

No. 2

Boeing 707-300C, D-ABUY accident near Serra Dos Macacos,
Brazil, on 26 July 1979.
Final report released by the Ministry of Aviation, Brazil.

SYNOPSIS

At about 2132 h GMT on 26 July 1979, Lufthansa flight 527, a scheduled cargo flight from Rio de Janeiro to Dakar, crashed into mountainous terrain shortly after take-off. At the time of the accident the crew was following radar vectoring instructions issued by ATC. The accident occurred at night.

All three crew members on board were killed and the aircraft was destroyed.

1. FACTUAL INFORMATION1.1 History of the Flight

Lufthansa Flight 527 was a scheduled international cargo flight from São Paulo to Frankfurt, with stops at Rio de Janeiro and Dakar. The crew, composed of three persons (captain, first officer and flight engineer), boarded in Rio de Janeiro. After a normal start, LH 527 initiated the taxi to Runway 27 at 2105 h ^{1/}, receiving from ground control the en-route clearance and climb procedure No. 16; after changing to tower frequency it received additional instructions to make a right turn after the take-off, heading the Caxias VOR, climbing to and maintaining 2 000 ft. The aircraft took off at 2127 h and the tower gave the departure message confirming the preceding instructions, with no reply from the aircraft because it switched frequency to 120.3 and at 2128 h established contact with Rio approach control. The following messages were then exchanged:

Aircraft: Galeão, LH 527, good evening.

Approach control: 527, Rio, go ahead, LH.

Aircraft: We are passing 15 hundred feet inbound to Caxias.

Approach control: Turn right, heading 040, turning right, heading 040 and maintain 2 thousand feet until further advice, LH 527, and increase your speed, if feasible.

These instructions were followed so that at 2129 h the aircraft was 2.5 NM north-west of the airport at 2 000 ft, heading 040° and increasing its speed progressively up to 304 kt (IAS). At 2131 h when the aircraft was at 10.66 NM from the airport and still maintaining the assigned heading and altitude (040° - 2 000 ft), Rio approach control established the following contact:

^{1/} All times in this report are GMT, unless otherwise indicated.

2131 h:

Approach control: LH, turn right heading 140, just now, over.

Approach control: LH 527, turn right heading 140 and climb without restrictions.

Aircraft: Roger, leaving 2 thousand, LH 527, turning right heading 140.

Approach control: Continue to the right until 160, LH, and increase your rate of climb 3 thousand per minute, over.

After approach control's first call (2131 h) the aircraft initiated a normal change of heading without acknowledgement; after the second call, which was acknowledged, a normal climb was initiated; the third call coincided with the sound of ground proximity warning signal (GPWS) in the cockpit, causing an immediate reaction from the crew, too late, however, to avoid collision with the ground.

The impact occurred at night, around 2132 h, on a heading of 070° at 2 045 ft of altitude, at a position 22°35'S and 43°13'W, in the location called Serra dos Macacos, 13.37 NM from the airport.

The aircraft struck the ground with the underside of the left wing and underside of the fuselage at a speed of 296 kt (IAS) on the south slope of the mountain in a left wing up and nose up attitude, indicating a climbing right turn.

1.2 Injuries to persons

<u>Injuries</u>	<u>Crew</u>	<u>Passengers</u>	<u>Others</u>
Fatal	3	-	-
Non-Fatal	-	-	-
Light/None	-	-	-

1.3 Damage to Aircraft

The aircraft was destroyed.

1.4 Other Damage

The freight was totally destroyed.

1.5 Personnel Information

a) The crew was qualified to carry out the duties entrusted to them and had valid airman certificates. The captain of the aircraft was making his third flight through Rio de Janeiro. The co-pilot was making his tenth flight to or from Rio de Janeiro.

b) All air traffic control personnel on duty in Rio approach control and Galeão tower had the basic training that qualified them to carry out their duties.

1.6 Aircraft Information

a) The aircraft maintenance reports showed that it was properly released for the flight and had been properly maintained in accordance with manufacturer's instructions.

b) The load manifest indicated that the cargo was within the normal limits and that there was no restricted cargo on board.

c) The aircraft was carrying 47 000 kg of fuel (Jet A-1) by the time the taxi was initiated.

1.7 Meteorological Information

GL METAR at the accident time was the following:

SPECI SBGL 2140 200/13 9999 05HZ 2 SC015 6AC073 22/17 1019.

Local witnesses stated that it was drizzling in the area at the time of the accident.

1.8 Aids to Navigation

After the accident a special flight inspection was made, showing that the radar ASR-7 of Rio approach control was operating within international parameters concerning range and accuracy limits, and showing also that the Caxias VOR was in normal operation and maintenance conditions.

1.9 Communications

According to the cockpit voice recorder read-out and the air traffic control tape recording, it was verified that all the communications made were normal and clear.

1.10 Aerodrome Information

Not pertinent to the accident.

1.11 Flight Recorders

Both the flight data recorder and the cockpit voice recorder were recovered with substantial damage to the external protection due to impact; however, the recording medium of both recorders was undamaged. The information obtained through the readout of the tapes was necessary for the precise reconstruction of the sequence of events that culminated in the aircraft crash.

1.12 Wreckage and Impact Information

The crash area was a mountainous region, covered by a tropical forest. The impact point was on a mountainside with a high slope.

At the impact point the aircraft cut some trees with its left wing, gradually increasing the contact surface and culminating to drag the underside of the left wing and the underside of the fuselage on the ground. At that location part of the left wing, No. 1 engine and the tail section were found.

After ground impact, the aircraft continued in a ballistic trajectory, disintegrating on the basic course of 085° until reaching a distance of 800 m, where several aircraft parts were found, such as: the cockpit, fuselage lateral parts, main landing gears, nose landing gear and part of the right wing.

Along that track, on the same general course, several aircraft parts were found including engines No. 2, No. 3 and No. 4 and small structure fragments, as well as the flight engineer's body fastened to his seat.

1.13 Medical and Pathological Information

The autopsy revealed that the crew members' death was caused by the injuries they sustained due to impact forces. There was no evidence of negative influences (drugs, alcohol, etc.) that might have caused physical or mental incapacitation of the crew members.

1.14 Fire

The wreckage area showed evidence of fire which broke out after the impact.

1.15 Survival Aspects

This was a non-survivable accident. It should be noted, however, that the flight engineer's body was found fastened to his seat without any external evidence of severe injuries.

1.16 Tests and Research

Due to the nature of the accident there was no necessity to make any tests regarding the aircraft components. On the morning following the accident, a flight test was conducted using a HS 125 navairs test aircraft that followed the same instructions as were given to LH 527 (heading, altitude and transponder code), which showed that the aircraft had complied with all instructions given by air traffic control.

1.17 Additional Information

The statements of the controllers on duty in approach control and Galeão tower and the readouts of the flight data recorder and cockpit voice recorder brought out the following facts:

- a) the alphanumeric system of approach control No. 1 radar scope was inoperative;
- b) there was a grouping of APP control positions during a period of significant traffic. The job normally done with four radar scopes was being done with only three;
- c) there was a deficiency in internal co-ordination in approach control and between approach control and the tower;
- d) the communications between approach control and Rio de Janeiro tower were being carried out by the departure assistant controller;

- e) use was made of non-standard phraseology;
- f) there was simultaneous vectoring of five aircraft by the departure controller: four in the south sector and one in the north sector of the terminal control area (LH 527);
- g) there was a potential traffic conflict at 2129 h between aircrafts PT-DEL and PT-NDC, in the vicinity of Ilha Raza (IH);
- h) there was traffic (PP-VLY and RG-409) in the Runway 27 take-off sector when air traffic control issued the take-off clearance to LH 527, requiring ATC to impose climb restrictions on LH 527;
- i) there was a significant delay (four minutes) between the time that LH 527 was cleared to No. 3 position and for take-off, and the time it actually took off;
- j) the vectoring instructions given to LH 527 were incomplete because they neither stated the purpose intended by the controller nor provided the required alternate instruction and clearance limits;
- k) the crew of LH 527 received incomplete instructions without requesting any explanation from the departure controller;
- l) having been requested to increase speed, if feasible, LH 527 exceeded the maximum speed (250 kt IAS) established for the Rio terminal control area when below 10 000 ft;
- m) the LH 527 crew had available on board a radar terminal chart, issued by the company, centered on Caxias VOR/DME, aligned to true north, and indicating minimum safe altitudes in the terminal area;
- n) at the time there was not a valid, officially published chart for radar control vectoring showing the relevant minimum safe altitudes within the Rio de Janeiro terminal control area;
- o) there was not at the time an approved IFR approach chart for Runway 27;
- p) the topographical characteristics of the area, in conjunction with the proximity of Galeão and Santos Dumont airports, impose restrictions on all IMC operations in the Rio area.

2. ANALYSIS

There is no evidence that the accident occurred due to failure of the aircraft, its systems, powerplants or flight controls. The aircraft had a valid Certificate of Airworthiness, it had received the maintenance prescribed by the manufacturer, and its dispatch and loading were normal.

The aircraft crew and the ATC controller directly involved were qualified to carry out their duties.

The crew had previously received the weather and flight data necessary for departure. At 2105 h the aircraft initiated the taxi, during which it received the en-route clearance and was assigned climb procedure No. 16; in that phase there were no doubts about the clearance given by air traffic control.

Upon reaching No. 2 position, already on tower frequency (2122 h), LH 527 received instructions to hold position; meanwhile the tower co-ordinator requested approach control (departure) to give the procedure that the aircraft should follow after take-off. The procedure given by approach control was: "After take-off, head CAX VOR and maintain 2 000 feet". In spite of the fact that this procedure was already prescribed in the briefing for all aircraft outbound to the N/NE sector, it was confirmed by the departure controller to avoid conflict with two aircraft, one over Caxias making the approach to SBRJ (PP-VLY) and another in the right down-wind leg to Runway 27 (RG-409).

It should be noted the relative critical positions in which Santos Dumont and Galeão airports are located with conflicting inbound and outbound flight patterns when GL Runway 27 at Galeão is being used and the terminal control area is subject to instrument meteorological conditions.

In conjunction with this situation the terrain conditions in the terminal area dictate that all IFR approaches to SBRJ cross the SBGL area at low altitudes. This requires that all take-offs from Runways 27 and 32 make a compulsory right turn, overflying the north sector of the airport where traffic for landing on Runway 27 normally flows.

To handle this whole situation, approach control demands a precise degree of co-ordination and also imposes restrictions on aircraft taking off from Galeão. Most of the time these are altitude restrictions which are highly inconvenient because soon the aircraft have to climb to avoid the terrain which rises up near the terminal control area centre.

Such a complex situation puts a heavy work-load on the controllers and penalizes both airports' operations.

The departure clearance and the initial climb instructions to LH 527 were issued in an improper manner, showing a poor command of the English language on the part of the tower controller.

The instruction to make a right turn, heading Caxias and maintaining 2 000 ft, was not well understood by the pilot who questioned the tower asking if he should head Caxias and then make a right turn to intercept 093° (heading of climb procedure No. 16). The tower confirmed to LH 527 only that it should head Caxias maintaining 2 000 ft and then he should call departure control (120.3) to continue the climb, thus not clarifying the pilot's doubt.

The exchange of messages between tower and pilot to eliminate doubts about the initial climb procedure originated a delay of four minutes, during which there was a change in the traffic situation that had imposed climb restrictions on LH 527 when the initial clearance was issued. During this four-minute period the traffic situation changed in such a way that there was no more restriction to the aircraft's initial climb and, at the actual take-off time, LH 527 itself was then traffic to RG-409, on final approach to land on Runway 27.

The departure controller was not advised that the traffic situation had changed; therefore, he did not cancel the restrictions to LH 527's initial climb which were no longer necessary. The lack of co-ordination between the tower and approach control is evident. Such co-ordination should have been more precise owing to the difficulty of seeing the radar primary echo (RG-409 had the transponder set at stand-by position) close to the antenna with a radar scope range set to 60 NM.

The aircraft took off at 2127 h and immediately changed to departure control frequency (120.3); the aircraft called approach control as soon as it was possible to do so since the frequency was congested.

At 2128 h LH 527 established contact with departure control, giving its position - heading Caxias VOR crossing 1 500 ft. The controller instructed the aircraft to turn right to 040°, maintaining 2 000 ft until further advice and requested an increase in speed, if feasible.

Technically, the clearance given by the controller (restricting the initial climb to 2 000 ft) would make sense if he had traffic from Caxias to Rio de Janeiro. In the same way, the restriction imposed upon the turn (restricting it until 040°) also would be valid if he had traffic in the right down-wind leg to Runway 27.

In this case, such a situation had existed when LH 527 was cleared to take position and take off, and no longer existed when the aircraft actually took off, due to the delay in initiating the take-off roll as discussed above. This new situation, however, was not communicated to approach control and therefore the aircraft was unnecessarily deviated from the normal climb procedure No. 16.

It should be pointed out that the instructions originated from departure control (heading 040° - 2 000 ft), when necessary from the operational standpoint, are perfectly correct and safe, provided that all radar vectoring requirements be complied with.

The instruction to increase speed issued by the controller was given with the intent that the aircraft should increase speed but should not go beyond the below 10 000 ft speed limitation in the terminal control area (250 kt IAS). As the controller's instruction failed to clarify this intent, the flight crew interpreted the request to indicate that the aircraft was not subject to any speed limitations.

In the case under consideration it should be noted that there were deficiencies in the clearance issued to LH 527, such as:

- a) the pilot was not informed of the reason for radar vectoring;
- b) the pilot was not informed of which procedure he should follow in case of radar or communications failure. This was important if we consider that the vector 040° was leading the aircraft directly into a mountainous region, as the controller was well aware;
- c) the pilot was not informed which speed limits he should comply with.

On the other hand, the following should be pointed out:

- a) Although clearances or instructions in case of radar vectoring should be given in a specific manner, including a clearance limit or alternate instructions to allow for a possible loss of communications or radar coverage, such instructions were not issued by the controller, as required by ICAO regulations; nevertheless LH 527 did not object to these incomplete instructions, even while being maintained at a low altitude, heading into a mountainous area and deviating from departure procedure No. 16.
- b) The aircraft, when requested to increase speed, did so beyond the established limits inside the terminal control area (250 kt below 10 000 ft) by interpreting the instruction to increase speed as an exemption from speed limitations.
- c) The LH 527 crew had available on board a chart issued by the operator with indications of minimum safe altitudes by sectors, for radar vectoring in Rio terminal control area. This chart is centered on VOR/DME Caxias and aligned to true north. The chart gives an idea of the position of the chain of mountains, north of the airport; nevertheless, the behaviour of the crew indicates that they were not conscious of the proximity of danger. Contributing to this may be the limited experience in the area of the captain, who at the time was responsible for monitoring the navigation (it was only the third time that he was flying in the region).

At 2129 h the departure controller told LH 527 that it was in radar contact at 2.5 NM north-west of the airport and repeated the preceding instruction (turn right heading 040^o, maintaining 2 000 ft until further advice), which was acknowledged by the pilot. From that moment, in which LH 527 traffic needed maximum attention from the controller, he had his attention deviated to the south sector of the radar scope, where he was vectoring four other aircraft, two of them (PT-NDC and PT-DEL) in a potential traffic conflict situation requesting his immediate attention. After solving the traffic conflict situation, the controller made contact with two other traffics in the sector (RG-319 and SC-930) issuing unnecessarily long and detailed instructions. It should be noted that the service being made (radar vectoring) requires the controller to take charge of the aircraft navigation (ICAO Doc. 4444-RAC/501/11 - PANS/RAC, Chapter 10, 1.7.2) which requires all his attention. For that reason, it is not recommended that a controller perform radar vectoring of more than four aircraft simultaneously.

It should be pointed out that radar vectoring demands a heavy mental exercise from the controller. He has to compute and integrate rapidly several parameters and items of information, such as: performances, speeds, headings, altitudes, obstacles, weather conditions, heterogeneous traffic, etc.

When the departure controller most needed his assistant to help monitor the traffic, the latter, although in his position, was doing the work that should be done by the final approach control position (point-to-point communications with Rio de Janeiro tower, informing traffic (PP-VLY) making the approach to that airport).

The lack of an effective performance by the assistant departure controller was due to the following facts:

- a) the telephonic communications between approach control and Rio de Janeiro tower, which is the responsibility of the arrival assistant controller, was being made by the assistant departure controller;
- b) the grouping of sectors should not have been ordered, since the failure of No. 1 radar scope's alphanumeric system did not render it unfit for operation, particularly when taking into consideration the great amount of traffic flying in the terminal control area at that time;
- c) the co-ordination of approach control operations was being done by one co-ordinator only, when it should have been done by two of them (arrival co-ordinator and departure co-ordinator).

The deficient supervision at that moment allowed an abnormally heavy workload to be placed on the departure controller. This fact became evident from the following:

- a) the simultaneous vectoring of five aircraft;
- b) the grouping of positions due to the alphanumeric system of No. 1 radar scope being inoperative;
- c) the assistant departure controller performing tasks out of his established area of responsibility;
- d) the deficient co-ordination between the tower and approach control.

At 2130:25 h, LH 527 was crossing 10 NM north of the aerodrome while the departure controller was vectoring another traffic in the south sector of the terminal (lower part of scope).

Between the time when the departure controller established radar contact with the aircraft, already on heading 040° at 2 000 feet and increasing its speed, and the time he issued the instruction for the aircraft to change heading, 1 min 56 s had elapsed, of which 1 min 41 s was without any radio communication between departure control and LH 527.

Upon listening to the transcribed crew conversation from the voice recorder during that period of time (1 min 41 s) we could formulate the following hypothesis:

- a) At 2128:47 h the captain says: "Increase speed he only said".

This statement seemed to indicate that there might have been doubts on the part of the crew as to how much they should increase its speed. At this time the aircraft was passing through 242 kt.

- b) At 2128:55 h one crew member says: "280 ..."

This number (understood among unintelligible words) suggests under the circumstances a reference to speed, and may have been said by the co-pilot, probably asking if that would be the speed to maintain, since the aircraft was crossing 253 kt IAS at the moment.

- c) At 2129:04 h the captain says: "... I am on two now ..."

This phrase suggests a reference to the communications equipment, possibly the No. 2 VHF, which was found set at departure control frequency (120.3).

- d) At 2129:29 h the captain says: "... We are under radar, that means theoretically nothing can happen to us ..."

This phrase, after one minute without contact between LH 527 and departure control, seems to indicate that the captain was not entirely satisfied with the flight progress, probably due to the time elapsed flying on that course and at that altitude, and he was relying on the radar controller as far as terrain clearance was concerned.

Supporting this hypothesis, the following phrases, pronounced by the captain, suggest a consultation of the chart of minimum safe altitudes of the Rio de Janeiro terminal area.

Captain: "2 000 ft".

This altitude (uttered after unintelligible words) suggests that the captain was checking on the chart the minimum safe altitude in the area where they were flying.

Captain: "Well, Caxias is 20/23 miles 2 000 ft and is rising up to 4 000".

This phrase suggests that the captain had verified on the chart that he could fly at 2 000 ft close to 23 NM DME VOR Caxias, where the minimum safe altitude rose to 4 000 ft.

During this quick glance at his chart, the captain obviously believed that the chart was aligned with magnetic north, thereby assuming his course to be 040 degrees magnetic, further right (or south) than he actually was. Not realizing the variation of 19°W, he probably concluded that he was further south, in an area in which the altitude of 2 000 ft would be safe for some time longer.

Possibly the result of such consultation had given the crew the tranquillity showed in the subsequent manoeuvre until the activation of the GPWS.

At 2130:34 h the departure controller turned his attention once more to LH 527, at the moment crossing 10.66 NM, and was surprised by the position of the aircraft beyond the 10 NM range, whereas by his calculation it should be before this point. This had happened, owing to LH 527 having increased its speed beyond the limit (250 kt IAS) which was prescribed in the legislation and which the controller had in mind. Another contributing factor was the wind which at that moment was blowing almost at the aircraft's tail, with an intensity of 13 kt. The controller immediately instructed the aircraft to turn right to a heading of 140°, which was done by LH 527 entering a normal turn, although without acknowledging the message. As he did not receive an answer, after 2 s the controller repeated the instruction for a right turn and added that the aircraft should climb without restriction. At this moment LH 527 acknowledged the message and reported leaving 2 000 ft turning to 140°. Noting the critical situation of the aircraft, the

controller issued another instruction to LH 527, telling it to continue the right turn until 160° and to increase the rate of climb to 3 000 ft min. in an attempt to avoid obstacles. At that time the GPWS sounded in the cockpit and the pilot immediately made an ascending manoeuvre of 3.2 Gs, which however did not avoid the collision with the terrain.

The controller's tone of voice was only slightly upset which in conjunction with the use of the words "just now" instead of "immediately", failed to give the crew an impression of imminent danger. On the other hand, the smooth and calm actuation of the aircraft controls in performing the initial manoeuvre showed that the crew did not have the slightest awareness of the obstacle's proximity.

It should be noted that when the GPWS sounded, the aircraft was already too close to the obstacles for an effective evasive manoeuvre because the terrain rises up sharply at the accident site.

3. CONCLUSIONS

3.1 After analysis of the facts revealed in the present investigation, the Board concluded the following:

- 1) The captain accepted the take-off clearance, although he had not received complete instructions for the entire departure procedure to be followed after take-off.
- 2) The approach control co-ordinator did not advise the departure controller that the aircraft (RG-409) imposing restrictions on the normal profile of standard climb procedure (DEP 16) to LH 527 was no longer traffic for it at the time that the aircraft actually took off.
- 3) The departure controller issued incomplete instructions to LH 527 neither giving any explanation of his reasons for vectoring it, nor giving alternate procedures, nor stating any limitations.
- 4) The crew did not request from departure control any clarifications of the instructions received.
- 5) The captain of LH 527 probably interpreted the instruction to increase speed, if feasible, as an exemption from any speed limitations so that the aircraft exceeded the speed limit of 250 kt IAS prescribed below 10 000 ft within the terminal control area and finally reached approximately 304 kt IAS.
- 6) While LH 527 in the north sector of the radar scope was flying towards mountainous terrain and increasing its speed, the controller was busy vectoring an excessive amount of aircraft in the south sector.
- 7) At the same time that LH 527 was progressing in the north sector, the assistant departure controller was doing tasks that he was not expected to do; therefore, not assisting the departure controller in monitoring the traffic.
- 8) The supervisor on duty failed when he allowed the development of the approach control operation in such a way as to place an undesirably heavy work-load on the departure controller.

- 9) On the basis of a hypothetical assumption, the brief checking of the Radar TMA Chart (published by LH) performed by the captain to verify the aircraft's position could possibly have given the crew a false impression of safety; probably because the captain assumed that his position was further to the right than his actual flight path really was, not realizing the local variation of 19⁰W. Thus he believed that he was flying in an area in which he could proceed safely in that heading and altitude for some time longer. The limited experience of the captain in the area (it was his third flight in the region) may have contributed also to this false impression of safety.

3.2 Probable Causes

Based on the above conclusions, it is clear that there was a breakdown in the team-work of the personnel on duty in Rio approach control at that time.

The departure controller, through incomplete instructions, caused LH 527 to fly for a period of time on a heading and at an altitude that led the aircraft to collision.

The assistant controller, the co-ordinator and the supervisor on duty did not support the departure controller as they should have done.

A contributing factor was that the crew accepted the incomplete ATC instructions (no clearance limit or alternate procedure) and flew during 1 min 41 s without bilateral communications and in a combination of heading, altitude and speed, without being aware of the potential danger inherent in these incomplete instructions.

4. SAFETY RECOMMENDATIONS

- 1) To modify the system of operation from circular areas to sectorial areas (already executed).
- 2) To elaborate and to publish IFR procedure to land on Runway 27 (already executed).
- 3) To elaborate and to publish a Minimum Safe Altitude Chart for radar vectoring in the Rio de Janeiro terminal control area (already executed).
- 4) To utilize, normally, surveillance radar service, performing radar vectoring only in case of operating necessity. Specifically for IFR departure, it is recommended that all aircraft should comply with the prescribed climb pattern with adequate vertical separation from arriving traffic until the aircraft has reached the minimum safe altitude for the sector under consideration.
- 5) To ensure that the controllers assigned to control positions in Galeão tower and approach control have an adequate knowledge of the English language.

- 6) To plan the installation, in all locations where the control utilizes radar equipment, of a system of automatic recording of the radar picture, which would greatly facilitate the work of accident/incident investigation, as well as personnel training. The compulsory nature of such equipment was already discussed at the ICAO Accident Prevention and Investigation Divisional Meeting (1979).
- 7) The controllers should always bear in mind that a delay on the ground is, by all means, preferable to the maintaining of the aircraft at low altitude and with extension of flight path.
- 8) The pilot should always carry out his own navigation, checking all the instructions received, bearing in mind that radar service of any type can become inoperative at any time, and any doubt concerning the instructions received should be immediately clarified.
- 9) All aeronautical charts to be used for air traffic operations in terminal control areas should be aligned with magnetic north.

ICAO Note: Appendices A, B, C, D to the report are not reproduced.

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