

Department of Transport and Communications

Bureau of Air Safety Investigation

# **Violations of Controlled Airspace Special Study**

RESEARCH PROJECT

RP/92/10

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## ABBREVIATIONS

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AIC	Aeronautical Information Circular
AIP	Aeronautical Information Publication
AMATS	Airspace Management and Air Traffic Services
ATC	Air Traffic Control(ler)
ATS	Air Traffic Services
BASI	Bureau of Air Safety Investigation
CAA	Civil Aviation Authority
CAIR	Confidential Aviation Incident Reporting
CTA	Control Area
CTAF	Common Traffic Advisory Frequency
CTR	Control Zone
ERSA	Enroute Supplement Australia
FS	Flight Service
IFR	Instrument Flight Rules
MTAF	Mandatory Traffic Advisory Frequency
NOTAM	Notice to Airmen
OCTA	Outside Controlled Airspace
RAS	Radar Advisory Service
RPT	Regular Public Transport
SR&S	Safety Regulation and Standards
VCA	Violation of Controlled Airspace
VFR	Visual Flight Rules
VHF	Very High Frequency
VTC	Visual Terminal Chart

## EXECUTIVE SUMMARY

In late 1992 the Bureau of Air Safety Investigation (BASI) noted a large increase in violations of controlled airspace (VCAs). Whereas in most of 1991, there had been around 25 such incidents per month, in December 1991 there were 42 of these incidents and throughout 1992 BASI received an increasing number of VCA notifications. The increase in VCAs was of particular concern as it may have reflected difficulties with the implementation of the Airspace Management and Air Traffic Services (AMATS) changes to Australian airspace. A VCA is a serious incident because of the risk of a collision between the intruder and an aircraft under air traffic control (ATC).

BASI saw a need to examine VCAs in order to understand why they occur and why they had increased in frequency. The Bureau consequently surveyed incidents throughout 1991-1992, and investigated in depth 92 VCA incidents occurring within a seven-week period in August-September 1992. In addition, the BASI project team sought comments from the relevant areas of the Civil Aviation Authority (CAA). A computer-based questionnaire was also used to examine pilot awareness of airspace procedures.

The data for 1991-1992 indicated that three-quarters of the VCA incidents involved visual flight rules (VFR) flights and in most cases, the flight was classed as private. Control areas (CTAs) were violated more often than control zones (CTRs) by a ratio of two to one. The incidents occurred in all states and mainland territories.

In the seven-week study period it was found that the two most commonly attributed factors responsible for VCAs were a failure of aircrew to follow standard procedures and pilot navigation errors. It was apparent that many pilots were not aware of AMATS procedures for entry into controlled airspace, partly because they had not taken full advantage of CAA safety publicity material. BASI considers that the presentation of information on charts can be improved, particularly on the Visual Terminal Chart (VTC), the most commonly used chart. A small number of pilots reported that they were not using any charts on the incident flight.

Given that most incident pilots did not request an airways clearance before violating controlled airspace, it is surprising that more than half of the pilots who were contacted believed that they understood the new airways clearance request procedures. Furthermore, approximately half of the pilots stated that they knew and understood the airspace arrangements, although others admitted that they did not understand the new procedures.

The investigations, the pilot questionnaire responses and subsequent discussions with pilots, controllers and other CAA personnel, highlighted the following system problems:

- A significant proportion of pilots are confused by charts.
- Many private pilots do not subscribe to a document amendment service and hence may not have access to up-to-date information or charts.
- The CAA has not evaluated the AMATS pilot education program which ceased in December 1991.

- The publicity which accompanied the changes to the airspace system may not have reached all target groups.

The removal of (Flight Service) FS monitoring and reminder functions and changed flight planning requirements for VFR pilots, removed a defence from the airways system. As a result, FS no longer remind VFR aircraft when they are approaching controlled airspace; nor do they co-ordinate a clearance with ATC. It appears that many VFR pilots have not adjusted to flying without FS monitoring.

A summary of the recommendations to the CAA from this study are as follows:

1. Evaluate the pilot education program, with particular emphasis on VFR, private operations.
2. Improve pilot access to operational documents.
3. Identify and establish methods to improve the protection of controlled airspace.
4. Ensure that pilots clearly understand the responsibility for unauthorised flights to remain outside controlled airspace.
5. Review the criteria used for displaying symbols and operational information on aeronautical charts, with particular emphasis on the VTC.

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## **1. INTRODUCTION**

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### **1.1 BASI trend monitoring**

BASI maintains a computer database of Air Traffic Services (ATS) incidents which enables the Bureau to monitor trends. This report was initiated in response to an upward trend in VCAs which became apparent in 1992.

VCAs are a significant threat to safety because each intruder aircraft occupies a level and position which could be assigned by ATC to an authorised aircraft.

### **1.2 Controlled and restricted airspace in Australia**

CTRs envelop controlled aerodromes and extend from the surface to the lower limit of the overlying CTA. In addition to the primary CTRs servicing major city airports, general aviation CTRs are provided at specific general aviation airports. Military CTRs operate in a similar way to civil primary CTRs.

CTAs link major destinations around the country and ensure that aircraft flying on major regular public transport (RPT) routes are separated from uncontrolled traffic. A significant feature of most CTAs are the steps which descend to meet underlying CTRs.

Restricted airspace is imposed by a controlling authority, such as the military, in which flight is restricted in accordance with specified conditions. The times of active operation of restricted airspace are listed in the Enroute Supplement Australia (ERSA) or are published via Notices to Airmen (NOTAMs). Restricted airspace is normally available to civil aircraft outside these times.

### **1.3 Changes to airspace management**

The CAA introduced major changes to the airspace management system on 12 December 1991. The AMATS changes were the first in a four-year period of staged changes towards the Australian Advanced Air Traffic System.

The AMATS changes were aimed at reducing industry costs and aligning Australian airspace, procedures and practices with the International Civil Aviation Organisation. The CAA planned to introduce the AMATS changes progressively at approximately six-monthly intervals commencing on 12 December 1991.

AMATS changed the way VFR flights entered controlled airspace. Up to December 1991, a pilot wishing to fly into controlled airspace on a VFR flight was required to lodge a flight plan before departure. Entry into controlled airspace would generally be made via a VFR approach point. FS monitored the progress of the flight and would co-ordinate a clearance with ATC as the aircraft approached controlled airspace. If a clearance was not available, FS would advise the pilot to remain outside controlled airspace.

Other pilots, while not planning to enter controlled airspace, often took advantage of full position reporting and the pre-flight briefing service provided by FS. The progress of the flight was monitored by FS, and the pilot would be reminded to remain clear of controlled airspace if it seemed to FS that the aircraft might infringe controlled airspace.

After December 1991, VFR flights could request a clearance direct from ATC, without the need for a flight plan. In addition, full reporting was no longer available for VFR flights and as a consequence VFR pilots no longer had the option of lodging a flight plan or receiving a

face-to face pre-flight briefing from FS. With the withdrawal of full reporting, FS ceased to monitor VFR flights and no longer reminded VFR pilots when they were approaching controlled airspace. The pilot briefing offices previously performed a number of functions such as pre-flight checking, validating, and acceptance of flight plans, as well as direct and indirect pilot education.

The AMATS changes also introduced radar advisory services (RASs). During August 1991, industry was notified of the intention to demonstrate RAS at Adelaide and Melbourne. The demonstration was conducted between late 1991 and February 1992. The RAS was then progressively implemented around the Cairns, Coolangatta, Melbourne, Adelaide and Perth terminal areas.

On 30 April 1992, the CAA issued *Aeronautical Information Circular (AIC) H9/92*, outlining a number of early problems identified from the initial changes of 12 December 1991. One of the problems addressed in that AIC was that there had 'been a number of instances where VFR pilots had entered controlled airspace without first obtaining a clearance'.

### **1.3.1 Pilot education**

Prior to the introduction of AMATS, the CAA conducted extensive pilot and staff education programs addressing the proposed changes. The program included seminars, videos and printed material. A BASI evaluation of the AMATS introduction and education programs concluded that printed material had been the most effective medium (BASI *AMATS report* (unpublished)). The education program came to an end once the initial AMATS changes were implemented in December 1991 and was not the subject of a CAA evaluation. (In October 1992 the CAA announced that it would re-commence the pilot education program (*Aviation Bulletin* October 1992).)

### **1.3.2 Previous studies**

BASI and the CAA have each undertaken both separate, and jointly sponsored, evaluations of the Australian ATS system. Although these studies have dealt with VCAs, they were directed at a wide range of ATS issues.

### **1.3.3 Ratner and Associates Inc.**

The largest and most recent such study was the 1992 report prepared by Ratner and Associates Inc. of the USA. Jointly initiated and funded by BASI and the CAA, this report looked at all aspects of the ATS system in Australia. It considered a large number of safety issues and recognised airspace incursions (violations) as a major problem:

A considerable number of operational incidents in Australia involve airspace incursions, instances where an aircraft enters controlled airspace without an ATC clearance. Most incursions are inadvertent and are committed by both experienced and inexperienced pilots. Radio navigation aids are scarce, and the VFR charts in areas where these incursions happen, around Sydney in particular, are difficult to interpret in terms of prominent urban terrain features. Often the uncontrolled airspace is wedged narrowly between controlled airspace regions, making navigation more difficult in any event. Thus airspace design, operational knowledge and airmanship, navigational aids and VFR charting all seem to be components of the problem. There is also some evidence of intended-entry type incursions probably due to pilot misunderstanding of the changed procedure for obtaining in-flight clearances to enter controlled airspace (*Expanded summary of the 1992 review of the Australian ATS system*, p. 8).



Ratner made a number of suggestions to address the problem of VCAs, including improved charts, further pilot education and airspace redesign. Ratner also addressed the new responsibilities which pilots would have to meet under the new airspace system:

...we are convinced that these changes can be accommodated without increased hazard of collision between aircraft, given one important assumption: the aviation community, general aviation and RPT, light plane pilots and jet captains, will accept their increased responsibilities for exercising the higher levels of airmanship required. This involves maintaining knowledge of and compliance with altitude regimes, airspace boundaries and clearance procedures; effective radio dialogue procedures for exchanging traffic information OCTA [outside controlled airspace], especially in MTAF/CTAF [mandatory traffic advisory frequency/common traffic advisory frequency] areas; and the techniques and limitations of see-and-avoid visual separation.

This is a most important assumption, and one that must be watched closely, to ensure that operating economics are not inadvertently put ahead of safety. We are particularly concerned that a relatively small number of noncompliant operators, especially general aviation operators OCTA, could increase collision risk for all operators in this airspace. The airspace and operational procedure changes were designed with the assumption of a high degree of compliance, and this assumption demands an enhanced degree of surveillance until proven (*Report of the 1992 review of the Australian Air Traffic Services system* p. ES-2)

#### **1.3.4 BASI incident investigations**

BASI incident investigations and special studies have raised a number of issues related to the VCA problem. Previous BASI investigations identified CTR penetrations as a significant problem. It was recommended that VFR flights be planned via more readily identifiable ground features, that a RAS be introduced adjacent to primary CTRs and that pilots have access to video briefing facilities to view safety promotion videos (BASI Investigations B/862/3200, B/872/3029, B/902/3396). The CAA has subsequently begun the implementation of RAS but has not acted on the other recommendations.

A BASI review of the AMATS changes of 1991 included in-depth investigation of AMATS-related occurrences, a pilot survey, and monitoring of Confidential Aviation Incident Reporting (CAIR) reports. This study identified VCAs as a major problem. Of 147 AMATS occurrences studied in the report, 62 involved violations of controlled or restricted airspace. It was found that in most cases, the pilot failed to follow the published procedures for entry into controlled airspace. The great majority of these incidents involved penetrations of CTA (48), with a relatively small number of penetrations of CTRs (8) and restricted areas (6). Pilots who replied to the questionnaire indicated that more education was needed about the AMATS airspace changes (BASI *AMATS report* (unpublished)).

#### **1.3.5 Overseas experience**

VCAs are a continuing problem in other countries. For example, in the USA, attention has focused on this issue over a number of years.

The pattern of violations over the three-year period 1985–1987 within the USA was found to be dominated by general aviation operators. The percentage of those involved in reported airspace violations had grown from 67 in 1985 to 77 in 1986 and then to 80 in 1987.

Of the known pilot certificate types involved, pilots with private certificates had the highest proportion of controlled airspace violations in all three years.

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## **2. OBJECTIVES**

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The objectives of this study were to:

- (a) identify trends and patterns in VCAs in Australia;
- (b) identify, where possible, the underlying causal factors behind VCAs; and
- (c) make broad recommendations to correct any deficiencies identified during the study.

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### 3. METHOD

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Information was collected from four main sources:

- (1) The broad background to the problem was examined with the aid of data spanning two years on the BASI ATS database. Incident trends over a two-year period were examined and the VCA problem was broadly defined in terms of the flight category involved, the incidence of violations for various regions, the airspace involved and ATS controlling agency locations.
- (2) Detailed information was gathered by investigating each VCA during the seven weeks from 13 August to 30 September 1992. In each BASI field office, an investigator was assigned to examine all VCA occurrences in that region. Where possible, both the ATS officer and the pilot involved were contacted by the investigator. For each occurrence, the investigator was provided with a special data form which listed over 100 data fields to assist the investigation. Some of the data collected was quantitative, (e.g. altitude of the aircraft at the time of the incident and distance travelled before detection), while other data was of a qualitative nature, (e.g. pilot understanding of airspace procedures and suggestions for VCA prevention from ATS officers and pilots).
- (3) A small-scale survey of pilots was conducted at the Avalon Air Show from 21–25 October 1992. The computer-based questionnaire was set up as part of the BASI display and pilots were invited to answer questions related to the Mackay VTC. Given various flight scenarios, pilots were asked about the procedures they would follow, including where they would call for a clearance to enter controlled airspace. The Mackay VTC was used as it was felt that most pilots at Avalon would be unfamiliar with the area, and the intention was to test knowledge of procedures and airspace requirements rather than familiarity with a particular region.
- (4) Managers and operational field officers from the CAA's ATS and Safety Regulation and Standards (SR&S) Divisions were invited to provide BASI with submissions.

## 4. RESULTS AND DISCUSSION

### 4.1 ATS database trends and patterns

Figure 1 indicates that VCAs have been reported at an increasing rate in the 10 months since December 1991, coincident with the first stage of the AMATS changes outlined in chapter 1. There was a marked increase in July 1992, coincident with the closure of face-to-face pilot briefing offices. Violations peaked in October 1992 with 100 reported occurrences.

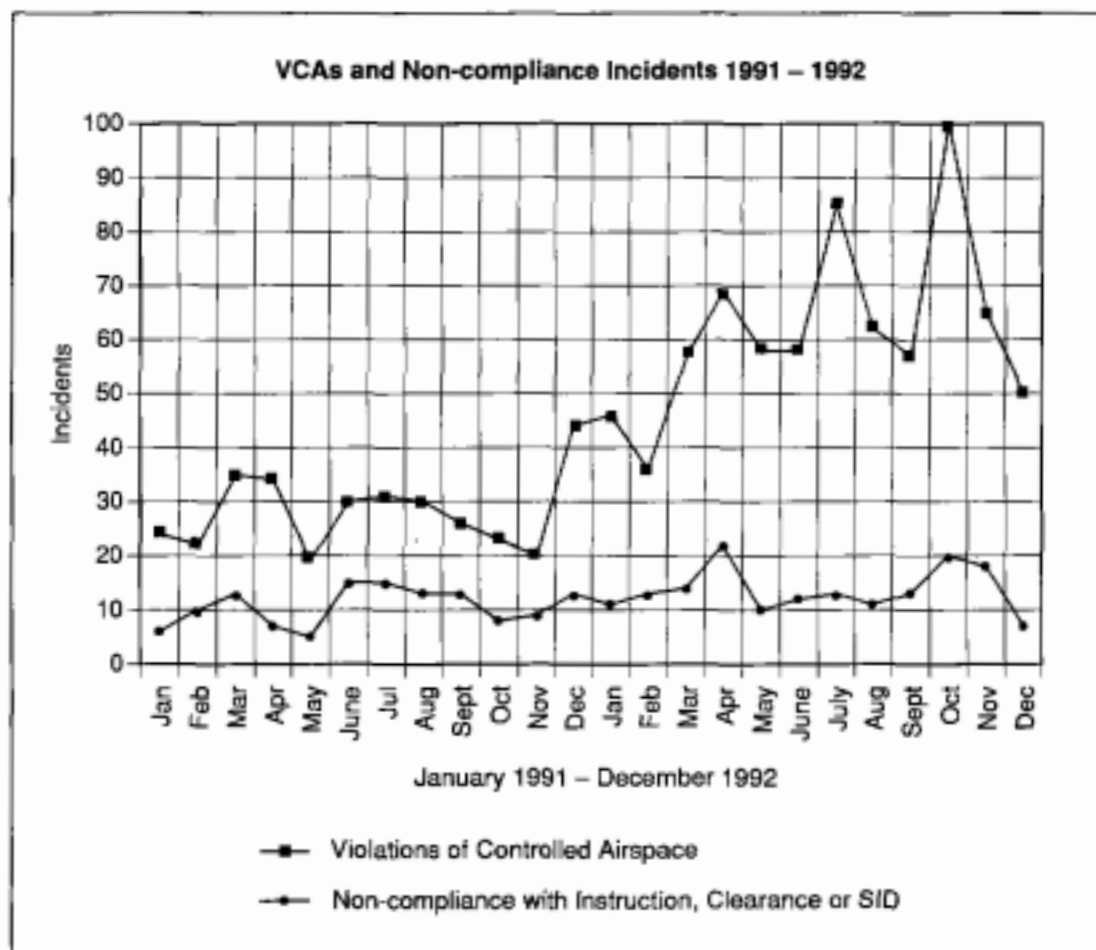


Figure 1

The increase in reported VCA incidents possibly reflects a general increase in the reporting of all ATS incidents by ATS officers. To check this possibility, the reporting of three other types of ATS-related incidents was examined for the two-year period 1991-92. Non-compliance with ATS instructions, non-compliance with clearance and non-compliance with Standard Instrument Departure procedures are incidents in controlled airspace which would not have been affected by the AMATS changes. The frequencies of these incidents were summed for each month in the two-year period. As can be seen from figure 1, these incidents were reported at a relatively constant rate throughout these two years. Therefore it was concluded that the increase in VCA reports did not reflect a general increase in reporting of ATS incidents.

Figure 2 indicates that a relatively large number of VCAs occurred in 1992, compared with the preceding five-year period 1987-1991. The previous highest level of such incidents occurred in 1989 and may have been associated with industrial disputes within the aviation industry.



Figure 2

Figure 3 illustrates that there has been an increase in reported VCAs involving both instrument flight rules (IFR) and VFR flights since the end of 1991; however, the increase in VFR occurrences is particularly large.

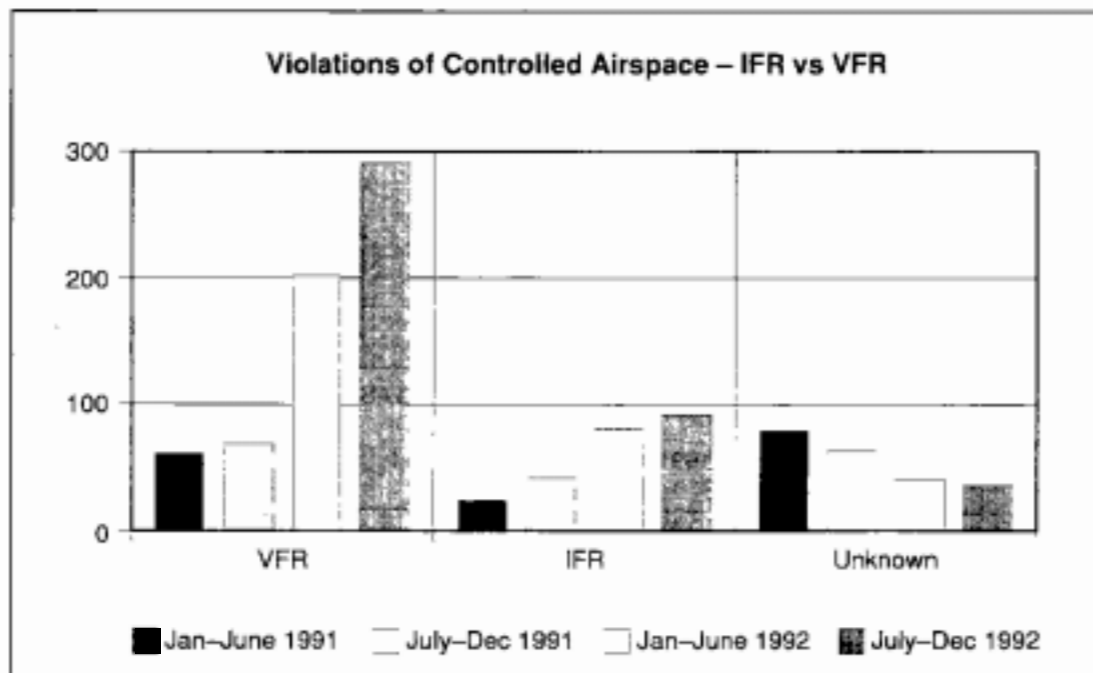


Figure 3

Figure 4 indicates that the increase in VCA occurrences noted in 1992 was particularly apparent in controlled areas, which includes associated steps, but was also noted to a lesser extent in CTRs and restricted airspace. In this period, there were approximately two penetrations of CTA for every penetration of a CTR.

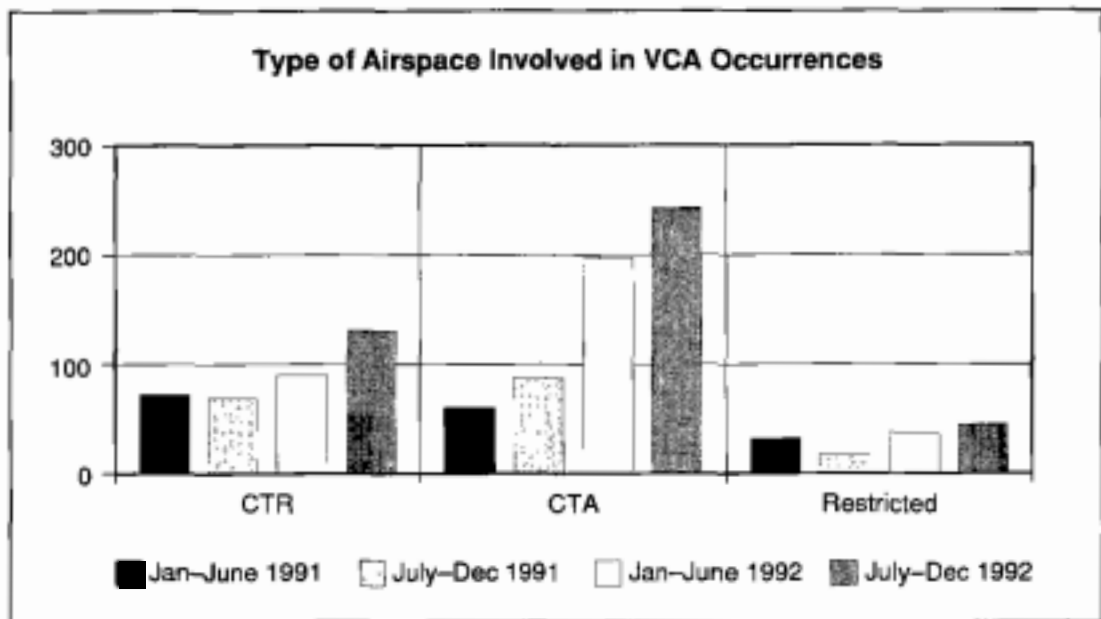


Figure 4

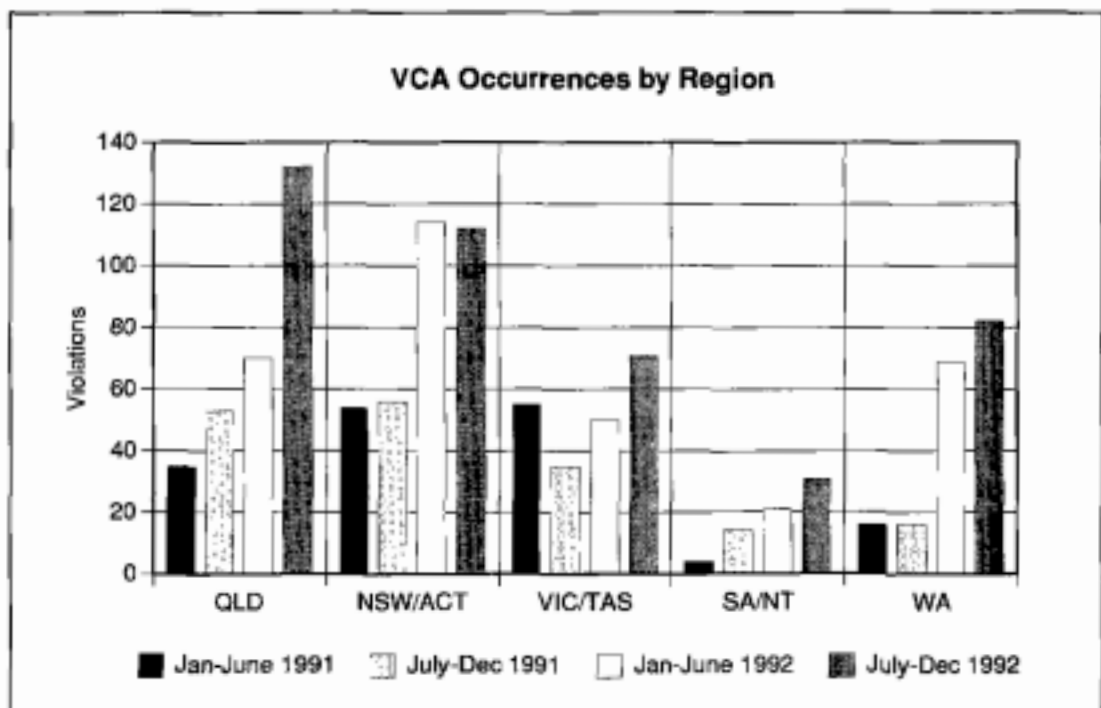


Figure 5

Figure 5 indicates that in general, the increase in VCA occurrences has been a nationwide phenomenon. However, Qld, NSW/ACT and WA have recorded particularly notable increases. Qld and SA/NT have continued to show a steady increase while the Vic./Tas. region, which had previously experienced a decline in these occurrences, also recorded an increase in VCA occurrences after December 1991.

#### 4.1.1 Location of VCA incidents by controlling agency

VCA occurrences were categorised by the location of the ATS controlling agency centre or unit in whose airspace they occurred (see figure 6). Note that some controlling agencies have

airspace which covers large areas, and a VCA incident may have occurred some distance from the actual location of the ATS facility.

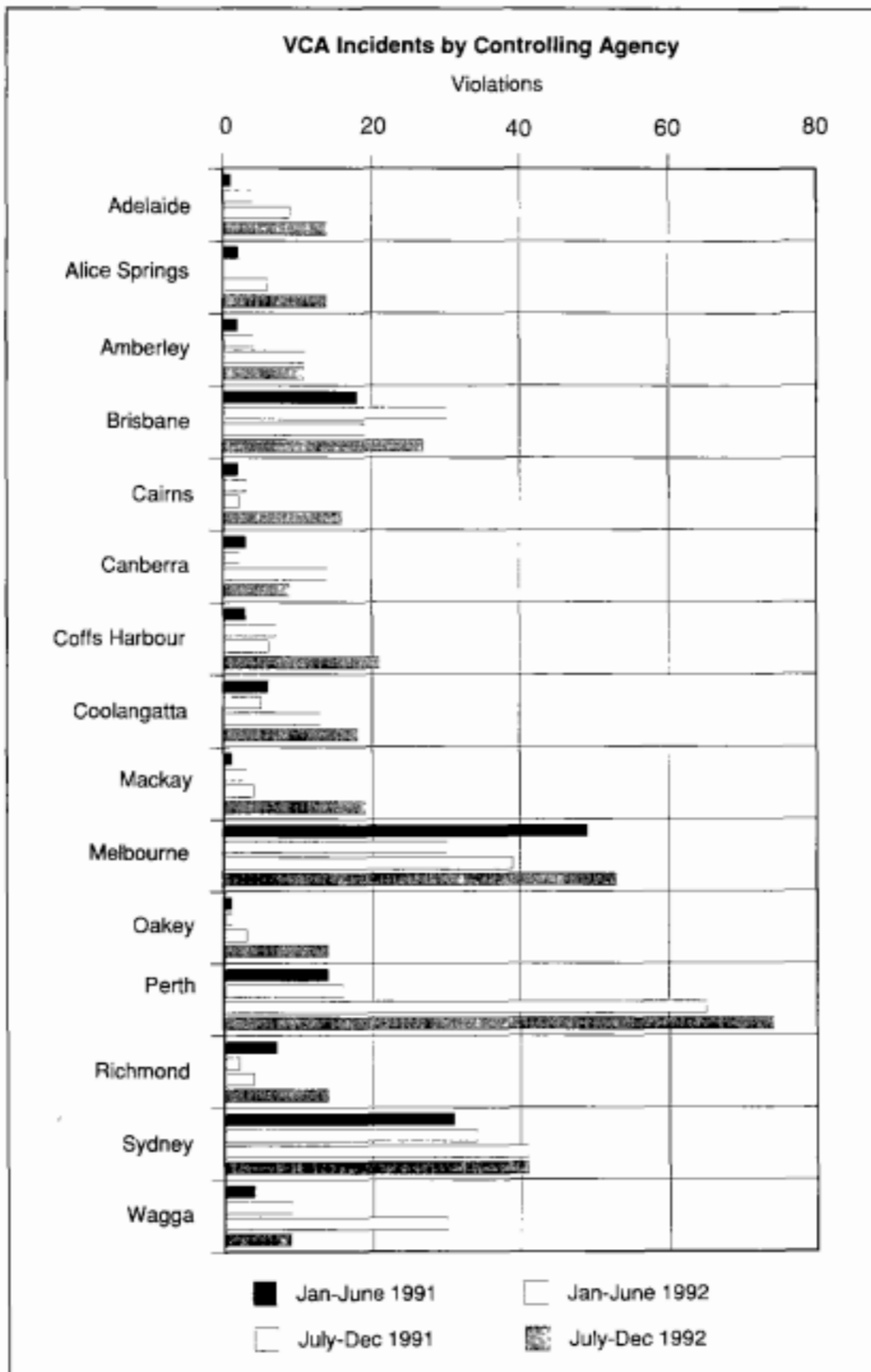


Figure 6

The increase in incidents from 1991 to 1992 was particularly noticeable in the airspace associated with Perth, Adelaide, Canberra and regional centres. While Melbourne and Brisbane recorded high numbers of VCAs relative to other locations, these facilities did not show a consistent increase in such incidents. Although Airways Operations Instructions require that all VCA occurrences be immediately notified to BASI, anecdotal evidence suggests that some ATS officers are more particular about filing reports than others. This may have had some effect on the distribution of incidents.

#### 4.1.2 Type of operation

Figure 7 indicates that for each of the six-month periods, the majority of the incidents involved private flights. Military, charter and RPT operations have been involved at a consistently low level throughout the two years and have not shown the well-defined upward trend evident for private and—to a lesser extent—air-work operations.

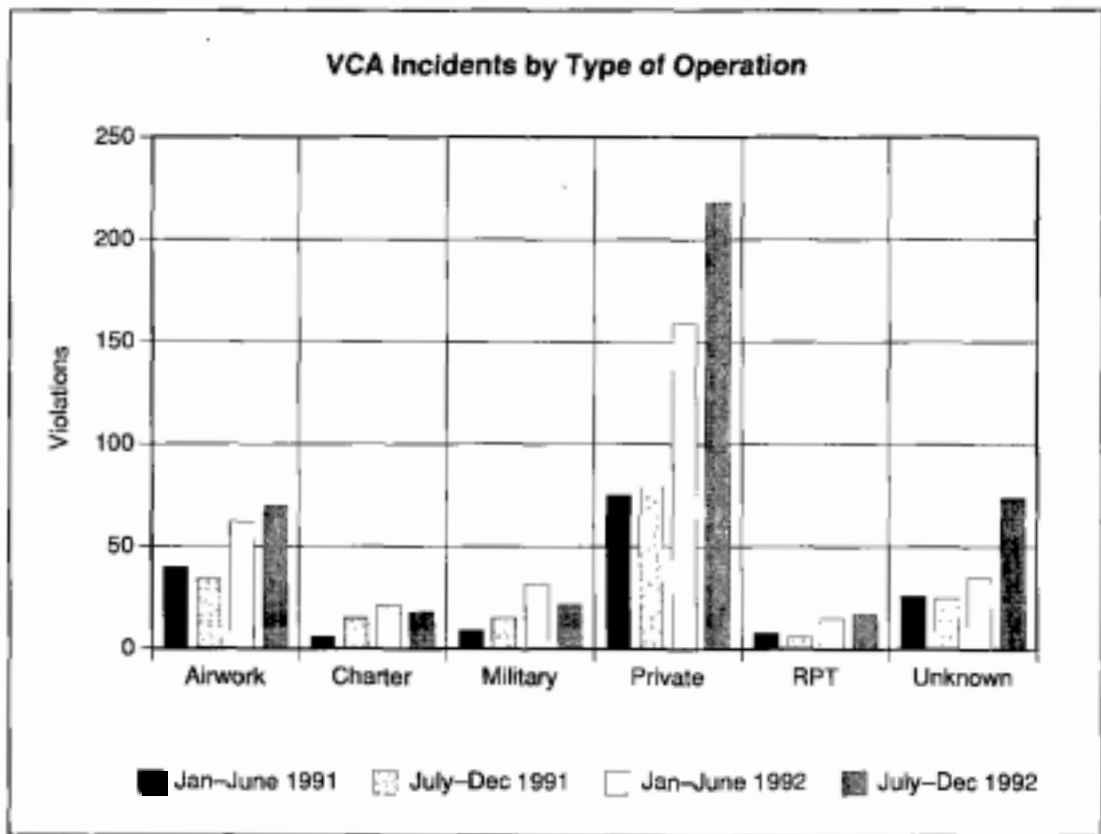


Figure 7

#### 4.2 The study period

During the seven-week study period from 13 August to 30 September 1992, there were 92 reported violations of controlled or restricted airspace. Four VCA incidents resulted in a breakdown of separation standards, all in the radar control environment.

Approximately three-quarters of the VCA incidents during the study period involved VFR flights. This is consistent with the findings for the six-month period July–December 1992 reported in figure 3. The study period findings were also representative for type of airspace penetrated and class of operation. Therefore, it can be assumed that the study period captured a representative sample of recent VCA incidents.



Most CTA violations in the study period involved penetration of CTA steps. Of the 56 violations of CTA, 52% occurred between 5,000 ft and 10,000 ft (see figure 8). CTR violations were not analysed by altitude because CTRs have a limited vertical range and most incidents would occur below 5,000 ft.

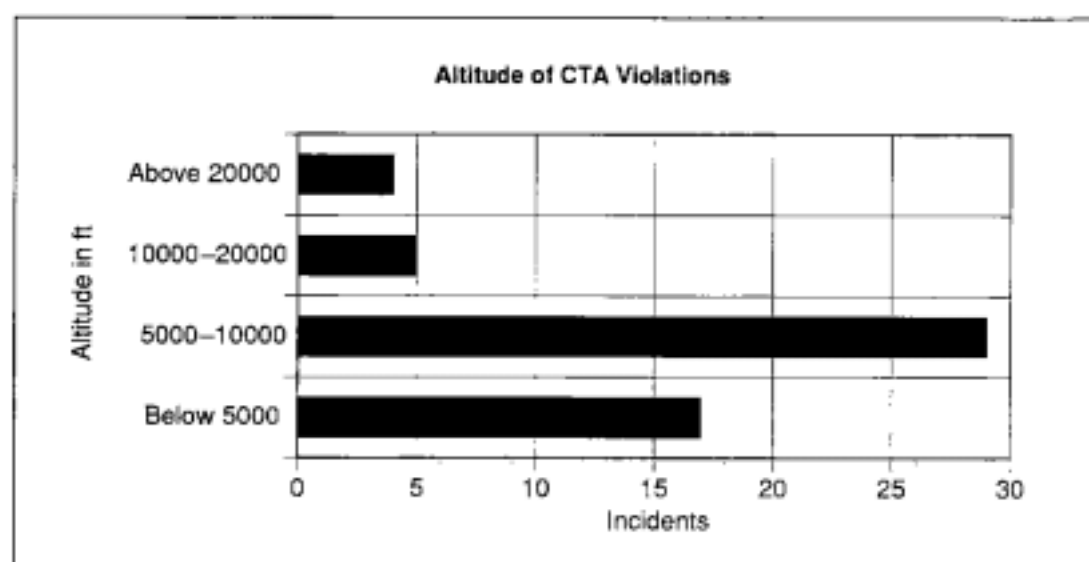


Figure 8

#### 4.2.1 Attributed factors

For the 92 VCA incidents, the most common factors attributed by BASI investigators were:

Aircrew failure to follow published procedures	56
Navigation error	26
Communication problems, including interference	9
Weather conditions	9
Pilot/ATS misunderstanding of phraseology	5

Note: A single incident may have more than one factor assigned to it.

The two most common factors ('aircrew failure to follow published procedures' and 'navigation error') are likely to reflect deficiencies in the pilot education and training program. In particular, investigators reported that some pilots had not understood the procedural changes while others appeared to have had difficulty interpreting documents and charts—a prerequisite to sound flight planning and navigation.

#### 4.2.2 Pilots' flying experience

For those incidents where information is available, the least experienced pilot had 37 h total flying experience, while the most experienced had 17,000 h. In general, the incident pilots had moderate to high levels of flying experience with an average of around 2,500 total flying hours and 51 h of flying in the 90 days preceding the incident. The median total flying hours was 900.

#### 4.2.3 Charts

The VTC was the most frequently used chart and was used by 46% of the VFR pilots interviewed. Of these, 61% were using the VTC alone; however, others were using the VTC plus the World Aeronautical Series Chart or the Visual Enroute Chart. The Enroute Chart (Low) was the chart most frequently used by IFR pilots. Four pilots, including one on an IFR

flight, reported that they were not referring to any chart on the incident flight.

The study highlighted four major problems with the presentation of information on the VTC:

- (1) There appears to be confusion in the industry about the purpose of VFR approach points to the primary airports. Although they are displayed on the VTC, there is no official CAA explanation of their purpose. Previously, when VFR flights were required to submit flight plans, pilots were advised that they should plan to fly over the VFR approach points when making an entry to a primary CTR. However, the original purpose of the visual approach point seems to have become obsolete, and in some locations the visual approach point is inside the zone (e.g. Sarina and Eton on the Mackay VTC). Additionally, not all VFR approach points are the same distance from the CTRs and some are immediately adjacent to the zone boundary. At some locations, such as Oakey, there are published VFR routes, but no published VFR approach points.
- (2) It became apparent that the coverage on some VTCs is inadequate and does not show all lower-level CTA steps leading into the relevant CTR. For example, a pilot approaching the Mackay CTR may penetrate the CTA step (LL 6000) while still outside the area of chart coverage.
- (3) Essential airspace information could be better presented. While the VTC presents ground features for visual navigation, airspace boundaries cannot always be readily linked to conspicuous ground features. Furthermore, information on the upper and lower limits of controlled airspace could be presented more conspicuously, and in a more standard format. For example, a single chart may have 'CTA LL 4000' and 'CTA LOWER LIMIT 4000' in close proximity. The information is presented in low impact shades of purple which do not attract the attention of the user. There may be better ways of presenting this information such as the system used on US visual charts where upper- and lower-limit information is presented in a clear manner.
- (4) Investigators and pilots alike commented on the clutter on the VTC. While the chart must convey a large amount of information, it may be possible to present this information in a less 'busy' form.

#### **4.2.4 Promulgation of aeronautical information**

Changes to airspace and procedures are publicised through AICs. As a result of the in-depth investigations, it became apparent that the AICs may not be an entirely effective means of communication. For example, major changes to airspace in various areas of Queensland in June 1992 were publicised via AIC H11/92. However, the AIC was sent only to pilots who subscribed to a document amendment service. Approximately 60% of unrestricted private pilots are subscribers, so about 40% of private unrestricted pilots did not receive notification of these changes. BASI investigators reported that pilots who were not aware of these changes were more likely to violate controlled airspace. Obviously, it would be beneficial for all licence holders to receive AICs.

#### 4.2.5 Phase of flight

The phase of flight during which each VCA occurred was examined. Most of the incidents occurred during cruise (see figure 9).

Climb	12
Cruise	75
Descent	4
Other	1

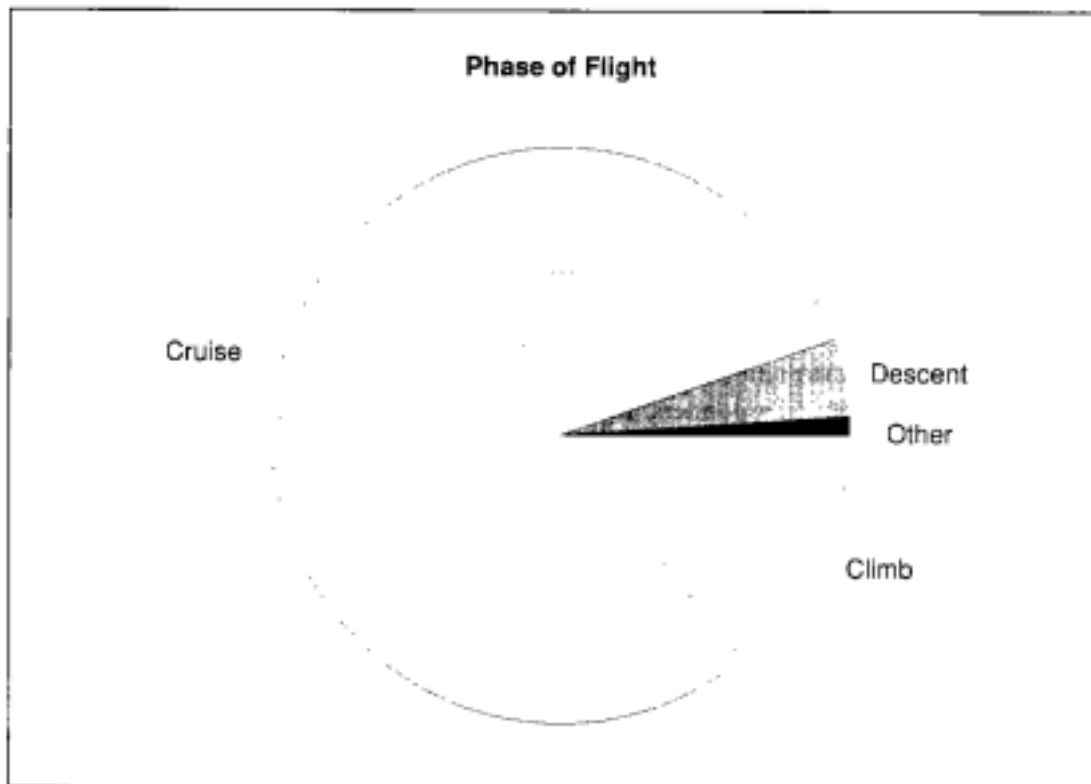


Figure 9

#### 4.2.6 Horizontal/vertical extent of violations

Of the 92 intruding aircraft reported during the study period, 14 were detected at the airspace boundary, while the remainder travelled some distance within controlled airspace before ATC became aware of the violation. On average, intruders were detected 8.8 NM within controlled airspace after the point of violation, although some individual aircraft travelled much greater distances before they were detected. For example, one VFR aircraft travelled 45 NM in procedural airspace before controllers became aware of the aircraft.

The vertical extent of penetrations was usually in the vicinity of 1,000–3,000 ft before the intruding aircraft were known to ATC. An intruder in procedural airspace is likely to go undetected for much longer than an intruder in a radar environment because at non-radar units, FS or ATC generally cannot detect an intruder until the pilot reports at a position or requests a service. At radar units, ATC generally became aware of the VCA by direct observation of the intruder. Some pilots reported at positions within CTA/CTR when requesting a clearance. A number of VCAs were detected by reports from military firing range safety officers, and occasionally by direct controller observation from the control tower cabin, as the intruder flew by or overhead.

#### 4.2.7 Pilot understanding of airspace arrangements

Surprisingly, 67% of the pilots questioned stated that they knew and understood the airspace arrangements under which they were flying. The remaining 33% admitted that they were unclear or confused about the airspace arrangements.

#### 4.2.8 Low-level VHF coverage

In at least seven occurrences, communications problems were attributed to limited very high frequency (VHF) coverage which was inadequate to permit continuous communication between ATC and pilots approaching controlled airspace. For example, at Coffs Harbour and Cairns, low-level VHF coverage was adequate in the immediate vicinity of the CTR, but was marginal in other areas because of terrain. Some pilots who were unable to contact the tower mistakenly believed that their radios were faulty. Investigators were told that whereas the old FS radio facilities were sited to ensure that they provided good low-level coverage OCTA, ATC facilities were originally intended to provide low-level coverage only in the immediate vicinity of the airfield. In order to effectively deliver clearances to low-level aircraft OCTA, ATC may need better sited VHF facilities at some locations.

#### 4.2.9 Transponder use

Available information indicates that where relevant, most aircraft involved in VCAs were equipped with transponders, although in some cases the transponder was not operating at the time of the incident.

Transponder –	
Operating Mode A	12
Operating Mode C	33
Operating, incorrect code	1
Not operating	13
No transponder	5

It is apparent from the above figures that not enough use is made of transponders when suitably equipped aircraft are approaching or operating in the vicinity of radar-controlled airspace. The new airspace management procedures planned for introduction in November 1993 will rely on this equipment for controlled airspace integrity; therefore it is important that the use of Mode C transponders be actively encouraged.

#### 4.2.10 Protection of controlled airspace and clearance requests

Seventy-eight per cent of the pilots questioned said that they understood the new airways clearance instruction procedures. However, a number of pilots stated that the phraseology used by ATS officers caused some confusion and may have inadvertently led them to believe that the instruction given was their clearance to enter controlled airspace. In one case, controllers were reported to have used the phrase 'stand by for airways clearance'—a phrase previously used by FS whenever a flight plan had been submitted and the VFR aircraft was following full reporting procedures. Some pilots continued in anticipation of a clearance as they would have done pre-AMATS, but had violated controlled airspace by the time the clearance was delivered. Previously, a pilot would have been advised by FS that a clearance was not available and that the aircraft must remain OCTA.

Additionally, the term 'clearance' is no longer used in relation to VFR flights but has been replaced with the term 'instruction'. It is BASI's view that this change of terminology had the effect of making clearance procedures unclear to some pilots. The change may have made it difficult for some pilots to distinguish between situations where a clearance had been given

and situations where a clearance had not been given.

Although most pilots believe that they understand procedures, there is clearly a general lack of understanding of the new procedures and phraseologies for entry to controlled airspace. Further, many pilots do not appear to understand that they must remain OCTA until a clearance has been obtained. According to some controllers, many pilots believe that ATC have taken up the monitoring and reminder functions formerly performed by FS.

The documentation available to pilots may not place sufficient emphasis on the requirement to establish communications and obtain ATC clearance instructions by the intended 10-NM 'buffer' area protecting CTA/CTR and restricted airspace. This was apparent from the number of occurrences reported where the buffer proved to be either ignored, forgotten or inadequate.

The Aeronautical Information Publication (AIP) prescribes the pilot responsibilities and radio telephony phrases to be used when requesting a clearance, or instruction, for entry into controlled airspace. Implicit in this procedure is that the pilot must know the airspace configuration and his/her actual position relative to controlled airspace at all times.

Fifty-seven per cent of pilots did not make any request for entry instructions and a further 37% made late requests when they were already within controlled airspace. There were a few occurrences where the pilot reported a delay in making the request due to on-board distractions with navigation equipment, communications equipment, and passenger comfort due to turbulence.

On eight occasions, VFR pilots reported difficulties locating the correct frequency on which to contact ATC for instructions. There were also VCAs involving high-performance IFR aircraft. In some occurrences, the aircrew had insufficient time to contact ATC direct and obtain a clearance even though they received the correct instructions from FS, primarily due to frequency congestion. In one case, a VCA occurred where an IFR commuter aircraft had a ground speed of approximately 400 kts and covered the 10 NM 'buffer' in 1.5 min.

#### 4.2.11 Pilot views

Although it was impossible to contact all pilots involved in the VCA occurrences, those pilots interviewed were asked how violations might be avoided. The most common responses indicated requirements for:

	Number of responses
More attention to flight planning and briefing . . . . .	21
More attention to navigation and tracking . . . . .	17
<b>More education</b> <i>(e.g. on use of airspace, new procedures, holding OCTA, NOTAMs, phraseology, instructions, and interpretation/presentation of ATC frequencies)</i> . . . . .	13
<b>Better use and presentation of charts</b> <i>(e.g. display of steps, scale/coverage, ATC frequencies)</i> . . . . .	9
<b>Better awareness of the operational problems which can distract attention when near airspace boundaries</b> <i>(e.g. icing, turbulence, passenger comfort, weather avoidance)</i> . . . . .	7
Provision of a larger 'buffer' area . . . . .	4

#### 4.2.12 ATC views

ATCs involved in VCA occurrences were also asked how violations might be avoided. The most common responses from controllers were that pilots required:

	Number of responses
<b>More education</b> ( <i>e.g. on new procedures, holding OCTA, NOTAMS, phraseology, instructions, and interpretation/ presentation of ATC frequencies</i> ) .. .. .	18
<b>More attention to flight planning and briefing</b> .. .. .	12
<b>More attention to navigation and tracking</b> .. .. .	11
<b>Better use and presentation of charts</b> ( <i>e.g. display of steps, scale/coverage, ATC frequencies</i> ) .. .. .	8
<b>Better communications equipment</b> .. .. .	1
<b>Better airmanship</b> .. .. .	1

ATS officers indicated that there were also pilots who did not provide ATC with the required details when first contacting controllers for their airways clearances. (The AIP specifies the details to be provided.) VFR pilots in particular appeared to be reluctant to use the radio. Some controllers stated that the required information had to be laboriously extracted, often when the controller was busy processing IFR aircraft. Anecdotal evidence suggests that pilots felt that they would be charged if they spoke too much because much of the AMATS educational material, such as *Airspace 91*, encouraged them to be silent participants.

#### 4.3 Pilot survey

A multi-choice questionnaire was developed to test pilot knowledge of controlled airspace and primary CTR procedures. The questionnaire covered items such as use of VFR/IFR hemispherical levels, approach points to primary airports, clearance requirements, 'buffer' area applications, vertical/horizontal extent of upper and lower limits of CTA/CTR, chart coverage, symbols and legends.

The questionnaire was made available to pilots at the Avalon Air Show in October 1992. Approximately 150 pilots attempted the airspace questions in the questionnaire. Of 107 pilots who completed the exercise, only one answered all questions correctly. Only 40% of respondents answered more than three of the six questions correctly (see table page 19).

About 50% of the respondents had more than five years of flying experience. Fifty-two per cent of respondents held private pilot licences and 39% held higher qualifications. The remaining 9% held student licences. There was a significant association between licence type and correct answers, in that private pilots tended to have poorer knowledge of procedures than more qualified pilots.

The questionnaire results indicated that many pilots could not apply airspace procedures correctly and did not know when, or where, to request clearances before entering controlled airspace. Private pilots in particular were confused about procedures. That only one pilot out of 107 was able to answer all questions correctly indicates that there is scope to make pilot education more effective.

Number of questions answered correctly	Number of respondents	Percentage of respondents
0	14	13.1
1	21	19.6
2	11	10.3
3	17	15.9
4	21	19.6
5	22	20.6
6	1	0.9
Total	107	100.0

#### 4.4 CAA submissions

The VCA team sought the views of the ATS and SR&S Divisions of the CAA on the VCA problem. The ATS Division provided a written response which summarised the consolidated views of field office and operational staff.

##### 4.4.1 ATS Division views

In addition to comments on the VCA occurrences themselves, the ATS response provided an insight of events which follow a VCA, such as an immediate increase in controller workload, particularly in the non-radar environments. Controllers stated that most penetrations seemed to be by VFR pilots who had not previously submitted details, thereby necessitating that ATC quickly establish and notate the intruder's position and altitude. An immediate assessment of the total traffic disposition was then required so that instructions, as necessary, could be issued to provide separation assurance.

If the intruding aircraft was under radar surveillance, the aircraft could be radar identified and a flight progress strip raised. Details of the intruder could then be co-ordinated and forwarded through the ATS system to other units as necessary. An airways clearance would also be issued.

ATS management acknowledged that there were some ATC units which had marginal VHF communications coverage areas. However, they also indicated that poor quality on-board VHF equipment and use of non-standard phraseologies by both pilots and ATS officers alike may have been a contributing factor to airspace violations.

Some ATS officers indicated that ATS were not reporting all pilot operational errors and violations since the introduction of the AMATS procedures. They had been conducting local counselling of pilots in lieu of formal reporting. Indications are that many officers were prepared to 'nurse' the new procedures through an unofficial 'shake down' period. One Victorian ATS officer reported that during the Avalon Air Show, there had been one VCA approximately every 10–15 min, but staff had been too busy to fill in reports on all of the incidents.

The ATS response confirmed individual VCA reports that at radar units, ATS generally became aware by direct observation of the intruder's radar symbol. At non-radar units, FS or ATC first became aware of a violation when an aircraft reported a position or asked for a service when already within CTA. Occasionally, the violation was detected by direct observation of the intruding aircraft as it transited a CTR or an active restricted area, such as a live firing range.

ATS officers considered that some VCAs occurred when high-performance aircraft climbing

into low overlying CTA were unable to obtain a timely clearance due to poor low-level ATC VHF coverage. On a number of occasions the aircraft had departed and climbed into the controlled airspace before suitable two-way communications had been established and an airways clearance issued by ATC. Interim measures have since been reinstated for the FS organisation to relay messages and instructions in these situations.

ATS management expressed an opinion that the majority of VCAs were the result of poor pilot performance, and from an ATS operational field officer's perspective, stemmed from pilots:

- not being properly aware or educated in new procedures
- not using the radar for fear of incurring airways charges
- not carrying up-to-date maps and documents (ERSA in particular)
- not availing themselves of a proper pre-flight briefing
- not receiving follow-up education, whereby any concerns that had arisen during operations since the change could be discussed and resolved
- general confusion on the new airspace and procedures and a misconception that VFR flights do not require a clearance.

In summary, the ATS response to violations indicated that:

the main causes of VCAs appeared to be lack of pilot familiarity with the airspace and requests for clearance not being made in sufficient time prior to the controlled airspace boundary. Pilot education and awareness, or lack thereof, seem to be at the nub of the problem.

The ATS response indicated that it was possible some pilots may have misinterpreted an instruction (particularly the phraseology used) to call by 10 NM from the CTA boundary as an instruction to call 10 NM from the destination. (An amendment to AIP, effective 10 December 1992, addressed this situation.)

#### **4.4.2 SR&S Division views**

The CAA's SR&S Division indicated their awareness of the problem in *Aviation Bulletin 11* (1992). That publication stated that there had been 'significant increases in the number of penetrations into both controlled airspace and restricted areas' and that it was the intention of SR&S Division to take a 'tougher line' with pilots violating controlled airspace. SR&S cites 'poor navigation skills' and the failure of pilots to use 'sound judgement when requesting clearances into controlled airspace' as causal factors.

Some of the actions being taken by SR&S Division to reduce the VCA occurrences include 'airspace re-design and introduction of special routes having clearly identifiable landmarks for navigation around controlled airspace'. In addition, flight operations inspectors have been instructed 'to take particular interest in the standard of navigation technique being taught in flying schools'. Pilots seeking renewals will also 'be required to demonstrate a sound knowledge of navigation and correct procedures'.



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## 5. CONCLUSIONS

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The analysis of incidents for the two-year period 1991–1992 indicated that nationwide, VCAs have increased in frequency since 1991. The increase has been particularly apparent in Qld, WA and NSW. Perth experienced the largest increase although regional centres across the country also showed significant increases. The upward trend of VCA reports does not reflect an overall increase in incident reporting by ATS officers. Most VCAs involve private VFR flights and CTAs are infringed twice as frequently as CTRs.

The investigation of 92 VCA incidents occurring in a seven-week period in August/September 1992 indicated that the incidents were not confined to inexperienced pilots. The two most commonly attributed factors leading to an incident were pilot failure to follow published procedures, and navigation error. Most pilots did not call for a clearance before entering controlled airspace. Despite their failure to follow procedures, most pilots were confident that they understood them. Pilots and ATCs alike expressed the view that more pilot education was required and that pilots must give more attention to flight planning and navigation. Problems with the VTC were uncovered in the course of the investigations. Not only is there scope for improvement in the way information about controlled airspace is presented, but charts and aeronautical information should be distributed to a greater proportion of private pilots than at present. The issue of pilot education is particularly important, as the AMATS education program ceased as the first AMATS changes were implemented, and the education program was never evaluated.

A pilot questionnaire brought to light widespread ignorance of airspace procedures. Most pilots who answered the questionnaire had a less than perfect knowledge of how to operate into controlled airspace. Once again, the need for further pilot education is evident.

Submissions from the CAA stressed the need for pilot education to raise awareness of airspace procedures. It was acknowledged that pilots were confused about the new procedures and that some pilots were not carrying up-to-date documents and charts.

A system-level perspective is needed to explain why violations of controlled airspace occur and why the number of such incidents has increased markedly in recent months. Since the removal of full reporting procedures for VFR aircraft, FS no longer monitor the progress of any VFR flights. This has had the effect of removing a defence from the airways system, in that FS no longer remind VFR aircraft when they are approaching controlled airspace and no longer co-ordinate a clearance with ATC. Changes to phraseology may have exacerbated the problem.

The removal of flight planning and full reporting requirements for VFR flights transferred the monitoring and reminder responsibilities from FS to pilots themselves, yet it appears that many pilots believe that the monitoring and reminder functions were transferred to ATC. The increased responsibility transferred to pilots has brought to light longstanding problems, in particular:

- pilot navigation deficiencies;
- problems with the presentation of operational information on charts;
- inadequate distribution of charts; and
- inadequate promulgation of procedural changes.

Although poor navigation and poor procedures emerged as the most common factors in VCA incidents, it is unlikely that the large increase in such incidents reflects a sudden deterioration

in pilot skills. Rather, the increase reflects the removal of system defences and the transfer of responsibility to pilots who are ill-equipped to meet their responsibilities.

The closure of face-to-face pilot briefing offices in June 1992 also removed a system defence. Protection of controlled airspace may have been sustained, and enhanced, had face-to-face pilot briefing units been maintained until the last phase of the transition program had been successfully completed.

The CAA attempted to educate pilots about the AMATS changes and much of the educational material was well received by pilots. However, the initial education program ceased in 1991 and the CAA did not evaluate the effectiveness of that program. In recent months, the CAA has re-commenced the pilot education program. It is hoped that the new program will emphasise the importance of the buffer area in which a pilot must call ATC for a clearance when approaching the airspace boundary and the mandatory requirement to remain OCTA if that clearance is not immediately available.

Education must be tailored to the needs of pilots. This study has identified that many pilots are confused about clearance procedures. However, more detail is needed on exactly what pilots do not understand. This information would form the basis of an effective education campaign.

*This study has identified a number of problems in the design and distribution of charts. There is a need to broadly evaluate the effectiveness of charts in order to ensure that information is presented to pilots in an easily understood manner. All pilots should have correct and up-to-date charts and other pertinent operational information.*

The problem of VCAs does not have a single cause. It has resulted from a combination of changes to the airspace system which has transferred responsibilities to pilots which pilots have not been trained to accept. It is clear that the important assumptions made within the Ratner review of 1992, particularly concerning pilot acceptance of increased responsibilities, have not eventuated and that further caution and continued surveillance are required. The airways system will only work effectively when all participants understand what is expected of them and comply with the rules. While the IFR segment of the industry is not immune from VCA occurrences, it is the VFR private operators who must improve their performance in this regard. Further changes are planned for the airspace system. The VCA problem, if not addressed, has the potential to jeopardise the success of these changes.

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## 6. RECOMMENDATIONS

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BASI recommends:

1. That the CAA evaluate the former and currently planned pilot education programs to determine the level of understanding of the new airspace arrangements and controlled airspace entry procedures. Particular emphasis in the evaluation should be placed on VFR private operations.
2. That the CAA examine ways to ensure that all pilots have the operational documents necessary for the proposed flight.
3. That the CAA establish methods to improve the protection of controlled airspace.
4. That the CAA ensure that pilots clearly understand their responsibility to remain OCTA and active restricted areas until authorised to enter.
5. That the CAA review the presentation of information on aeronautical charts, with particular reference to the VTC, and that it improve the presentation of:
  - (a) the upper and lower vertical limits of controlled and restricted airspace;
  - (b) the lateral boundaries of controlled and restricted airspace; and
  - (c) the relevant ATC frequencies for requesting airways clearance.

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