

**Aviation Safety Investigation Report
199301823**

**Embraer-Empresa Brasileira de
Aeronautica
Bandeirante
British Aerospace Plc
BAe 146**

20 June 1993

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Occurrence Number: 199301823 **Occurrence Type:** Incident
Location: 76km NW Brisbane
State: QLD **Inv Category:** 3
Date: Sunday 20 June 1993
Time: 1730 hours **Time Zone** EST
Highest Injury Level: None

Aircraft Manufacturer: British Aerospace Plc
Aircraft Model: BAe 146-100
Aircraft Registration: VH-NJY **Serial Number:** E1005
Type of Operation: Air Transport High Capacity Passenger
Damage to Aircraft: Nil
Departure Point: Mackay QLD
Departure Time: 1620 EST
Destination: Brisbane QLD

Crew Details:

Role	Class of Licence	Hours on	
		Type	Hours Total
Pilot-In-Command	ATPL 1st Class	1800.0	4500
Co-Pilot/1st Officer	ATPL 1st Class	980.0	3100

Aircraft Manufacturer: Embraer-Empresa Brasileira de Aeronautica
Aircraft Model: EMB-110P1
Aircraft Registration: VH-XTL **Serial Number:** 110407
Type of Operation: Air Transport Low Capacity Passenger
Damage to Aircraft: Nil
Departure Point: Brisbane QLD
Departure Time: 1713 EST
Destination: Bundaberg QLD

Crew Details:

Role	Class of Licence	Hours on	
		Type	Hours Total
Pilot-In-Command	ATPL 1st Class	2500.0	5587
Co-Pilot/1st Officer	ATPL 1st Class	980.0	4810

Approved for Release: Tuesday, August 6, 1996

FACTUAL INFORMATION

Circumstances

Both aircraft involved in the incident were operating Regular Public Transport flights, under IFR procedures, in controlled airspace to the north of Brisbane. The airspace was under the jurisdiction of the Arrivals North Radar (ARR N (R)) sector located within the Brisbane area approach control centre (AACC). The ARR N (R) sector adjoins Approach/Departures (APP/DEP) at the inner boundary, and control sector 3 (SECT 3) at the outer boundary.

The staffing configuration for the AACC terminal area cell was normal with the ARR N (R) and Arrivals North Procedural (ARR N (P)) operating positions fully staffed. The ARR N (R) controller was an experienced SECT 3 controller nearing completion of rating training at the ARR operating position. He was being supervised by a fully rated ARR N (R &P) training officer. There was also a senior terminal area controller (STAC) and a flow controller (FLOW) overseeing the operation. The FLOW was constantly moving between the enroute and terminal area sectors. All officers in the terminal area cell were appropriately licensed, rated, current and medically fit for the duties being performed.

Route Structure

The normal route structure for northern traffic management is such that outbound jet traffic is processed on published routes via Kilcoy, while non-jet traffic is processed via Maleny, approximately mid-way between Kilcoy and Maroochydore. The published inbound route for both jet and non-jet aircraft is via Maroochydore.

Runways 01 and 14 were in use at Brisbane. This particular runway configuration requires inbound jet traffic from the north to be re-routed and processed via Kilcoy in lieu of Maroochydore. The location and runway configuration of Brisbane airport dictates that all aircraft being processed for runway 01 from the north will over-fly residential areas. Radar vectoring from Kilcoy to a point approximately 5 NM from the runway 01 threshold is required to comply with noise abatement procedures.

Due to a disabled aircraft, runway 01 was not available to high capacity jet aircraft for a short period. Consequently, ARR N workload and traffic complexity increased sharply with the sudden closure of runway 01. This was due to combinations of sudden ad hoc holding requirements, amended (FLOW) arrivals sequencing, amended enroute vectoring and increased co-ordination requirements. There were also parachute jumping operations at Toogoolawah up to FL120. Aircraft that were able to use runway 14 were provided with amended airways processing.

Traffic Processing

Two BAe146 aircraft, with similar aircraft identifications, inbound from the north were being processed for runway 14 arrivals. The first BAe146 was VH-NJZ at FL250 from Rockhampton. The second BAe146 was VH-NJY, inbound from Mackay at FL270 and approximately 10 NM behind VH-NJZ. The FLOW had instructed SECT 3 to vector both VH-NJZ and VH-NJY via the Brisbane 320 radial (320R), the published outbound track for non-jet aircraft via Maleny, and achieve a 15 NM trail for arrival sequencing. This course of action was intended to avoid conflicts with heavy jet aircraft which would have to hold in the vicinity of Kilcoy.

Both VH-NJZ and VH-NJY were radar identified by SECT 3 at 160 NM Brisbane and then co-ordinated with ARR N (R) for tracking via amended routes, in trail, to Brisbane.

In the period immediately preceding the occurrence, there were a number of possible conflicts to be resolved by ARR N (R). The first scenario was a series of conflicts which involved VH-NJR (a BAe146, outbound) which had to be vectored off the published track and between VH-EWA, VH-EWD (both FK28s, inbound via Kilcoy), and VH-ATL (a BE58 outbound via Maleny). The second anticipated conflict concerned the incident aircraft VH-NJY (BAe146, inbound) and VH-XTL (E110, outbound via a non published track on the 331 radial for direct tracking to Bundaberg).

Air Traffic Management

The strategic traffic processing plan stated by the ARR N (R) controllers was to track VH-NJZ direct to runway 14, vector VH-NJY off track then direct to runway 14, behind VH-NJZ and west of VH-XTL. Their plan also included vectoring VH-XTL east of VH-NJY's expected track and vectoring of a third aircraft, VH-MVW, (an SD3-60, inbound via overhead Maroochydore at 9,000 ft) to follow behind VH-NJY.

At the time SECT 3 transferred jurisdiction of VH-NJY to ARR N (R), the required 15 NM trail reference VH-NJZ had not been achieved and SECT 3 had therefore given VH-NJY a shallow vector to track east towards the 335 R.

Shortly after VH-NJY and VH-NJZ contacted ARR N (R) both aircraft were authorised to descend to FL110 respectively. Once satisfied that the desired trail had been established, VH-NJY was instructed to resume own navigation and track direct to Brisbane. VH-NJY did not copy the instruction and requested a repeat. ARR N (R) then instructed VH-NJY to turn right onto a heading of 200 degrees and then diverted his attention to the two aircraft holding adjacent to Kilcoy.

The ARR N (R) controllers strategic plan recognised the possibility of conflicts between VH-NJY and VH-XTL, VH-XTL and VH-MVW and that VH-NJY could not be assigned descent below FL110 until past VH-XTL, who was assigned 10,000 ft.

Shortly after VH-MVW passed overhead Maroochydore descent was requested and 7,000 ft, the standard level assignment for hand-off to APP, was assigned and read back. Immediately after that transmission, ARR N (R) instructed VH-NJY to cancel the last heading, commence tracking direct to Brisbane and assigned descent to 7,000 ft. As the heading and descent instruction was read back, VH-XTL was instructed to turn right onto a heading of 340 degrees and then approximately one minute later the heading was further adjusted to 350 degrees.

The flight crew of VH-NJY thought that the descent instruction to 7,000 ft when at 61 NM and descending through 18,500 ft was given a little earlier than normal, but associated it with the fact that ARR N (R) was busy and that they had been vectored east of track to facilitate their early descent associated with the reduced track distance to run for a runway 14 arrival.

VH-NJZ at 32 NM and descending through 12,000 ft was then instructed to descend to 7,000 ft and contact APP. VH-XTL and VH-MVW were requested to report levels and responded passing 9,500 ft and 7,000 ft respectively. VH-MVW was then instructed to turn right onto a heading of 230 degrees.

Approximately one minute later, when VH-XTL reported maintaining 10,000 ft, there were five aircraft active on the ARR N (R) frequency. VH-NJY was then advised to expect further descent in five miles. The disposition of the five active aircraft at that time was as follows:

- a) VH-XTL (E110, outbound) maintaining 10,000 ft approximately 30 NM north-north-west of Brisbane,
- b) VH-NJY (BAe146, inbound) had vacated FL110 and 10,000 ft at approximately 38 NM and 35 NM north-north-west of Brisbane respectively,
- c) VH-MVW (SD3-60, inbound) had reported vacating 9,000 ft and was approximately 38 NM north-north-west of Brisbane,
- d) VH-CZE (B737, inbound) was just completing the inbound leg of a right hand holding pattern at Kilcoy at FL130 prior to tracking to Brisbane, and
- e) VH-TAJ (B737, inbound) was on descent to FL160 and approaching Kilcoy to enter the holding pattern from the north.

The aircraft symbols for VH-NJY, VH-XTL and VH-MVW were then observed to merge on the radar display. VH-NJY was advised to expect further descent in 5 NM. Approximately one minute later, ARR N (R) instructed VH-NJY to descend to 7,000 ft and contact APP.

Conflict Detection

The flight crew of VH-NJY then advised ARR N (R) that there was another aircraft rather close to them and that they had already been assigned descent to 7,000 ft approximately five minutes earlier. The flight crew of VH-XTL immediately reported sighting and passing VH-NJY. The mutual sightings were enhanced by aircraft lighting displays, particularly VH-NJY's selection of the landing lights during descent transition level checks.

The ARR N (R) controllers did not realise that VH-NJY had been assigned descent below FL110. They were both fully aware that VH-XTL had been assigned and reported maintaining 10,000 ft and had no reason to doubt that vertical separation between VH-XTL, VH-NJY and VH-MVW was not assured. Consequently intended radar conflict avoidance vectoring to facilitate descent for VH-NJY was not applied.

Closest Point of Approach

Radar data recording indicated that the point of closest proximity was approximately 34 NM from the Brisbane VOR on the 336 radial. At the time VH-NJY and VH-XTL were at the same altitude (9,800 ft) their horizontal separation was 4.28 NM. At the time that horizontal separation was at a minimum of 0.78 NM, VH-NJY was 900 ft below VH-XTL. The required separation was 5 NM horizontally and 1,000 ft vertically. Thus there was a breakdown of the prescribed separation standards between VH-NJY and VH-XTL. The pilot in command of VH-XTL reported that he initiated a slight left turn as VH-NJY passed below and to the right.

Operational Errors and/or Omissions

All the relevant radar "shrimp boats" and required flight progress strips for ARR N (R) were provided and correctly located at the time of the occurrence. However, there were omissions of level assignment and confirmation notations on the relevant flight progress strips. One such omission occurred when the ARR N (R) trainee controller assigned VH-NJY descent to 7,000 ft, but failed to record that action or the readback on the appropriate strip.

Neither the trainee ARR N (R) controller nor the training officer could recall that VH-NJY had been assigned 7,000 ft prior to the confliction. Neither officer could recall hearing the assigned level of 7,000 ft correctly read back by VH-NJY.

Previous Skills

The ARR N (R) trainee controller stated that the two radar vectors of ten degrees given to VH-XTL were adequate to facilitate descent of VH-NJZ. However, they were too shallow to achieve the desired lateral track displacement and separation assurance to facilitate VH-NJY's continued descent below FL110. VH-XTL had already been vectored a number of times since departure and vectoring further east would unnecessarily increase track miles and still not provide a lateral radar standard. He believed that he had reverted to his previous SECT 3 practices where only small vectors were required to achieve the desired outcomes whereas arrivals sectors required larger vectors in the order of 40 degrees to achieve rapid results.

Conflict Alerting

The confliction between VH-NJY and VH-XTL was the last traffic management problem to be resolved at the end of a busy period. There was no radar based conflict detection and alerting systems, nor airborne collision avoidance systems fitted to either aircraft, to protect the system against human errors or omissions being undetected and/or uncorrected.

There were no reported equipment problems or deficiencies with any of the relevant operational workstations in the Brisbane AACC SECT 3, ARR, APP/DEP cells which may have contributed to the incident. All aircraft involved in this occurrence were fitted with fully functioning SSR transponders. However, no Mode C altitude readout data is available for radar display to the Brisbane controllers.

Workload and Distractions

Both the ARR N (R) trainee and training officer stated that the workload was very high. It had built up quickly due to the problems created by the temporarily disabled aircraft obstructing runway 01. The controllers stated that the holding requirements imposed the necessity for constant instructions and amended requirements to be injected from the FLOW, and while not unusual in itself, the holding added a level of distraction. The two inbound jet aircraft, VH-CZE and VH-TAJ, had to be processed via unpublished holding patterns at Kilcoy. This required a full description of the pattern direction and requirements for each individual aircraft.

Both controllers had discussed the proposed method of operation at the commencement of the shift. The training controller provided continuous monitoring and support for the trainee by cross-checking and discussion.

The controllers stated that, in their opinion, they had become distracted at a critical time during a period of high workload. Neither controller could remember that descent to 7,000 ft had been assigned to VH-NJY prior to passing VH-XTL. The ARR N (R) controllers reported that they were not suffering from any work related stress or fatigue.

Safety Levels

Flight crews regularly operating into Brisbane stated that arrivals can be severely disrupted whenever Brisbane is busy. There is continual vectoring, level checks/read-backs, variations of high/low speed control, all of which are demanding on controllers and flight crews alike. They did not imply that there was a lacking of skills of the part of controllers, but rather an inadequate system that is incapable of safely and efficiently processing the movements offered during busy periods. The flight crews expressed concerns at the present and future safety of all aircraft operating into what they perceive to be a poorly equipped, busy terminal area.

ANALYSIS

Route structure

The Brisbane AACC route structures and traffic management limitations imposed by combinations of noise abatement requirements, aerodrome location and runway configuration added a level of complication to the controllers' operational environment and standard operating procedures. Traffic cross-over manoeuvres, particularly within the confines of ARR N airspace, is considered to be a fragile operation given the existing facilities and terrestrial navigation aid limitations.

Traffic confliction

The traffic confliction was a basic scenario with two opposite direction aircraft climbing and descending on the same track under radar surveillance. One aircraft, VH-XTL, had just reached cruising level of 10,000 ft and the other, VH-NJY, had unknowingly descended from FL270 through the level of the cruising aircraft.

Traffic management

The procedures and traffic management techniques which were followed preceding this occurrence were considered to have been effective with the exception of VH-NJYs descent instruction to 7,000 ft. The planned processing of VH-XTL and VH-NJY would also have been an acceptable traffic management technique had vertical separation assurance been maintained.

The possibility of controller confusion created by the similar aircraft identifications of VH-ATL (outbound), VH-XTL (outbound), and VH-NJZ (inbound) and VH-NJY (inbound), was examined and rejected. Examination of synchronised radar and voice recorders verified the controllers' stated rejection of the possibility of such confusion. The vectoring of VH-XTL was to provide a conflict free path for the descent of VH-NJZ. But it was insufficient to provide a radar standard clear of a descent flight path of VH-NJY.

Workload

The high workload of the controllers was evidenced in that there were flight progress strip notations omitted and aircraft were given incorrect frequency and holding instruction which had to be corrected. The normal mix of inbound and outbound traffic combined with the re-routing of inbound jet traffic via the outbound jet route at Kilcoy, created an additional level of complexity and aggravated an already high controller workload.

System safety net

The system safety net had been jeopardised by a set of unusual circumstances associated with the runway configuration in use, high workloads, constant vectoring/heading adjustments and traffic holding requirements. Errors and omissions on the flight progress strip notations relating to the assigned levels of VH-NJY deprived both ARR N (R) controllers of vital level assignment and readback confirmations. Consequently neither controller was aware that VH-NJY had already been assigned descent to 7,000 ft and that a readback had been provided. The radar displays in the Brisbane AACC are also considered poor by comparison with facilities at other locations, particularly the display resolution and absence of altitude display data.

The absence of complete and comprehensive radar displays and conflict detection and avoidance systems contributed to a weakening of the safety net. It was not failsafe. It was fortuitous that meteorological conditions were favourable for visual sightings and that the company transition level checks required of VH-NJY's flight crew were conducted correctly and as prescribed.

Descent profiles

Analysis of the descent profiles for both VH-NJY and VH-NJZ verified that VH-NJY and VH-NJZ descended through 10,000 ft at 42 NM and 22 NM from Brisbane respectively. The descent profiles obtained from the radar data were very similar, except that VH-NJY was lower for any given distance. This was considered as supporting evidence that the ARR N(R) trainee had unknowingly assigned VH-NJY descent to 7,000 ft earlier than intended.

Human factors

Both controllers occupying the ARR N (R) position suffered some level of distraction at a critical time when the assignment of 7,000 ft was first given to VH-NJY. There was the potential for considerable distraction arising from inputs by the FLOW controller, holding requirements phraseology, vectoring requirements originating from APP/DEP and SECT 3 and the constant requirement to verify levels due to the Brisbane radar display Mode C limitations.

Degraded performance by the ARR N(R) trainee was manifest by errors such as omissions, queuing, approximations and regression to previous SECT 3 shallow vectoring techniques. There was also some evidence of repetition type error, or responding by reflex and/or habit, such as automatically assigning 7,000 ft to aircraft about to be transferred to APP. This type of error would not be uncommon in any air traffic control system where trainees are being exposed to new job skills. The trainee controller's thought processes addressed the plan to assign further descent to VH-NJY. However, the first, unrecognised assignment of 7,000 ft to VH-NJY at 61 NM was unusual as descent had not been assigned to the preceeding higher aircraft VH-NJZ. This action was considered to have been a repetition type error following immediately after assigning descent to 7,000 ft to VH-MVW.

Evidence indicates that the trainee controller was willing to accept constructive comments as a vital part of his training and of the trainer's back-up role. They were working as an effective team. It is considered probable that as the trainee controller was approaching rating standard, a subconscious delegation of continuous vigilance and monitoring by the training officer may have occurred at a critical time as a direct result of high workload and distractions.

The training officer was reluctant to resume control of the operating position. He later considered and agreed that the trainee was most probably at, or approaching, the limit of his ability for that stage of training. The omission of required flight progress strip entries and corrections to transmitted instructions were valid indicators of the increased workload. However, as the trainee had almost completed the busy period and had been receptive to all advice and comments offered, the training officer elected to continue in a monitoring role. The training officer's judgement that relieving of the trainee at the time would have had a negative effect on his training when rating checks were pending is not challenged. Had the training officer been aware of the first 7,000 ft level assignment to VH-NJY, and the correct readback, his actions may well have been very different and either direct or indirect intervention could have prevented this occurrence.

CONCLUSIONS

Findings

1. The relevant ATS personnel involved in this occurrence were suitably qualified, licensed for the tasks they were performing and fit for duty.
2. The normal staffing configuration for the Brisbane AACC was in place.
3. The existing route structures and traffic management limitations added a level of complexity to the controller's traffic sequencing plans.
4. Brisbane was operating runway 01 and runway 14 configuration with associated holding and delays for arrivals and departures for the respective runways.
5. The mix of inbound and outbound traffic, aircraft types and the processing of inbound jet traffic via the outbound jet route associated with the runway 01 configuration, created a level of complexity which aggravated a very high workload.
6. There were five aircraft on ARR N (R) frequency at the time of the occurrence, three in the immediate vicinity of the occurrence and two in the vicinity of Kilcoy.
7. The controller's strategic plan recognised the possibility of confliction between VH-NJY and VH-XTL.
8. The controllers also recognised that VH-NJY could not be assigned descent below FL110 until more than 5 NM south of VH-XTL.
9. The premature descent instruction to VH-NJY did not result from confusion between the similar aircraft identifications of VH-NJZ (also inbound).

10. There were omissions in the 7,000 ft level assignment notations and readback on the flight progress strips pertaining to VH-NJY.
11. Neither controller could assist in recalling that VH-NJY had been assigned 7,000 ft, nor hearing the assigned level read back.
12. Vertical separation assurance had been presumed and consequently no radar conflict avoidance vectoring was applied to VH-NJY or VH-XTL prior to the aircraft symbols merging on the radar display.
13. The traffic management plan, techniques and procedures for processing the traffic were generally sound, with the exception of the descent instruction to 7,000 ft provided to VH-NJY.
14. There was evidence of degraded performance such as errors, omissions, queuing, approximations and regression with the trainee controller originating from the workload which had placed him at, or near, the limit of his abilities at that time.
15. The training officer did not detect an early descent assignment by the trainee.
16. The absence of Mode C SSR altitude labels on the Brisbane radar displays increases controller vertical separation assurance workload and communications exchanges.
17. There were no terrestrial or airborne conflict detection, alerting and avoidance systems available to enhance system failsafe mechanisms against human errors or omissions.
18. The Brisbane ARR N airspace procedures and practices are considered to be fragile given the existing procedures, facilities and terrestrial navigation aid limitations.

Significant factors

1. The controllers were preoccupied with complex, amended, traffic processing requirements associated with standard operating procedures for Brisbane's traffic management plans.
2. Neither controller was able to maintain a continuous situational awareness of the traffic disposition when operating in such high workload conditions which were exacerbated by omissions in flight progress strip notations.
3. The Brisbane AACC route structures and traffic management limitations imposed higher than optimal demands on the controller's use of existing facilities and terrestrial navigation aids.

SAFETY ACTION

Deficiencies identified during the course of this investigation have been incorporated into Interim Recommendation IR930273 and Recommendation 940091 (resulting from Investigation Report 9302543, and Safety Advisory Notice SAN940154 (resulting from occurrence 9302780)). They will therefore be addressed by those reports.