy landing the right wing broke off and then during the inversion of the aircraft the tail surfaces broke and twisted and the tail cone was partially destroyed.

16) From the ruptured right wing the fuel spilled on the runway and immediately was set on fire by sparks which resulted from the contact of the flaps with the runway.

17) After separation the right wing and tail continued to move in a streight line and stopped in flames on the runway. Airborne fire-fighting system for extinguishing the fire on the engines had been activated and prevented fire in the engines.

18) The fuselage with the left wing became inverted at a speed of over 200 km/h and slid along the runway for a distance of some 700 m., while the passengers baggage fell out of the rear freight hold. After that, the fuselage with the left wing veered off the runway to the right, when it passed off the runway it turned through an angle of 180° and soon afterwards stopped.

19) After the aircraft had stopped, four crew members managed to leave the aircraft using a cockpit window and one passenger jumped out through a hole in the rear part of the fuselage.

20) Fire-fighting team and other participants in the rescue arrived at the accident site within one minute after the aircraft had stopped.

21) The rescue team and survived crew members has concentrated their efforts to open the main and service doors and to cut the fuselage by a motor saw. Due to the aircraft attitude and many other circumstances already described in the report, they did not manage to do so.

22) The fire-fighting team consisted of 9 firemen, surviving crew members and other persons who were present at the site. Nevertheless, the aircraft and passengers were burned in the fire as previously described.

b) Probable cause of the accident

It is considered that the probable main cause of the accident of the TU-134A aircraft, registration marks YU-AHZ, which occured on the 23rd May, 1971, at "Rijeka" airport was a heavy landing on the right leg of the main landing gear, emphasised by an irregular

position of the wheels and 0.7% slope up of the runway at the point of touchdown.

The Commission consider that the described deviation from the flight tehnique in itself, did not cause the crash of the aircraft, but that loading which resulted from the conditions under which the landing was performed made a greater contribution to the crash.

However, non-adequate handling of controls of the aircraft and engines could be explained only by false perceptions (illusions) of the crew concerning the aircraft position in respect to the runway.

The last minute of the flight was analysed on the basis of:

- flight recorder oscillogram
- results obtained during the investigation on the flight on board of the same type of aircraft.
- study of aerodynamic characteristics and stability of TU-134A
- analysis of meteorological situation
- analysis of crew members' statement

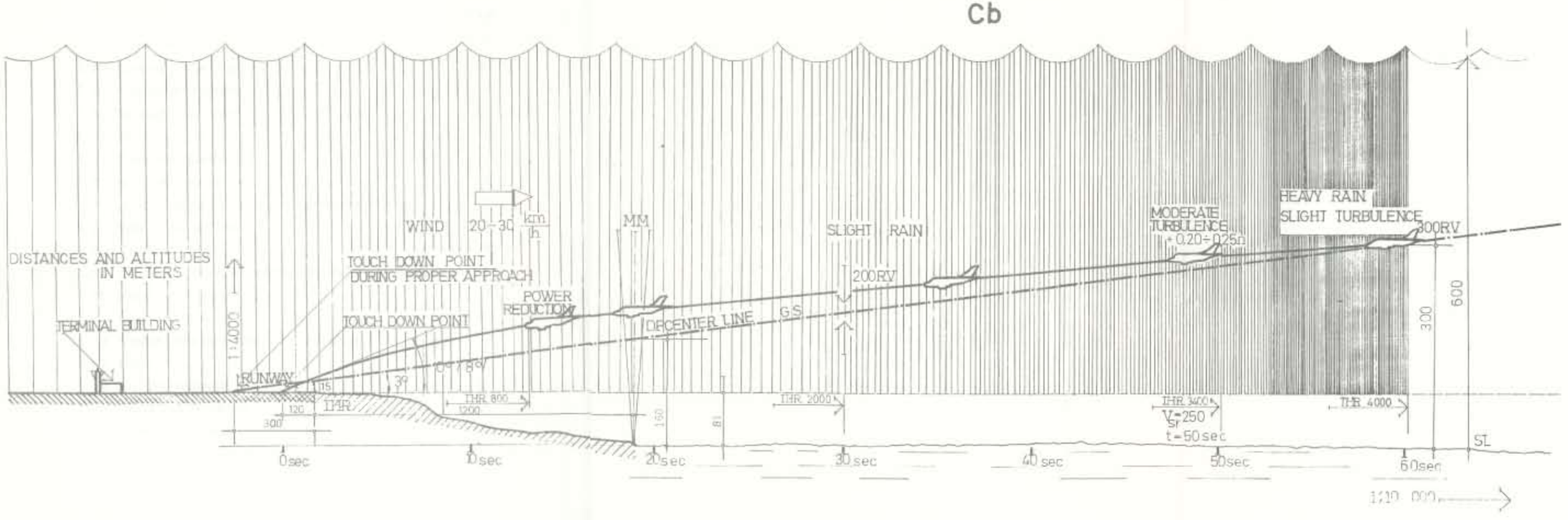
According to the opinion of the Commission this was an exceptional and complex case of many unfavourable circumstances which resulted in this catastrophy.

3. Recommendations

- to conduct a more effective inspection of charter carriers,
- to study with pilots possible illusions that could be encountered during the landing in heavy rain,
- to enlarge the training programmes for captains
- to point out to some modifications on this type of aircraft
- to modernize the training programmes for fire-fighting personnel
- to reconsider meteorological minima at "Rijeka" airport.

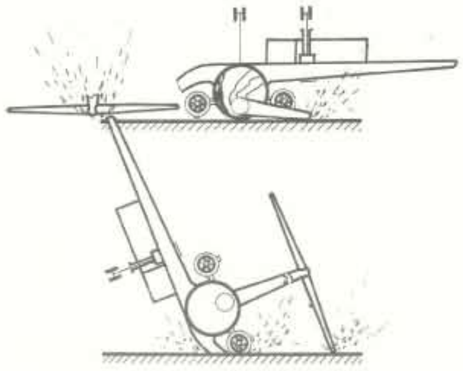
PROBABLE FLIGHT PATH OF THE AIRCRAFT YU-AHZ

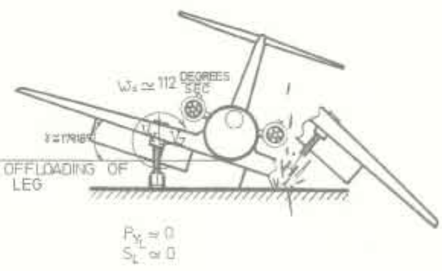
SKETCH No. 1.

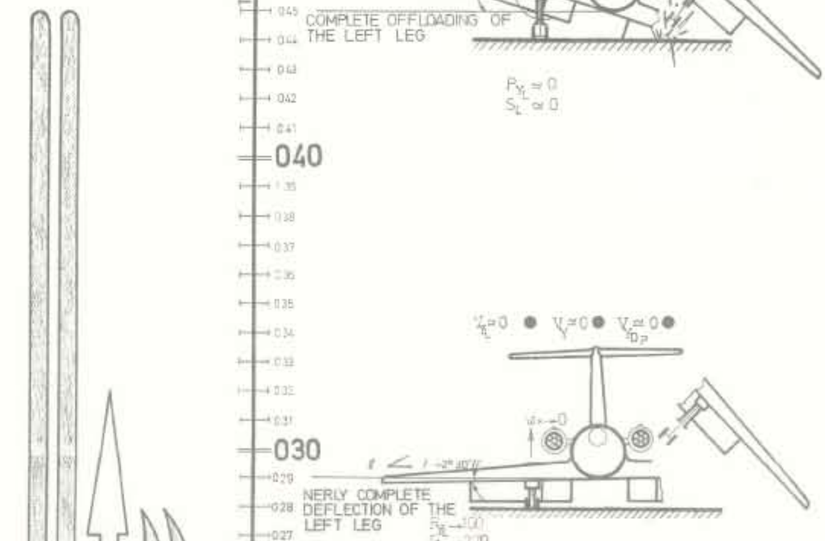


SURVEY OF LOADING AND RUPTURE OF THE AIRCRAFT YU-AHZ

SKETCH No. 2.



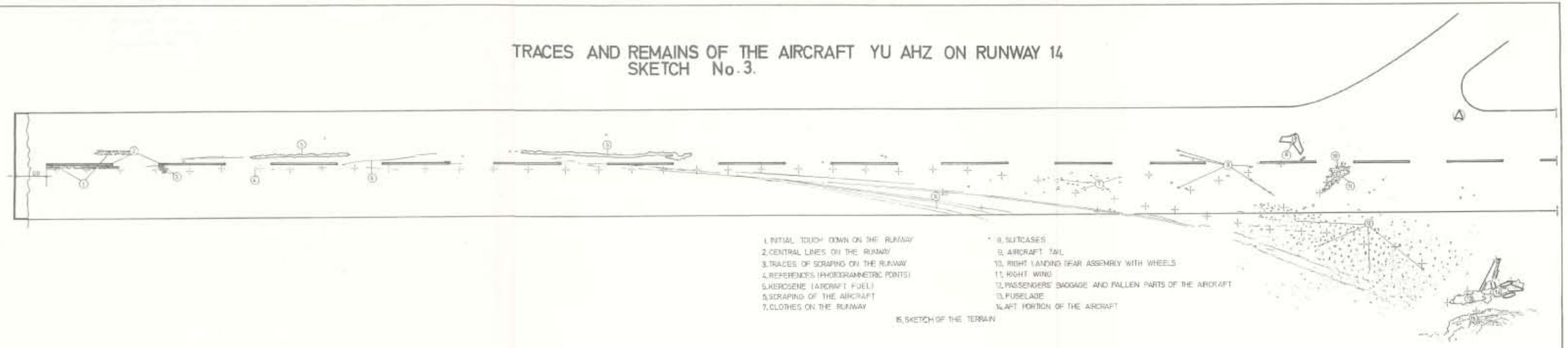




V_{VD} ... VERTICAL SPEED OF THE RIGHT LEG
V_{VL} ... VERTICAL SPEED OF THE LEFT LEG
P_{VL} ... VERTICAL FORCE ON THE LEFT LEG
P_{VD} ... VERTICAL FORCE ON THE RIGHT LEG

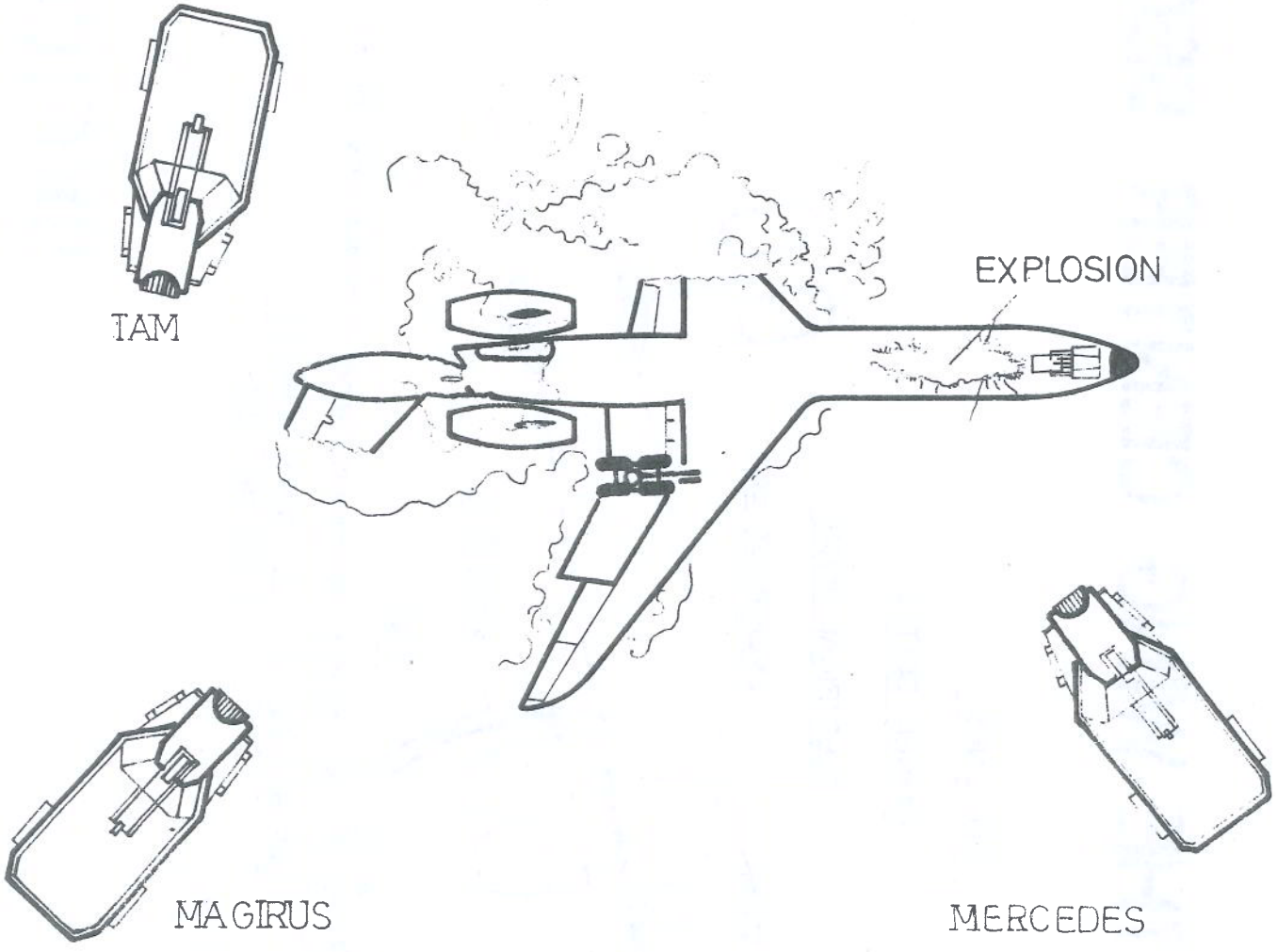
V_V ... VERTICAL SPEED OF THE AIRCRAFT
S_D ... DEFLECTION OF THE RIGHT LEG
S_L ... DEFLECTION OF THE LEFT LEG

TRACES AND REMAINS OF THE AIRCRAFT YU AHZ ON RUNWAY 14
SKETCH No. 3.



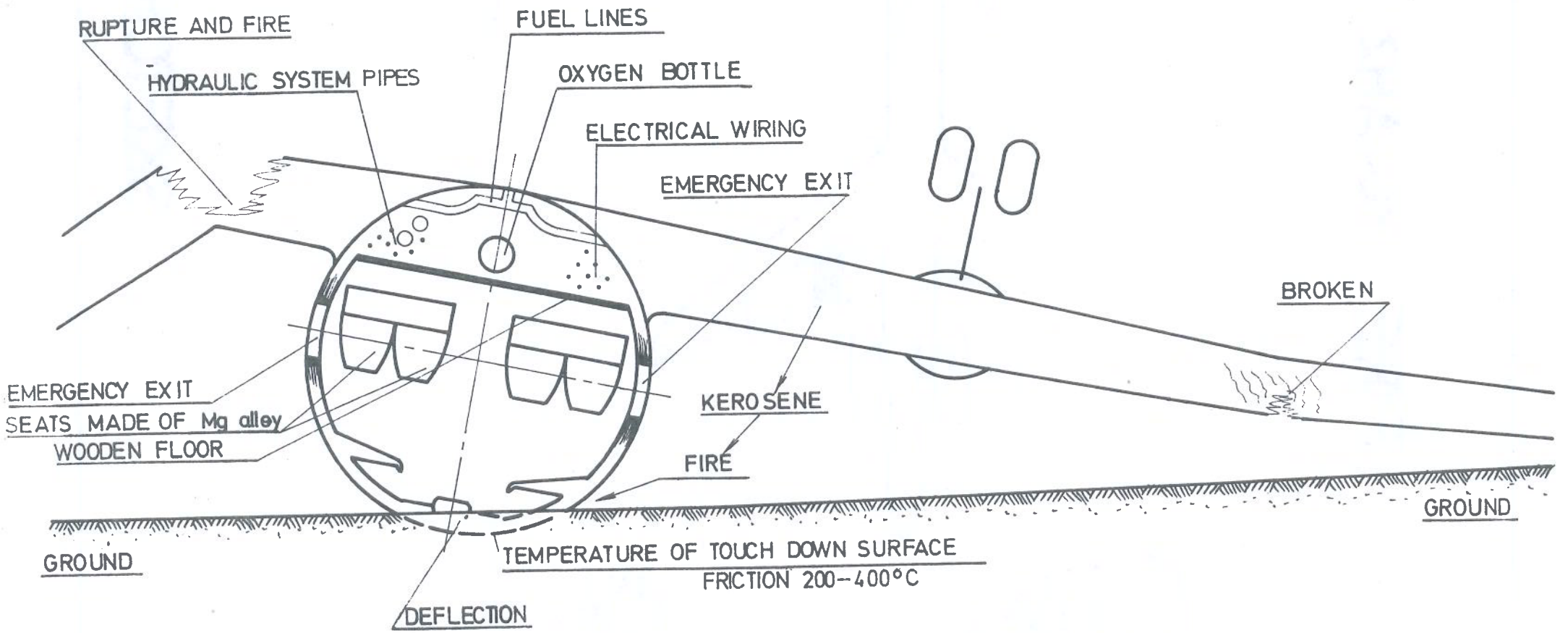
1. INITIAL TOUCH DOWN ON THE RUNWAY
2. CENTRAL LINES ON THE RUNWAY
3. TRACES OF SCRAPING ON THE RUNWAY
4. REFERENCES (PHOTOGRAMMETRIC POINTS)
5. KEROSENE (AIRCRAFT FUEL)
6. SCRAPING OF THE AIRCRAFT
7. CLOTHES ON THE RUNWAY
8. SUITCASES
9. AIRCRAFT TAIL
10. RIGHT LANDING GEAR ASSEMBLY WITH WHEELS
11. RIGHT WING
12. PASSENGERS' BAGGAGE AND FALLEN PARTS OF THE AIRCRAFT
13. FUSELAGE
14. AFT PORTION OF THE AIRCRAFT
15. SKETCH OF THE TERRAIN

FIRE YU-AHZ



SKETCH №4.

PROFILE OF THE WING CENTER SECTION



SKETCH No. 5