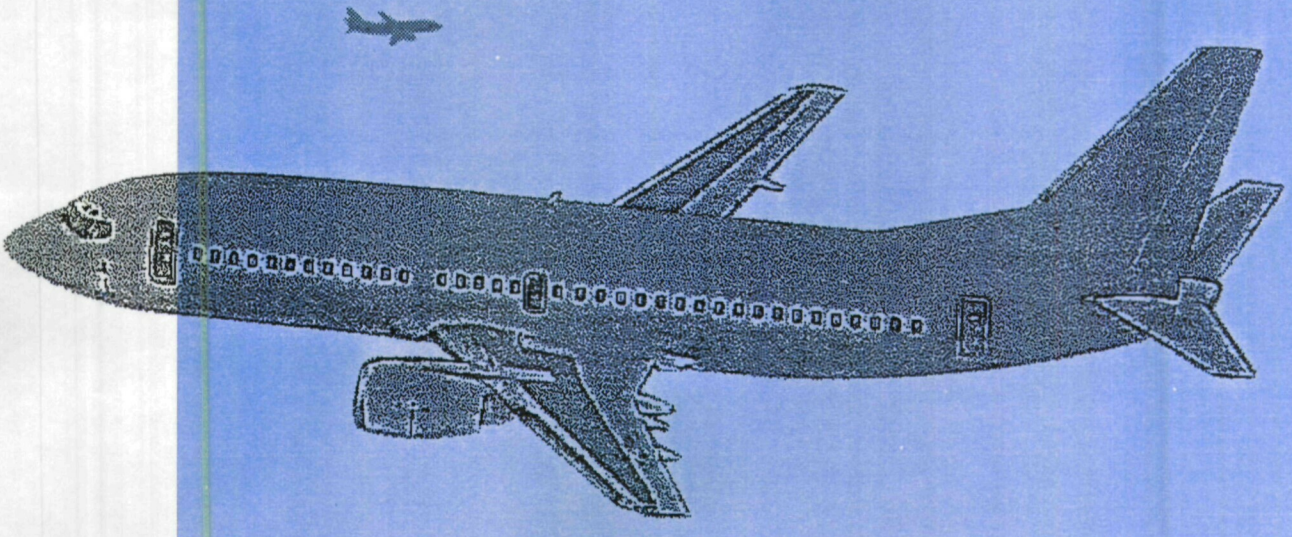
# BUREAU OF AIR SAFETY INVESTIGATION REPORT

**Boeing 737-377 and**
**Boeing 737-376**
**Mt Isa, Queensland**
**1 March 1991**



**BASI Report**
**B/911/3044**

BASI
Bureau of Air Safety Investigation

AUSTRALIA
DEPARTMENT OF Transport

Department of Transport and Communications

Bureau of Air Safety Investigation

INVESTIGATION REPORT
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# Boeing 737-377 VH-CZG
# Boeing 737-376 VH-TJD
# Mount Isa, Queensland
## 1 March 1991

BASI
Bureau of Air Safety Investigation

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## SYNOPSIS

Two aircraft were operating on reciprocal routes between Brisbane and Darwin when the crew of one aircraft became aware that both aircraft were flying at the same level near Mount Isa. The crew initiated avoidance action and clearance for operation at a lower level was given. Each crew saw the other aircraft pass less than 1 min later.


# 1. FACTUAL INFORMATION

## 1.1 History of the flights

On 1 March 1991, two Boeing 737 aircraft were operating Regular Public Transport services on a track between Brisbane and Darwin which passes over Mt Isa, outside radar coverage. Some of the position reporting points along the route known as A464 are Longreach, Swords Range, Mt Isa, Ubdog and Tindal. Swords Range and Ubdog are 150 NM south-east and north-west of Mt Isa respectively.

Boeing 737-377 registered VH-CZG was operating Ansett Australia Flight 2133 from Darwin to Brisbane. A Standard Instrument Flight Rules Flight Plan had been submitted by the crew, indicating that the flight would depart Darwin at 2240 Universal Co-ordinated Time (UTC), [0810 Central Standard Time (CST)] and cruise at flight level (FL) 330. The aircraft departed Darwin at 2245 UTC. Prior to reaching Tindal the pilot requested, and was issued with, a clearance to cruise at FL 350, a non-standard cruising level for flight in a south-easterly direction. Position reports made by the pilot at Tindal and Ubdog indicated that the aircraft was at that level. The aircraft passed Tindal at 2308 hours UTC. The Darwin Sector 1 controller then advised the Brisbane Sector 5 controller of the position report. The flight level of VH-CZG was reported as 'three five zero' by the Darwin controller. The Brisbane console was being operated by a trainee controller, and he was being supervised by a rated controller. Both controllers thought that the level had been given as 'three nine zero' so the trainee read the level back as 'three niner zero', using normal acknowledgment terminology. When the word 'niner' was received in Darwin, a temporary loss of signal clarity occurred. The Darwin controller interpreted the sound as a 'five'. VH-CZG subsequently reported at Ubdog at 0003 UTC to Brisbane Sector 5. The pilot reported that he was maintaining flight level 'three five zero' and expecting to be over Mt Isa at 0024 UTC. At the time of this report the trainee was still operating the console and was being monitored by a second supervising controller. Both supervising controllers had thought that the aircraft was cruising at a level higher than was usual for a Boeing 737 aircraft (i.e. FL 390). However, after discussion with other controllers and in the absence of any knowledge to the contrary, they had accepted that the aircraft could operate at that level (FL 390). The flight strip endorsement of '390' as the cruising level was maintained after the position report.

Boeing 737-376 registered VH-TJD was operating Australian Airlines flight 480 from Brisbane to Darwin. An International Flight Plan was submitted by the crew, indicating that the flight would depart Brisbane at 2210 UTC, [0910 Eastern Summer Time (ESuT)] and cruise at FL 350. The aircraft departed Brisbane at 2221 UTC. The pilot subsequently reported to Brisbane Sector 5 at Longreach and Swords Range, indicating that the aircraft was at FL 350. The aircraft passed Swords Range at 0000 UTC and the pilot reported that he was estimating over Mt Isa at 0020 UTC.

The pilot of VH-CZG was monitoring the Brisbane radio frequency for only a short period before transmitting his Ubdog position report. Consequently, he would not have heard the pilot of VH-TJD report at Swords Range because he was not on that frequency at the time the report was made. However, both aircraft were on the same frequency and within radio range of each other for the Ubdog report.

At 0020 UTC the pilot of VH-TJD reported that his aircraft was overhead Mt Isa at time 20, maintaining FL 350, estimating Ubdog at 0040 UTC. Shortly after this report the pilot of VH-CZG asked for confirmation of the cruising level of VH-TJD. The pilot of VH-TJD confirmed that he was maintaining FL 350, whereupon the pilot of VH-CZG advised that he was also at that level and was turning left as the two aircraft were only about 20 miles apart.

The trainee controller established the cruising level of VH-CZG and the supervising controller issued a clearance for that aircraft to descend to FL 330. Each crew saw the other aircraft as they passed at 0021 UTC. Both flights continued uneventfully to their destinations.

## 1.2 Injuries to persons

No injuries were sustained as a result of this incident.

## 1.3 Damage to aircraft

No damage was sustained by either aircraft.

## 1.4 Other damage

Nil other damage.

## 1.5 Personnel information

### 1.5.1 Flight crews

The captain of VH-CZG was aged 41 years and held a current first class airline transport pilot licence. His last aviation medical examination was in June 1990 and his last proficiency check had been undertaken in the company flight simulator in December 1990. His total flying experience amounted to over 10,000 h, with 2,400 h on B737 aircraft. He had flown 217 h in the 90 days prior to the incident, including 81 h in the previous 30 days.

The first officer of VH-CZG was aged 31 years and held a second class airline transport pilot licence. His last aviation medical examination was in November 1990 and his last proficiency check had been undertaken in the company simulator in February 1991. He had over 4,000 h total flying experience, including 1,100 on the aircraft type. He had flown 116 h in the previous 90 days and 46 h in the previous 30 days.

On the day before the incident both pilots had flown 8 h 55 min on routine duties before having a rest period in Darwin. Neither pilot was suffering from any condition which may have reduced his ability to conduct the flight. There were no other persons on the flight deck during the incident.

The captain of VH-TJD was aged 49 years and held a first class airline transport pilot licence. His last aviation medical examination was in January 1991. He had accrued 9,100 h total flying experience and 400 h on the aircraft type. During the previous 90 days he had flown 243 h, including 70 h in the previous 30 days.

The first officer of VH-TJD was aged 22 years and held a second class airline transport pilot licence. His last aviation medical examination was in February 1991. He had accrued 3,000 h total flying experience, with 380 h on the type. During the previous 90 days he had flown 188 h, including 59 h in the previous 30 days.

Both pilots of VH-TJD had been on duty for 6 h 30 min on the day before the incident, including a flight time of 5 h 30 min. No evidence was found that either pilot was suffering from any condition which may have reduced his ability to conduct the flight.

No other flight crew members were involved in the incident.

### 1.5.2 Air traffic controllers

The air traffic controller at Darwin was an ATC Band 2 and had held a sector rating since 2 February 1991. Prior to moving to Darwin she had been employed as a Perth sector controller for five years. The current sector rating was part of a sequence intended to provide experience in the Darwin airways environment prior to undertaking training in a permanent position. Her last proficiency check had been conducted when obtaining the sector rating and her last aviation medical examination was in July 1990. She had been employed as a controller since June 1982. Her duty shift had commenced at 0600 hours CST on the day of the incident.

The trainee Sector 5 air traffic controller at Brisbane had been working in the position for one week prior to the incident. He held no ATC licences but had previously been employed in Flight Service for eight years. His duty shift had commenced at 0630 hours ESuT on the day of the incident.

The supervising air traffic controller for Brisbane Sector 5 during the time of the Tindal position report co-ordination with Darwin was an ATC Band 1 with en-route sector ratings, both procedural and radar. His last proficiency check had been conducted in September 1990. He had held an ATC licence since July 1986 and his last medical examination had been undertaken in December 1990. On the day of the incident he had commenced duty at 0630 hours ESuT.

The supervising air traffic controller for Brisbane Sector 5 during the time of the Ubdog position report until just after the time of the incident was an ATC Band 1 with en-route sector ratings, both procedural and radar. Her last proficiency check had been conducted in January 1991 and she had held an ATC licence since January 1987. Her last medical examination was undertaken in December 1990. She had also commenced duty at 0630 hours ESuT on the day of the incident, having completed the previous shift at 2030 hours ESuT the previous night.

## 1.6 Aircraft information

Both aircraft involved were serviceable to conduct the flights.

The Boeing 737-300 series aircraft has a maximum operating ceiling of FL 370 due to cabin pressurisation considerations. Generally, FL 350 is the optimum cruising level for the aircraft.

## 1.7 Meteorological information

Bright daylight conditions prevailed during the period of the flights. There was no cloud and visibility was not limited by atmospheric conditions.

## 1.8 Aids to navigation

All electronic navigation aids located at Mt Isa were operating normally at the time of the incident.

## 1.9 Communications

All required and relevant airborne and ground-based aeronautical mobile communications facilities were serviceable at the time of the incident.

The fixed service communications equipment between Brisbane Sector 5 and Darwin Sector 1 was also serviceable. The link between the two centres utilises satellite facilities. No faults in the

satellite communications nets were reported during the incident period. Advice from Civil Aviation Authority (CAA) engineers indicated that the temporary loss of communications quality during the co-ordination of the Tindal position report for VH-CZG probably stemmed from two factors. Firstly, the controller's microphone technique at the Brisbane end was such that, while the word 'niner' was spoken clearly enough for it to be recorded at that location, it was not received at Darwin in a readable form. Secondly, audio levels at the Darwin end of the system were less than optimum, and had been for some time. These factors would not normally have degraded the quality of the co-ordination between Brisbane and Darwin. However, the result in this instance was that the transmission of the word 'niner' from Brisbane when received in Darwin was, for all practical purposes, unreadable.

Background noise in the Area Approach Control Centre (AACC) at Darwin was low. There were no reported distractions to the controller's concentration on communications or thought processes.

In the Brisbane AACC, with a supervising controller at the Brisbane Sector 5 console, noise can be a problem because of the position's proximity to the Flight Data console. The controllers were aware of this and reported that there were no distractions to their duties during the incident sequence. Generally, the Brisbane AACC room is small, considering the number of people required to operate the equipment, especially when training is being conducted at a number of consoles.

## 1.10 Aerodrome information

Not relevant.

## 1.11 Flight recorders

Both aircraft were required to be fitted with serviceable flight recorders and cockpit voice recorders. The recordings were not examined during this investigation.

## 1.12 Wreckage and impact information

Not relevant.

## 1.13 Medical and pathological information

Not relevant.

## 1.14 Fire

Not relevant.

## 1.15 Survival aspects

Not relevant.

## 1.16 Tests and research

### 1.16.1 Standard cruising levels

In 1986, Ratner Associates Inc., from California, USA were commissioned by the then Department of Aviation to review the Australian Air Traffic Services system with regard to its adequacy in preventing collisions between aircraft. The resulting report (*Review of the Air Traffic Services System of Australia* (April 1987)) stated in part:

> A relatively lower degree of prescription and proscription of operating practices and techniques exists in Australia's ATS system than in other modern ATS operations in the world. That is, good operating practices and techniques—specific operational procedures—are specified to a

> greater degree of detail and completeness elsewhere than in Australia. This is evident in the examination of breakdown of separation incidents where an ATS officer's choice of technique and/or phraseology was within the bounds of accepted practice but either was unusual and misunderstood or exposed the operation to a subsequent error that was the proximate cause of the breakdown of separation incident. The use of nonstandard altitudes across sector boundaries on bidirectional airways, without formal and specific local or interfacility agreements, is an example of an operational procedure in use in Australia today that is largely proscribed in other modern systems that have complex airspace and significant traffic levels.

Also, at a later point:

> Some practices in accepted use in Australia today need reexamination in light of today's heavier traffic loads and more complex airspace. The use of nonstandard altitudes to avoid head-on enroute conflict on two-way airways is a case in point. In other advanced ATS systems examined, as traffic and complexity have increased, intersector use of nonstandard altitudes has been proscribed in virtually all situations.

The report subsequently produced a recommendation which stated:

> *Standardise the application of well-defined, consistent, and uniform procedures, practices, and techniques, including further prescription, proscription, and detailed development where appropriate* [italics ours]. Standardisation on a national basis should reduce the occurrence of those breakdown of separation incidents associated with inappropriate or non-fault-tolerant procedures.

In November 1987 the Department advised airways staff of intended amendments of Airways Operation Instructions (AOI) to reinforce the assignment of standard cruising levels in accordance with the tables published in the Aeronautical Information Publication (AIP). Exceptions to the requirement for aircraft to cruise at standard levels were to be permitted for operational reasons affecting flight safety, or on promulgated one-way route structures. Feedback was received from airways staff and, in January 1989, an amendment was issued for effect from April 1989. As a result, controllers were permitted to assign non-standard levels within radar coverage when traffic or other circumstances required. Outside radar coverage, non-standard levels could only be assigned for operational reasons affecting flight safety or as approved by the shift supervisor.

From that time, controllers were unable to assign aircraft non-standard levels outside radar coverage, even if the aircraft was on a one-way route, without the approval of the shift supervisor. This led to a loss of flexibility in handling aircraft and/or an increase in workload involving controllers and supervisors. The supervisors were also expected to make decisions critical to separation outside the normal duties of their position. Co-ordination procedures were not altered.

In August 1989 the instructions were further amended to read: 'Outside radar coverage, levels not conforming to this table may only be assigned for operational reasons affecting the safety of flight, or on one-way routes, or as approved by the shift supervisor.' From December 1989 a further amendment gave additional instructions to assist the shift supervisor. The supervisor was to consider controller workload, alternative measures, co-ordination and the ability to revert to standard levels if required.

From September 1990, the instructions for controllers advised that standard levels should normally be assigned. Prior to assigning a non-standard level the controller was to consider workload implications, co-ordination and the effect on aircraft already at standard levels.

The AIP throughout this period, and for some years earlier, had stipulated that pilots plan in accordance with standard levels.

At the time of the incident and prior to issuing levels to an aircraft, controllers were required to co-ordinate any intention to allocate a level not included in the table of cruising levels. These

requirements were amended as a result of this incident to indicate that a controller was to co-ordinate, prior to issue, any intention to assign a level not in accordance with the table of cruising levels, i.e. any non-standard level.

No failsafe procedures for the assignment of non-standard levels on bi-directional routes, with aircraft operating in opposite directions at the one level, were in place at the time of the incident. Controllers developed their own techniques for highlighting the fact that such a situation existed. For example, some controllers would 'cock' the strips (i.e. make one end protrude over the mounting frame) relating to the two aircraft to remind them something needed to be done. Others would specify a time by which one aircraft must return to a specified level. The AOI contained a separation standard based on time for the situation where two aircraft were approaching each other and a level conflict required resolution.

The aircraft operators involved in this incident are of the opinion that additional attention needs to be drawn to the situation when aircraft are at non-standard levels. They have proposed that the words 'non-standard' be used by both pilots and controllers when reporting or reading back a non-standard level.

## 1.17 Additional information

### 1.17.1 Examination of recorded communications

The recorded air-ground and co-ordination communications for the Brisbane and Darwin ATC centres in the period leading to the incident were examined. These disclosed that the workload for the Brisbane controllers was very light. Significant intervals during which no recorded activity occurred were present. All communications involving the number five were pronounced as 'five' by all parties—air crews and controllers. In general, the number nine was spoken as 'niner' during air-ground communications by all parties, while it was often spoken as 'nine' by the Brisbane controller in co-ordination communications. The one notable exception was when reading back the level of VH-CZG after the Tindal position co-ordination with the Darwin controller. On this occasion the Brisbane controller said 'niner'. However, the complete phrase was not heard clearly in Darwin. This readback was monitored repeatedly by supervisors in Darwin and others involved with the investigation. They were unable to identify the word recorded. However, the controller was satisfied that she had received a valid response to her co-ordination.

### 1.17.2 Aircraft performance data

One pilot involved in the incident considered that his company should advise the CAA of pertinent data relating to the aircraft operated. The information should, for example, include turbulence penetration speeds and maximum operating altitudes. Since December 1980 that information has been available to airways staff in the AOI. The information has not been updated since then, however, and information applicable to the particular aircraft type involved in this incident is not included.

## 2. ANALYSIS

### 2.1 Systems to avoid collisions between aircraft at standard and non-standard levels

The Ratner Report addressed the problem of aircraft at the same level on bi-directional routes. In conditions of low traffic density, there may be reasons for making one level available for bi-directional traffic. For example, in this instance there was no other traffic so the one level could reasonably have been assigned. One aircraft was between Darwin and Tindal and the other was near Taroom, 370 km NW of Brisbane, with over 75 min before they would be expected to pass. However, in conditions of higher traffic density, such use of one level may not be a viable option.

The present system is not failsafe in that no procedures are in place to ensure that aircraft will be separated before an appropriate time or position. If two aircraft are simply assigned the one level, the continued separation of those aircraft relies on communication facilities remaining available.

It should be noted that, in this instance, both FL 350 and FL 390 are non-standard levels for the southbound VH-CZG. There was no conflict consideration by the Brisbane controllers because they regarded both aircraft as being vertically separated. Also, had the aircraft at a non-standard level been reporting levels as 'non-standard', the situation would not have been corrected for the same reason.

The issuing of self-terminating clearances and the reporting of 'non-standard' levels are both considered worthy of further consideration, and are the subjects of recommendations later in this report.

### 2.2 Use of terminology

The controllers at Brisbane misheard the level stated in two position reports—one by the Darwin controller and one by the pilot of VH-CZG. Although using acceptable phraseology while making transmissions, the trainee and supervising controllers were not ensuring that they obtained the correct phraseology from other parties during interchanges. In this case, the other parties did not pronounce the word five in accordance with the instructions. The word was pronounced as 'five' and sounded more like 'nine' than if pronounced correctly as 'fife'. At the same time, the word 'niner', when pronounced correctly, is a two syllable word and is easily distinguishable from 'five' or 'fife'. The controllers were not in the habit of listening for the two-syllable word before writing the figure '9'.

### 2.3 Co-ordination breakdown

There were two aspects to the co-ordination breakdown. One related to the microphone technique of the Brisbane controller and the other to the receipt of information by the Darwin controller. The way that the Brisbane controller spoke into the microphone appeared to degrade the quality of the word 'niner' to the extent that, while it was recorded at Brisbane, it was not of a high enough quality to be received clearly at Darwin. The microphone technique of the controller is considered a factor.

The second aspect is that, while there were no significant problems with the co-ordination communications system, the audio levels at Darwin were less than optimum, and had been for some time. Nevertheless, this did not fully explain the loss of the word 'niner' at the Darwin end. The Darwin controller was expecting the word 'five' as the readback of the level. The transmission of the word 'niner' was interpreted as 'five' by the controller. This was probably due to her expectation to hear 'five' read back. There was no system failsafe mechanism to protect against readback/hearback errors made by any one controller.

## 2.4 Aircraft performance knowledge

The controllers in Brisbane had no clear understanding of the maximum operating level of the Boeing 737 aircraft. Information in the AOIs did not include data for that aircraft type. To use the AOI information correctly, it may be necessary to know the particular model of aircraft involved. This information is not readily available to controllers. The operating controllers had referred the matter to other Brisbane controllers, all of whom had been satisfied that the aircraft could operate at FL 390.

## 2.5 Monitoring of communications by flight crews

The crew of VH-TJD was operating the same radio frequency as VH-CZG when the latter aircraft reported at Ubdog. There were a number of triggers in that position report which should have alerted the crew of VH-TJD to the confliction. These included the same level and position that VH-TJD was to occupy in the next segment of its flight.

In this instance, the only aspect which avoided a potentially far more serious outcome was that the crew of VH-CZG were monitoring communications.

## 3. CONCLUSIONS

### 3.1 Findings

1. All pilots involved were correctly licensed to conduct the operations.
2. Both aircraft were serviceable for the respective flights.
3. All controllers were appropriately licensed and supervisory controllers were rated for the positions they occupied.
4. There were no significant malfunctions in air-ground or intercommunication systems involved in the incident, although CAA technicians reported that the Darwin incoming audio levels were low.
5. Both the supervising controller and the trainee controller at Brisbane misread the cruising level of VH-CZG during co-ordination with Darwin and there was no safety net to protect against readback/hearback errors.
6. The trainee controller's microphone technique resulted in degraded transmission of the word 'niner' during readback of the level.
7. The Darwin controller received a severely degraded transmission of the word 'niner' and accepted it as a satisfactory readback of 'five'.
8. Both the supervising controller and the trainee controller at Brisbane misread the cruising level during the position report from VH-CZG.
9. The crew of VH-TJD did not monitor radio transmissions sufficiently to detect a confliction potential in the position report from VH-CZG.

### 3.2 Significant factors

1. The Brisbane controllers were not demanding usage of correct phraseology in intercommunication transmissions or air-ground transmissions.
2. The trainee controller's microphone technique resulted in degraded transmission of the word 'niner'.
3. Audio levels for the co-ordination communications system in the Darwin AACC were less than optimum.
4. There was no safety net to protect the system against controller failure to obtain a correct readback of a co-ordination exchange.
5. The pilots of VH-TJD failed to adequately monitor transmissions by other stations.

## 4. SAFETY RECOMMENDATIONS

The following recommendations are made as the result of this investigation:

1. That the CAA specify procedures to be followed in the event of the assignment of non-standard levels on bi-directional routes when traffic at the same level is operating in opposite directions.

2. That the CAA take action to remind all users of aviation-related voice communication facilities that all words spoken or received by them conform to the phonetic pronunciation and correct telephony procedures as promulgated in appropriate manuals.

3. That the CAA advise all ATS personnel and technical aircrew of the importance of maintaining continuous situational awareness to guard against facility or human failures or omissions.

4. That the CAA introduce the requirement for an alternative means of supporting voice co-ordination exchanges relating to aircraft operating at non-standard levels in airspace where altitude/flight level information is not provided on electronic displays.

   *Note: During this investigation the CAA acted immediately to remove ambiguity identified in the voice co-ordination section of AOI thus clarifying co-ordination of non-standard levels.*

5. That the CAA enhance controller knowledge of the characteristics and cruise performance limitations of aircraft regularly operating in Australian airspace and examine that knowledge during
   (a) ab initio training,
   (b) on-the-job training, and
   (c) initial rating checks and each subsequent proficiency and performance check.

Considerable discussion during this investigation centred on the desirability of adding the words 'non-standard' during any transmission of a level which was not in accordance with the tables of cruising levels.

It is further recommended that:

6. The CAA consider implementing communications procedural changes which identify aircraft, operating on bi-directional routes, at non-standard cruising levels.

   *Note: ATS within the Brisbane Flight Information Region adopted this practice immediately following this occurrence.*

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