No. 10

SABENA (Société Anonyme Belge d'Exploitation de la Navigation Aérienne), DC-6 aircraft, OO-SDB, crashed at Costone dell'Acquasanta, Reatini Mountains, on 13 February 1955. Report by Ministerio Difesa Aeronautica, Italy.

Circumstances

The aircraft departed the Brussels-Haren airport for Rome at 1617 hours Greenwich Mean Time on an IFR flight plan. According to radio communications between the aircraft and the area controls at Zurich, Milan and Rome the flight appears to have been normal. The aircraft was in touch with Rome area control at 1829 hours and the last message from it was received at 1853 hours. At about 1850 GMT the aircraft after overflying the village of Leonessa continued in flight on a heading of 163 degrees until it hit the slope of the Costone dell'Acquasanta at a height of 1 700 metres, after breaking off the tops of trees in a wood in line with the point of impact, near the end of its course. There were no survivors among the 8 crew members and 21 passengers on board.

Investigation and Evidence

The weather situation in general was as follows: anticyclone over the North Atlantic with a large area of low pressure from the Baltic to the Central-Western Mediterranean. The low was over the Gulf of Genoa and extended to the Central Tyrrhenian. In addition, there was a disturbance produced by the influx of cold masses originating in the Atlantic, meeting with pre-existing warm and very humid masses.

At 1800 GMT, the cold front of the above disturbance, which had been detected previously lay along the line from the Strait of Bonifacio to Ortebello and Perugia, and at 2100 GMT, this front must have been on the aircraft's route in the vicinity of Viterbo.

The evidence gathered from the weather charts and from the testimony of the inhabitants of Leonessa (closest inhabited centre to the scene of the crash) indicates that clouds were generally stratified and accompanied by moderate rain and snowfall. Cloud base varied from 400 to 750 metres; cloud top varied from 3 500 to 4 000 metres in the prefrontal zone, but may have been over 5 000 to 5 500 metres (16 500 to 18 100 feet) in the postfrontal zone. No meteorological phenomenon was reported by the stations in Latium and Tuscany or by aircraft in flight, either before or after the time considered. Such an assumption would imply an isolated phenomenon, which is not confirmed by the facts ascertained in situ.

The 0° C isotherm in the prefrontal zone was at 2 200 m (Ciampino sounding at 1400 GMT on 13/2/55) and fell in the postfrontal zone to 1 600 - 1 800 m (Ciampino sounding at 0200 GMT on 14/2/55).

Wind analysis by altitude gives the following table:

	Prefrontal zone (Rome - Viterbo)	Postfrontal zone (Viterbo - Florence)
5,000 ft.	240° - 25 kt.	290° - 25 kt.
10,000 ft.	290° - 35 - 40 kt.	290° - 35 kt.
18,000 ft.	270° - 80 - 85 kt.	280° - 75 - 80 kt.

It should be pointed out that the information and forecasts supplied to the pilot are inferred, as regards high altitude winds, from the observations taken at 0200 GMT on 13/2. The chief meteorologist at the aerodrome of departure hastened to communicate later details on high altitude winds, following receipt of information from a crew which had flown the route in the opposite direction a short time before the departure of the aircraft OO-SDB.

Reports from various sources confirm the presence of strong winds at 75 - 90 knots from the West, stronger than forecast. It may further be assumed that on the Apennine crest, i.e., along the aircraft's route, the velocity of crosswind must have increased by Venturi effect.

Position reports relating to the navigation of a USAF-Navy aircraft, which flew the section of advisory route 512 (Brenner - Padua - Lugo - Viterbo - Civitavecchia) involving the Apennine region north of Rome, at about 1930 GMT, indicate a navigation time of 38 m 30 sec. between Viterbo NDB and Civitavecchia NDB.

Such a value is obviously impossible, in view of the small distance between the NDB's involved (26 nautical miles) and one is led to the conclusion that during navigation over the Apennine section, the aircraft must have encountered an unexpected and very strong wind from the western sector, which carried it far to the East of the [1]advisory route and led to an error (probably not picked up) in position estimation over Viterbo NDB, and that this explains the transit time reported.

This deduction supports the conclusions of an analytical study by the Meteorological Service pointing to the existence of a West-East jet stream which must have influenced the navigation of the aircraft, causing a drift of greater extent than that taken into account by the crew on the basis of the flight plan data.

On the basis of analysis of individual thermodynamic soundings and of the presence of an active frontal system, with thick and extensive cloud, it was concluded that there may have been moderate to severe icing in the area between Florence and Rome, particularly at levels between 2 500 and 5 000 metres.

It is not considered, however, that the navigation of the aircraft was influenced by icing, the more so as there is no corroboration for this view in the reports of other aircraft flying the same route about the time of the accident.

Because the flight log and the radio log were not recovered, the investigation concerning the radio aids used by the aircraft had to be restricted to consideration of the communications exchanged between the aircraft and the ACC's at Zurich, Milano (Linate) and Rome (Ciampino) and to examination of the radio equipment salvaged from the wreckage.

It is apparent from the air-ground communications log that the aircraft regularly sent the prescribed position messages over the various beacons on Swiss and Italian MF's, without reporting difficulty or malfunctioning of the aircraft equipment or complaining of lack of effectiveness of the aids used.

The laboratory investigation on the radio compass points to the conclusion that in all probability the two ADF receivers were set to the radio beacons at Civitavecchia (345 Kc/s) and Rome Town (265 Kc/s), while the radio range receiver was set to the Ciampino radio range (255 Kc/s).

It should be observed that weather conditions were particularly unfavourable for the use of medium frequencies.

This is corroborated by the reports filed by the pilots-in-command of aircraft in flight during the same period, which mention difficulties in reception from radio beacons on medium frequencies.

Difficulty in receiving from radio beacons was later confirmed by the navigation report of the USAF-Navy aircraft previously mentioned and by the inquiry by aircraft OO-SDB itself, at 1848 GMT, as to whether the Viterbo radio beacon was operating at full power.

A few small pieces (crew seat cushions) found burnt near the engines indicate a very limited post-crash fire in the vicinity of the engines.

It may be inferred that the fire fighting equipment was not used

a) because the accident must have been unexpected, and,

b) because some of the CO_2 extinguishers found among the wreckage were still charged.

There were no eyewitnesses to the accident. The location of the accident is uninhabited, inaccessible and invisible from any inhabited place or road within a radius of about 15 km in a straight line. At the time of the accident (1853 GMT) night had already fallen, it was windy and raining and there was no fire visible from a distance.

A large part of the wreckage was discovered in the vicinity of Point A in Figure 7. Many parts and fragments were found near the rocky spur (see Figure 7) and in the meadow, not far from the precipitous slope to the right of the fuselage (viewed from the rear).

The state of the wreckage confirms that all forward and under parts of the aircraft struck the rock face violently; to wit:

Translator's Note: In Italian "assisted route". In Italy there are no advisory areas or routes within the ICAO meaning of the terms. There are "assisted routes and areas" the rules applying thereto differing from those for the advisory service. (See Buiatte, Terminologia Aeronautica, page 2, ICAO Library Ref. 453 B-932).

- the lower portion of the fuselage was split open at about the level of the cabin floor;

- the wing and its appendages were reduced to fragments, some of extremely small size, with the exception of about three metres of the right wing tip discovered near the rocky spur;

- the propeller blades were not twisted, but were nearly all broken off at the hub or reduced to broken fragments which bear witness to an impact at full power.

The fuselage broke up into three parts presumably at the very second of impact upon the slope. The engine cradles were torn from their moorings. In the engines some cylinders were wrenched off, casings cracked and in some cases the reduction gear was torn away and the corresponding cowlings were twisted, fragmentary and widely scattered.

The wings were shattered into small pieces, except near the landing gear, to which portions of the spars remained attached, and except the piece of the right wing tip.

The cockpit suffered greater damage than the rest of the fuselage as it is situated in that part of the aircraft which sustained the first and most violent shock. Nevertheless, the instrument panel was in relatively good condition, with all the instruments in place and some with the glass still intact. Many windows were unbroken and the emergency exits in the usual position as apparently no attempt had been made to use them.

The technical examination of the wreckage and the inspection of the surrounding terrain produced no evidence of any defect in the aircraft before the accident.

Technical examination of the radio equipment gave the following results:

- the ADF receiver was tuned to the frequency of 350 Kc/s (corresponding to the Civitavecchia NDB);

- the ADF receiver was tuned to the frequency of 261 Kc/s (corresponding to Rome Town NDB);

- the RNG receiver control box was tuned to 225 Kc/s (corresponding to Ciampino range).

The VHF units had suffered too much damage to allow identification of the frequencies to which they were set at the time of the crash. However, contact with Ciampino control had been regularly established on 119.3 Mc/s.

A study of the radio messages exchanged between the aircraft and the area controls at Zurich, Milan and Rome brings out the following basic points:

Contact with Zurich control

The operator had no VHF contact with Monaco. At 1715 GMT he sent a radio-telegraphy message over the frequency of 3,481.5/3,478.5 Kc/s giving time of departure from Brussels, destination, estimated time over Strasburg, Rottweil and Trasadingen. He requested that the message be relayed to Monaco, as he had not contacted that station, and requested and obtained from Zurich the Monaco QNH. He later communicated with Frankfurt on the same frequency, and still later, again by direct message to Zurich ACC, reported his position over Rottweil and Trasadingen. He then requested to change to telephony on 119.3 Mc/s. Having changed to direct contact with Zurich control on 119.3 Mc/s, he apologized for having been unable to communicate before because of malfunctioning of the VHF. Contacts remained normal up to 17.49.10 GMT.

Contact with Milan control

Contact between the aircraft and Milan control took place on 3,481.5 and 125.3 Kc/s (the Linate thermoionic recorder was out of order between 1703 and 1819 GMT because of a damaged relay. It was, however, possible to gather from the transcribed tapes that the required position reports over the facilities were made in the proper manner and on schedule as estimated in the flight plan.

Contact with Rome control

Contact with Ciampino ACC was initiated according to plan at 1829 GMT, at which time the aircraft had passed over Florence -- or had so estimated -- at 17 500 feet and had sent Ciampino its estimated time over Viterbo as 1847 GMT. Later the aircraft was cleared to descend over Viterbo, first to 11 500 then to 7 500 feet. At 1847, as noted above, the aircraft should have been over Viterbo and have so reported to Ciampino. Not having received this message, at 1848 Ciampino control asked the aircraft whether it had passed over Viterbo. Instead of answering this question directly, the crew inquired whether the Viterbo NDB

was on full power. Control replied that another aircraft had overflown the Viterbo NDB shortly before and had found it to be operating properly.

At 1851 GMT the aircraft stated that it had passed over Viterbo NDB one minute previously and requested clearance to descend to 5 500 feet; this was granted. One minute later it inquired whether the Ciampino ILS were operating and received an affirmative reply. At 1853, OO-SDB called Rome control but communication was suddenly cut off.

The history of the aircraft supplied by the Belgian government reveals no element which might have contributed to malfunctioning or deficiencies in its operation. Overhauls of the aircraft throughout its lifetime were performed according to the approved procedure. The weight of the aircraft and its load distribution as it appears on the load sheet were in accordance with the certificate of airworthiness. The possibility of any sudden malfunctioning should be excluded as there is no mention of this by the crew in the last message immediately before the impact.

The weather conditions prevailing along the route were such as are well known to cause great disturbance in receiving from radio beacons on medium frequency; but the crew had other resources for communication in HF and VHF, which would have allowed them to determine their exact position at all times, using the corresponding range-finding networks. It was found that this was not done.

In view of the above-mentioned disturbance in MF communications, the aircraft certainly had difficulty in picking up the Viterbo beacon, as shown by the fact that while the estimated time over Viterbo was given as 1847 GMT, at 1848 the aircraft was still asking whether the Viterbo beacon was on full power. The 1851 message, stating that the aircraft had passed over the Viterbo beacon one minute earlier, when compared with the actual position of the aircraft at the time and with the indication found on its radio-compass, leads to the conclusion that the report was based on a polar pick-up of the Civitavecchia beacon. There is, therefore, good reason to assume that the aircraft never was able to pick up the Viterbo beacon.

It is evident from the investigation of the radio equipment that the crew continued the regular approach procedure, since the units were set on Civitavecchia, Rome City and Rome Ciampino for the routine communications required under Ciampino approach procedures.

The inquiry at 1852 GMT by the aircraft as to whether the ILS was in operation indicates that the crew believed it was already able to pick up the ILS, whereas this was in fact precluded by its true position.

It seems strange, in view of the foregoing, that the crew should not have declared an alert but should on the contrary have continued the descent without availing itself of all the other radio facilities by which it might have gained exact knowledge of its true position.

At the time of the flight the Italian aids also included two VOR facilities usable on the route flown -- one in the Milan FIR and one experimental* in the Rome FIR, -- which could have given much assistance in pick-ups and route indications in the Milan and Rome area.

The airborne VOR facility offered no clue as to its setting.

None of the messages from the aircraft gave the impression that the crew were in any doubt as to their position.

The gradual uncontrolled eastward drift may be assumed to have started along the Alpine route, in view of the atmospheric conditions then prevailing, and particularly because of the jet stream previously mentioned.

The message "passed Viterbo beacon one minute ago" sent by the aircraft at 1851 is certainly an error - actually, the aircraft struck the surface at 1853 at a point more than 60 km east of Viterbo on a heading of 163 degrees.

Probable Cause

The probable cause of the accident was that the navigation was conducted without making use of all such radio aids as would have permitted checking, and consequently correcting the drift of the aircraft, whereas the crew actually remained unaware of the drift. In fact, instead of making sure they were over the Viterbo beacon, they merely held that conviction, and therefore the approach procedure to the Rome terminal area (which prescribes overflight of the Viterbo beacon) was erroneously applied.

* inserted at the request of the Belgian authorities.

The following contributing causes may be taken into consideration:

- crosswind to the route stronger than forecast;

- weather conditions particularly unfavourable to radio reception in MF.

Recommendations

Since one of the causes contributing to the accident was the fact that the crew probably used only the medium frequency radio aids, and since reception of the latter may be considerably influenced by weather conditions and night effect, the Commission makes the following recommendations:

a) that the European medium frequency radio beacon network be replaced at the earliest opportunity by a network of radio aids to navigation offering adequate protection at night and in all weather conditions prevailing in Europe;

b) that, for the Rome terminal area in particular, work on the following projects be expedited - relocation of the Lazio VOR facility from Castel Decima (41° 47' 05" N - 12° 28' 10" E) to Monte Razzano (42° 07'25" N - 12° 22'55"E), and installation of a radar watch;

c) that in all cases of difficulty in navigation, crews be strongly urged to have recourse to the protection of the HF and VHF radio range-finding networks, when available.

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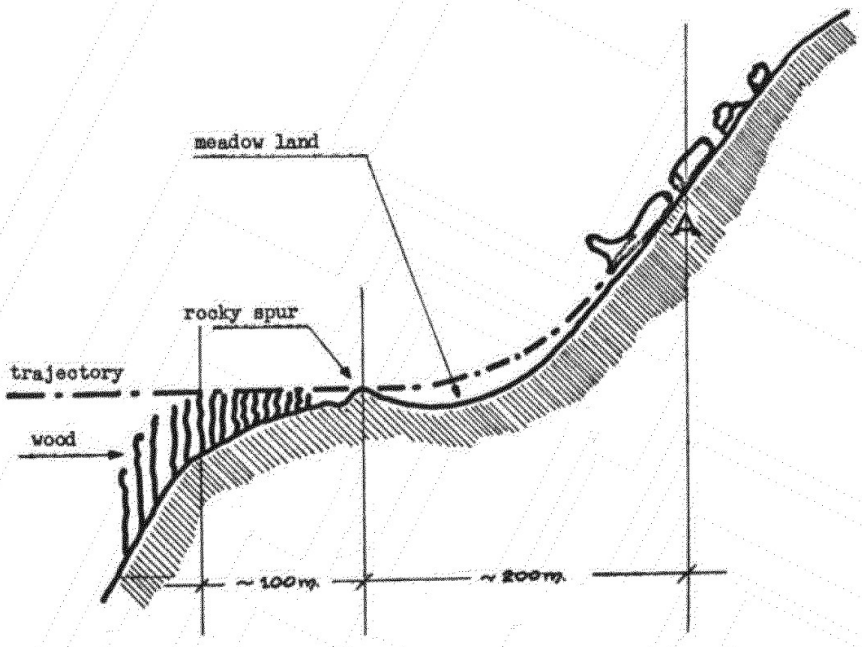

Figure 7
Diagram of territory in which SABENA DC-6 aircraft crashed.
Reatini Mountains

Figure 8
General view of crash area.
Costone dell'Acquasanta, Reatini Mountains.