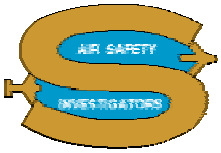

“The Jigsaw of Time in an ATS Investigation”

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10–11 June 2000

Abstract

Late in 1998, the aviation industry in Australia was experiencing major change to airspace and the associated operating procedures, specifically aircraft operating outside controlled airspace on Australia's East coast were participating in a Class G airspace trial.

At 1848 hours Eastern Summer Time on 16 November 1998, approximately 11 km south-west of Williamtown (a joint-user aerodrome for the city of Newcastle) a regional airlines Jetstream aircraft and a military Super King Air passed each other in close proximity. Both aircraft were flying under the IFR and the crews were not aware of the other's presence.

Initial statements by crews from both aircraft suggested that both crews had conformed to the procedures developed for the airspace trial. Those procedures were designed to enhance the safety of flight into and out of non-controlled aerodromes. Subsequent analyses of recorded radar data and various audio-recording tapes revealed why the procedures failed. An outline of the incident is provided, together with an explanation of how the apparently contradictory recorded audio data was pieced together and the puzzle solved.

"The Jigsaw of Time in an ATS Investigation"

A Paper Presented at the Australian and New Zealand Society of Air Safety Investigators

by

Christopher M Sullivan
ATSB
Christchurch, New Zealand
10-11 June 2000

Introduction

Late in 1998, the Civil Aviation Safety Authority (CASA) introduced a Demonstration Class G Airspace trial. During the trial, many incidents were reported to the Bureau, some of which were investigated, the majority being of a less serious nature. As a result of those occurrences, the Bureau undertook a systemic investigation of the Class G airspace demonstration. That investigation was part of the Bureau's normal systems safety investigation role. An interim recommendation (IR980253) was released on 9 December 1998, which recommended that CASA terminate the demonstration. The demonstration was terminated on 13 December 1998 by CASA.

One of the more serious of the incidents investigated, is worthy of more detailed consideration. What were the facts? The factual data included interviews with crews, including details of the preparation and training the crews had received, and the collection and transcription of recorded radar and audio data tapes. The investigation was a joint effort, involving investigators from the Bureau and the Australian Defence Force's Directorate of Flying Safety. Initial indications to the investigation team, were that all of the agencies involved in the incident, that is, both of the aircrafts' flight crews, air traffic control and flightwatch, had conformed to published procedures. Tape transcripts indicated that all of the required calls had been made at the appropriate times. Careful analysis of the data was required to determine why the incident happened.

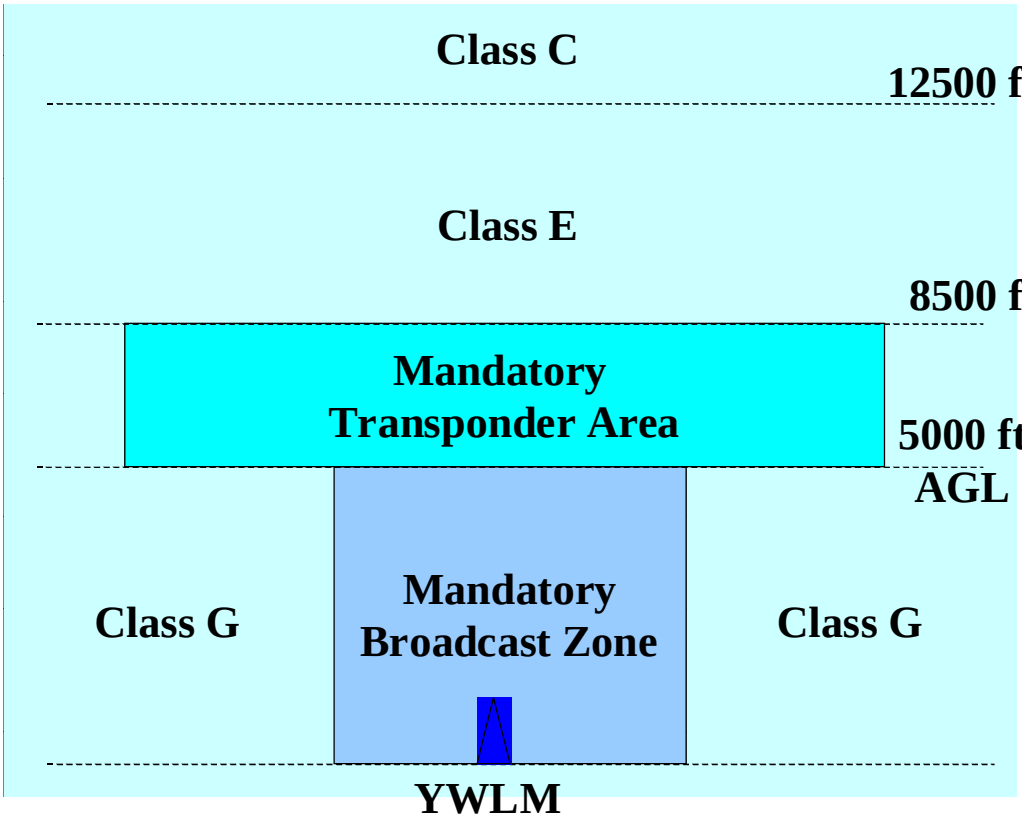
The investigation report is available on the ATSB's Internet website at www.atsb.gov.au. The report, as published, does not show how the analysis of the recorded data was conducted. A lateral thinking approach was used in the analysis, it was not particularly scientific – but it worked.

The Class G Airspace Trial

Before outlining the particular incident, it is useful to understand the airspace environment the crews were operating within. Prior to the airspace trial, IFR category aircraft operating outside controlled airspace were provided with: a directed traffic information service on other conflicting IFR aircraft; a flight information service; and, a SAR monitoring service by a flight service officer. While aircraft (when outside controlled airspace) may have been within radar coverage of ATC radars, a radar service could not be provided because flight service units did not have access

to radar monitors, nor were they trained to provide radar information or advisory services. There was some limited use of radar, ie traffic information was passed to IFR aircraft leaving controlled airspace on other radar observed traffic within 2,000 ft of the base of controlled airspace.

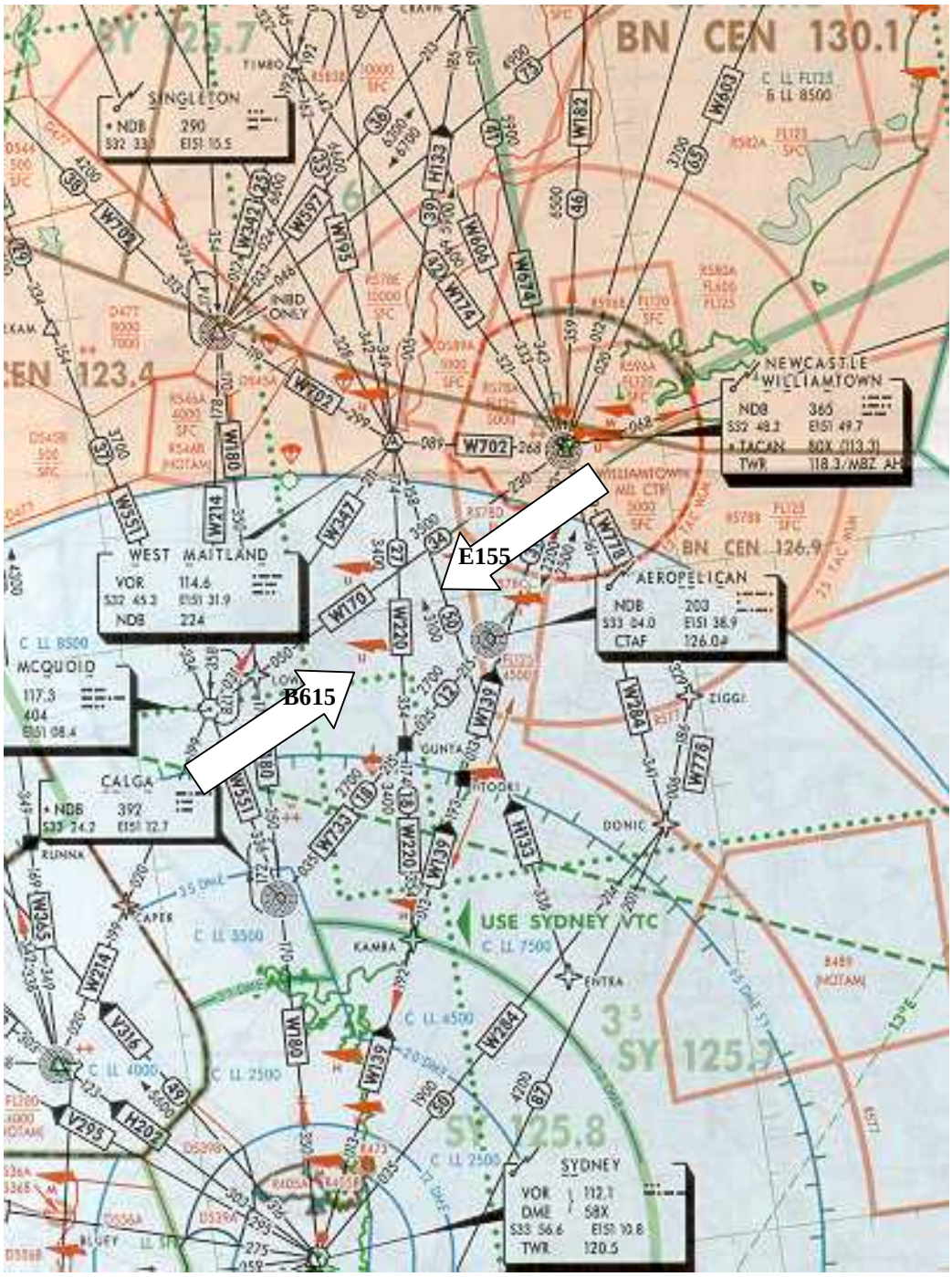
During the Class G airspace trial, the directed traffic information service previously provided by flight service was discontinued and replaced with a National Advisory Frequency (NAF) and, where radar coverage existed, with an ATC provided radar information service. Where practical, radar derived traffic information would be passed to identified IFR category aircraft on known and unknown radar derived traffic. A separation or control service would be provided in higher classes of airspace where appropriate. Flight service officers would continue to provide flight information and SAR monitoring on a discrete Flightwatch frequency. This is a fairly simplistic description of both systems, but is necessary to lay out the background to the incident. The Class G airspace for this incident included the mandatory broadcast zone (MBZ) overlying the Williamtown control zone, the mandatory transponder area overlying the MBZ, and other uncontrolled airspace to the south of Williamtown.



The Incident

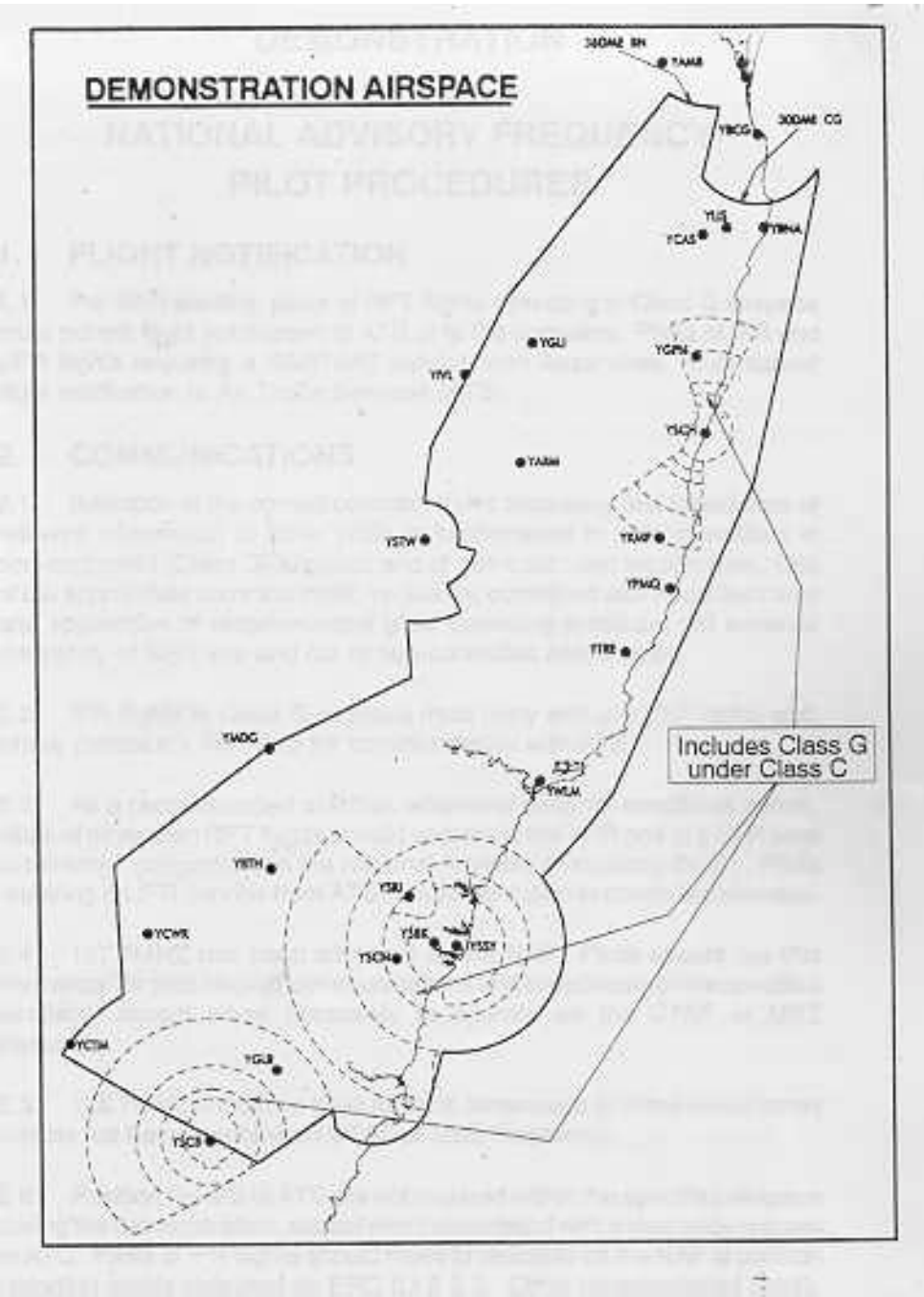
The crew of a British Aerospace Jetstream 31 had flight-planned from Williamtown to Sydney via Mt McQuoid at flight level (FL) 120. The crew of the Beechcraft Super King Air B200, had flight-planned from East Sale (approximately 320 NM south-west of Sydney), to Williamtown via

Mt McQuoid at FL 250. Both aircraft were equipped with dual very high frequency (VHF) radios and Mode C transponders, which were operating at the time.



The routes flown by the two aircraft were within the Class G demonstration airspace detailed in the Aeronautical Information Publication (AIP) Supplement H66/98 of 5 November 1998. The route segment from Williamtown to Mt McQuoid included airspace inside the mandatory broadcast zone for the Williamtown control zone up to and including 5,000 ft. It also included the mandatory transponder area from 5,000 ft to 8,500 ft for a radius of 30 NM centred on

Williamtown, and Class C airspace above 8,500 ft to the south-west. The crew of the King Air was descending on air traffic services route Whisky 170 (W170) on track from Mt McQuoid to Williamtown. W170 was a low-level two-way route. The crew of the Jetstream tracked to intercept W170 to Mt McQuoid after departing from Williamtown and was on climb.



The weather forecast for Williamtown was for 3 octas of stratus at 1,000 ft, 6 octas of cumulus at 1,800 ft and 6 octas of stratocumulus at 2,500 ft. The trend type forecast included moderate turbulence below 5,000 ft from 1800 to 1900 ESuT, and from 1900 to 2100 ESuT the visibility

was expected to reduce to 4,000 m in drizzle with broken cloud at 1,000 ft. The reported weather was consistent with the forecast.

While taxiing at Williamtown, the crew of the Jetstream made "all stations" broadcasts on the national advisory frequency and the mandatory broadcast zone frequency. The crew of the King Air did not hear these transmissions because they had not selected or transferred to those frequencies at that time, nor were they required to. The King Air was established in Class C airspace and the crew was communicating with the air traffic controller located in the Brisbane Centre.

The crew of the King Air selected and monitored the mandatory broadcast zone frequency at approximately 31 NM south-west of Williamtown, when their aircraft was passing approximately FL 150. The crew of the King Air was cleared by Brisbane Centre to leave the control area on descent and informed that control services would terminate passing 8,500 ft. They were also advised that Williamtown was operating on mandatory broadcast zone procedures. The crew acknowledged this transmission.

During this period, the crew of the Jetstream broadcast their departure on the mandatory broadcast zone frequency on their VHF 1 radio. On their VHF 2 radio, they had the Brisbane Control frequency of 126.9 MHz, selected, which they had been monitoring, together with the MBZ frequency, for four minutes prior to departure. The crew of the King Air reported that they did not hear the Jetstream's departure broadcast and were, therefore, unaware of the potential confliction.

Later, the controller asked if the crew of the King Air was still on the control frequency and provided the crew with traffic information regarding a third aircraft, a Beech 1900 inbound to Williamtown from the north that was descending through 6,000 ft. The crew of the King Air acknowledged the traffic information. The King Air was passing 8,700 ft on descent when the traffic information was passed.

Seconds later, the controller saw the Jetstream appear on radar, 3 NM south-west of Williamtown, and unsuccessfully attempted to advise the crew of the King Air with this information. The crew of the Jetstream reported their position to Brisbane Centre advising that they were passing 4,000 ft on climb. The controller instructed the crew to squawk ident, to squawk code 1201, and to maintain 5,000 ft due to inbound traffic. The squawk code and altitude restriction were read back correctly by the Jetstream crew.

The controller again attempted to provide traffic information about the Jetstream to the crew of the King Air, together with an instruction to maintain 6,000 ft. The controller later reported that he was "95% sure" that the King Air crew had read back "maintain 6,000 ft".

Subsequent analysis of the radar data indicated that the Jetstream and the descending King Air passed each other at approximately 18:48.40, with 0.39 NM horizontal separation and 700-800 ft vertical separation. The closing speed of the two aircraft was approximately 420 kts. The crew of the King Air sighted the Jetstream skimming through the cloud tops at 5,000 ft, in their 11-o'clock

low position. The crew of the Jetstream was in instrument meteorological conditions (IMC) and did not sight the King Air.

The incident quickly gained the media's attention, particularly as the trial was controversial with jobs at Airservices Australia under threat. Initial observations were as follows: the controller believed the King Air's crew had ignored the altitude restriction; the Jetstream's crew believed that they had conformed to all procedures and ATC requirements; and, the King Air's crew had assumed either ATC or the Jetstream's crew had made a mistake. CASA was defensive about the G airspace trial procedures and stated that the radar "averted a near tragedy". But what really happened?

national news

THE AUSTRALIAN

BACK

RAAF, Qantas '10 seconds' from crash

By STEVE CREEDY Aviation writer

20nov98

AIR safety officials are investigati
have passed within 100m of a C
opposite direction, and been ar

A Bureau of Air Safety Inves
bureau viewed Monday's in
seriously.

Letter

CASA's response demands a full inquiry

READERS may be sh
heads in disbelief
sponse from

Wires cross on air near-miss

SID MARRIS

AIR safety regulators and the air force are at odds over an incident involving a "near miss" between two aircraft in airspace now under controversial trial procedures.

The stand-off comes as the public aviation service provider, Airservices Australia, warns its 4000-strong workforce that up to one-third of jobs may go in the lead-up to co
ition expected by July 20

Civil Aviation
director Mi
that wh

CASA claim a load of codswallop

THE CLAIM by the Civil Avia
tion Safety Authority that radar
prevented a mid-air collision over
Newcastle (CT, November 21, p.3)
confirms, once and for all, the
lengths it will go to at brainwash-
ing the public into accepting it's
new airspace plan. While radar
might have "saved the day", the
near miss certainly appears to be
much more of a fluke than planned.

To have two aircraft, in cloud,
pass so close (inside the normal

be done by 2000 to complement

CASA says radar trial 'averted near-tragedy'

SYDNEY: Two aircraft which
missed colliding by 10 seconds
above Newcastle would have hit
each other if not for a radar air-
space management trial, Austra-
lia's aviation safety watchdog
said yesterday.

A Civil Aviation Safety Au-
thority spokesman said it was a
quick-thinking air-traffic con-
troller using a trial radar-track-
ing system who averted the
near-tragedy on Monday night.

A Qantas-owned plane carry-
ing 19 passengers and a Royal
Australian Air Force jet carry-
ing two crew passed

had reportedly found the inci-
dent was caused by a misunder-
standing about radio frequencies
and radar coverage.

But the CASA spokesman
said it appeared radar had pre-
vented a catastrophe.

"It's radar that really saved
them," he said. "The operator,
the man who runs the radar on
the ground, saw the potential of
either a collision or a very near
miss and he alerted them. . . . if
they'd been operating under the
old system of talking

The Investigation

Following receipt of the report of the occurrence, the Bureau responded and an investigation team was formed. The team included an ATS investigator from the Bureau, and two RAAF officers from the Directorate of Flying Safety. Evidence was collected and the crews were interviewed. The evidence in an ATS investigation normally includes the radar tape and audio tape, witness statements and documentation, such as flight progress strips, weather information, local orders and instructions, NOTAMs, the relevant sections of the Manual of Air Traffic Services, sections of AIP and legislation.

This investigation was complicated by the circumstances of the G airspace trial, in particular, the use of several radio frequencies. Radar data from the military SURAD radar sensor at Williamtown was not available because it was not recorded. However, radar data was available above 3-4000 ft from the sensor at Mt Boyce, which was recorded in the Airservices Centre at Brisbane. For the audio data, four frequencies were used. The NAF on 127.7 MHz , the MBZ on 118.3 MHz, Control on 126.9 MHz and Flightwatch on 125.7 MHz. The MBZ was recorded at Williamtown, the control frequency in Brisbane, Flightwatch in Sydney and the NAF was not recorded. On initial review of the tapes and the subsequent transcripts, it was not conclusive why the situational awareness of the crews was deficient. Both crews had conformed to procedures and had clearly made their intentions known. It was confirmed however, that the crew of the King Air did not acknowledge the “maintain 6,000 ft” requirement issued by the controller. This was not going to be a straightforward investigation.

Analysis

In most ATS investigations, both aircraft are usually on the same frequency and if they are not, then that of itself becomes a factor. The transcript of the radio transmissions is sequential, and the start of the transmission would be aligned with the time, which is injected onto the tape. An example is as follows:

Time	FROM	TO	Tape Record
02:50:30	SMC	CAR 23	CAR 23 enter runway 21
	Car23	SMC	Car 23 enter 21
50:40	ABC	TOWER	Tower ABC
	TOWER	ABC	ABC Tower, continue approach
	ABC	TOWER	Continue approach ABC
51:05	TOWER	XYZ	XYZ in your overshoot turn right now heading 240
	XYZ	TOWER	Right heading 240 XYZ
51:15	TOWER	EFG	EFG runway 24 clear to land
	EFG	TOWER	Clear to land EFG

If two frequencies are in use, then the initial transcripts are prepared in the same way before the two separate transcripts are woven together, using time to put the transmissions in the appropriate places. Obviously, there are occasions where two transmissions may overlap. With this investigation, four frequencies were in use, three of which were recorded. The unrecorded NAF transmissions were not an issue as there was no requirement for either aircraft to use the frequency. The transmissions made on the NAF by the crew of the Jetstream were well before the aircraft taxied.

Accordingly, the transcripts from the three other audiotapes were consolidated into the one transcript, but the resulting transcript didn't make sense initially. Although the tapes are all injected with UTC time, a variation was identified in the clocks associated with the different recorders. The Williamtown clock was 15 seconds behind Brisbane's, and Sydney's clock was three seconds faster. The transcript was adjusted to the correct timings and synchronised to the radar plots, which made much more sense. The implications of the transcript however, were still difficult to analyse because of the overlapping transmissions. An example of a portion of the transcript is below.

43.33	MBZ	JHC	MBZ	JHC turning base grass left 30
44.30	ATC	BN	UNK	(Coord with UNK agency ref KDQ)
45.38	ATC	B615	BN	B615 is approaching FL 110
45.41	ATC	BN	B615	B615 leave controlled area on descent, area QNH 1013, control services terminate passing eight thousand five hundred, WLM is MBZ procedures at the moment.
45.42	MBZ	JHC	MBZ	JHC turning base grass left runway 30
45.48	MBZ	E155	MBZ	Williamtown MBZ Eastern 155 airborne off runway 12 we're making a right turn now to set course tracking out to the south west on climb to flight level 120
45.54	ATC	B615	BN	Ahhh, leaving on descent 1013 QNH and will contact MBZ on 118.3, B615
46.00	MBZ	JHC	MBZ	Helicopter JHC . . . (unreadable)
46.05	ATC	BN	B615	B615, roger passing eight thousand five hundred, correction, approaching five thousand, radar procedures are terminated, squawk code 2000, frequency change approved.

For example, at 45.41 air traffic had started a transmission with Beaufort 615, but it was not clear where it ended. The crews had stated during interview that they had not heard certain transmissions, where the transcripts clearly indicated that they were on frequency at the time those critical transmissions were made. A new approach was required to determine not only what was said, but what was heard using a medium that was easily understandable.

A New Approach

The transcript clearly showed where a transmission started, but it didn't show where it ended and hence, where two transmissions overlapped. The method used was to create an Excel spreadsheet

using one-second intervals for each column. The rows were used for each relevant agency transmitting or coordinating with each other.

7:45:38	7:45:39	7:45:40	7:45:41	7:45:42	7:45:43	7:45:44	7:45:45	7:45:46	7:45:47
E155									
B615									
BN Centre									
FS4									
JHC									

The transmission made by the relevant agency was inserted in the appropriate row, starting the sentence in the column where the transmission started, and ending in the column at the time the transmission ended. The fonts were changed to ensure the sentence (transmission) started and finished in the correct columns; a transmission that was delivered slowly had a larger font, than would a rapidly delivered transmission that had to be fitted into a shorter time period.

7:45:38	7:45:39	7:45:40	7:45:41	7:45:42	7:45:43	7:45:44	7:45:45	7:45:46	7:45:47
Beaufort 615 is approaching flight level one one zero									
			Beaufort 615, leave controlled area on descent, area QNH one zero one three, control serv						
					Juliet Hotel Charlie turning base grass left runway three zero				

The process was extended to indicate on the spreadsheet, the radar derived altitudes of the Jetstream and the King Air as they approached, and then passed each other. An example is shown at Annex A. Although this was not a scientific approach that was dealing with micro-seconds, it enabled the team to analyse the data. With the radar and audio data presented in this way, it was easy to see what had happened. In particular, the unanswered questions of the investigation were explained as follows.

The Crew of the King Air did not hear the Jetstream crew's taxi broadcast on the mandatory broadcast zone frequency because they were not yet on that frequency at the time.

The crew of the King Air did not hear the transmissions made on the Brisbane control frequency by the air traffic controller that provided essential traffic information regarding the Jetstream because of an over-transmission on the control frequency believed to be made by MYD.

The controller attempted to pass traffic to the King Air within 3 seconds of the Jetstream appearing on radar.

The crew of the Jetstream did not hear the King Air crew's inbound broadcast on the mandatory broadcast zone frequency because Brisbane control was issuing the airways clearance to the crew of Jetstream at the time.

The crew of the King Air did not hear the transmissions made on the Brisbane control frequency that instructed them to maintain 6,000 ft because the King Air crew was transmitting on the MBZ frequency at the beginning of the transmission. Also, there was an over-transmission at the end of it.

The data recorded by air traffic control enabled the investigation team to solve a complex air safety incident that occurred outside controlled airspace. Airspace, that in normal circumstances would not be provided with recorded data or where limited data would be available.

Conclusion

Recorded audio information in air traffic control provides a record of what was said and what time it was said. Where radar coverage exists, recorded radar information provides a three-dimensional record of aircraft positional information. In some situations, such as the one described, this recorded information must be pieced together with crew reports and lateral thinking to solve the puzzle. In the future, there will be fewer variables as technology continues to develop. Already, on the new TAAATS equipment and the military ADATS equipment, time injection will be synchronised from the atomic clock that feeds into the GPS network. The quality of recordings is improving. Recording tapes are smaller and contain greater amounts of data. However, there is still no machine that can analyse the data, so investigators continue to need to be trained in this new technology. The aim of the ATSB is to maintain and improve transport safety. This is achieved through excellence in no blame independent transport accident, incident and safety deficiency investigations.

References:

Air Safety Occurrence Report 199805078, (1998). *British Aerospace Plc Jetstream Beech Aircraft Corp Super King Air 16 November 1998*. Canberra, Australia: Commonwealth Department of Transport and Regional Services.

7:48:01	7:48:02	7:48:03	7:48:04	7:48:05	7:48:06	7:48:07	7:48:08	7:48:09	7:48:10	7:48:11	7:48:12	7:48:13	7:48:14
							Two in together						
outbound, I'll have him identified shortly, maintain six thousand, you'll pass in 3 to 4 miles													
Traffic in the Williamtown MBZ, Alpha Foxtrot Romeo, Beech nineteen hundred IFR is now one two DME to the North on descent through five thousand five hundred, circuit area at time five													
													MYD maintaining