EUROPEAN ORGANISATION
FOR THE SAFETY OF AIR NAVIGATION

EUROCONTROL

CENTRE EXPERIMENTAL EUROCONTROL

EUROPEAN ACAS OPERATIONAL MONITORING
2001 REPORT

EEC Report No. 387

Project ACA-5-E1

Issued: December 2003

REPORT DOCUMENTATION PAGE

Reference: EEC Report No. 387	**Security Classification:** Unclassified
Originator: EEC – **ATM** (**A**ir **T**raffic **M**anagement)	**Originator (Corporate Author) Name/Location:** EUROCONTROL Experimental Centre Centre de Bois des Bordes B.P.15 F – 91222 Brétigny-sur-Orge CEDEX FRANCE Telephone: +33 (0)1 69 88 75 00
Sponsor: Safety Enhancement Business Division – ACAS Programme	**Sponsor (Contract Authority) Name/Location:** EUROCONTROL Agency Rue de la Fusée, 96 B-1130 Brussels Telephone: +32 2 729 9011

TITLE:

EUROPEAN ACAS OPERATIONAL MONITORING
2001 REPORT

Authors	Date	Pages	Figures	Tables	Annexes	References
Garfield Dean Tim Baldwin	12/03	viii + 37	16	16	1	

	Project	Task No. Sponsor	Period
	ACA-5-E1 (ACAS Operational Monitoring Project)	-	2001

Distribution Statement:
(a) Controlled by: Head of ATM
(b) Special Limitations: None
(c) Copy to NTIS: NO

Descriptors (keywords):

ACAS, TCAS, Monitoring, Evaluation, Reporting

Abstract:

This report describes an operational monitoring of TCAS II conducted by EUROCONTROL under the auspices of ICAO during 2001.

The data collection procedures & monitoring methods are explained, and both statistical and operational analysis are provided.

The analysis shows the continuing need to monitor closely the operational effects of ACAS systems in Europe after the first phase of ACAS implementation.

SUMMARY

The **Airborne Collision Avoidance System (ACAS)** is an aircraft system based on secondary surveillance radar (SSR) transponder signals which operates independently of ground based equipment to provide advise to the pilot on potential conflicting aircraft that are equipped with SSR transponders.

Since 1991, EUROCONTROL has helped to organise the operational monitoring of ACAS in the European airspace and for European carriers. This work was conducted under the auspices of ICAO; in parallel, the UK and France conducted their own monitoring for their respective airspaces and this forms an integral part of the European monitoring of ACAS.

The **Traffic Alert and Collision Avoidance System, TCAS II** is the only system commercially available that corresponds to the requirements for **ACAS II**. The current version of TCAS II is Version 7. From late 1999 onwards the new version of TCAS II progressively replaced V6.04A in all aircraft. This new version complies fully with the ACAS II requirements and includes significant safety, operational and technical improvements beyond the previous version.

TCAS II is an independent airborne system based on SSR technologies. It interrogates and receives via the aircraft transponder Mode C and Mode S messages. The interrogation rate is about 1Hz and the derived range and range rate and the received altitude from Mode C and or Mode-S replies are used to track other aircraft in the vicinity and the logic tests for a potential threat based on this data.

Once an aircraft is detected by the TCAS surveillance and determined to be a potential threat by the CAS logic, TCAS presents it to the pilot as a **Traffic Advisory (TA)**. If the threat becomes imminent then TCAS II proposes an avoidance manoeuvre to the pilot in the vertical sense: this is a **Resolution Advisory (RA)**.

The main source of information used in compiling this report was provided by pilot reports and controller reports. Different questionnaires were distributed to airline companies and ATC centres and the return of these reports are used to populate the main body of the database. Additionally, a procedure was in place requesting the controllers to secure radar data recordings for all reported events these have been analysed and results added to the database.

Some of the key statistics are provided from the reported events in 2001. However it should be noted that not all the reported events were RAs. Out of 1537 events, 1384 were reported as RAs, 98 as TA's only and 55 were not known.

The number of events by flight phase detailed below is based mainly on pilot reports.

Take off 4 (0.5%), Climb 347 (41.1%), Cruise 113 (13.4%), Initial descent 288 (34.1%), Hold 13 (1.5%), Approach 65 (7.7%), and Final 14 (1.7%).

When we look at the distribution of RA events by altitude for the European airspace peaks are evident in altitudes between FL80-140 and FL200-300, reflecting mainly the airspace organisation at these levels. High vertical rates in standard level-off procedures with clearances giving 1000ft separation cause the majority of RAs (approximately 76%).

In the majority of reported cases (95% - same as the previous year) the pilot follows an RA. Pilots decisions not to follow an RA are almost always based on additional information either visual with the intruder, traffic information and or ATC avoidance being issued.

When pilots did follow RAs about 56% deviated 500 ft or less and about 12% deviated more than 1000 ft. This is a small improvement on last year (54% and 13% respectively).

When controllers were asked, in 30% of cases (compared with 21% the previous year) the controller expresses the opinion that the pilot's action in response to an RA was justified. The controller's opinion about the disruptive effect of TCAS alarms reported when occupied with normal a workload was 23%, (6% down on the previous year), and was most disruptive when occupied with a high workload 51%, (5% down on the previous year).

When Pilots gave their opinion of events 36% were a nuisance (down 9% on the previous year) 42% useful (up 2% on the previous year) and 21% necessary (up 5% on the previous year). In only 5% of cases an airprox was filed.

The European Operational Monitoring Group categorised the events where operational issues were a factor throughout the evaluation period. As a result the biggest issue (76%, a 5% decrease on the previous year) remains the nuisance level offs, which are highly correlated with high vertical rates and reversed vertical rates. Another significant issue is large vertical deviations in reaction to some RAs which was 16%, a reduction on the previous year.

Identified misuses of TCAS and RAs not being followed, suggest that training remains a high priority for pilots.

The monitoring shows that TCAS improves the safety of the airspace when advisories are followed correctly.

The annexe A to the report gives some de-identified examples of ACAS events to assist training and awareness in the aviation community.

TABLE OF CONTENTS

LIST OF ANNEXES

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

In order to implement ACAS in ECAC airspace in a safe and operationally acceptable way, there is a need to monitor ACAS events occurring within that airspace and to provide feedback to operational and technical staff working with ACAS.

This report describes and analyses the monitoring carried out during 2001. It analyses data to verify that ACAS continues to provide a system that improves safety and is acceptable operationally, and technically. By doing this it provides useful operational and technical lessons about ACAS performance.

With reference to previous results, possible trends are also identified.

- Chapter 2 of this report provides some background information - including technical principles of TCAS and the International ACAS Standardisation and Implementation Process;
- Chapter 3 gives a brief technical description of the TCAS II system;
- Chapter 4 gives an overview of monitoring methods and data collection procedures;
- Chapter 5 gives the status of the operational monitoring during 2001;
- Chapter 6 provides a statistical description of the TCAS events;
- Chapter 7 presents a statistical description of pilot and controller assessments to TCAS events;
- Chapter 8 describes the main operational issues;
- Chapter 9 draws some conclusions and makes recommendations;
- Annexe A gives some de-identified examples of ACAS events to assist training and awareness in the aviation community.

1.1. OBJECTIVES

The purpose of the ACAS Monitoring Project is to provide information to the ACAS implementation programme that allows verification of the safe operation and harmonised introduction of ACAS.

In addition, the project seeks to detect any anomalies in the safe operation of ACAS and to provide any information that will help their correction.

2. BACKGROUND

2.1. DEFINITION OF TERMS

The **Airborne Collision Avoidance System (ACAS)** is an aircraft system based on secondary surveillance radar (SSR) transponder signals which operates independently of ground based equipment to provide advise to the pilot on potential conflicting aircraft that are equipped with SSR transponders.

Three levels of ACAS have been described by ICAO: ACAS I, ACAS II and ACAS III.

- **ACAS I** is an ACAS which provides information as an aid to “see and avoid” action but does not include the capability for generating Resolution Advisories (RAs).
- **ACAS II** is an ACAS which provides vertical resolution advisories (RAs) in addition to traffic advisories (TAs).
- **ACAS III** is an ACAS which provides vertical and horizontal resolution advisories (RAs) in addition to traffic advisories (TAs). Currently no ACAS III systems have been developed.

The **Traffic Alert and Collision Avoidance System, TCAS II Version 7.0** is the only system commercially available that corresponds to the requirements for **ACAS II**.

It is a system based on Secondary Surveillance Radar (SSR) technology that uses the altitude from the Mode C or Mode-S replies of the transponders of adjacent aircraft. Based on the horizontal and vertical closing rates TCAS calculates dynamic protective volumes around the own aircraft. If the closing intruder becomes a threat, a TCAS II system proposes an RA to the pilot as a **Vertical Avoidance Manoeuvre**. The system co-ordinates its RA with the intruder aircraft, if it too can generate an RA, so that the manoeuvres are complementary.

The current version of TCAS II is Version 7.

From late 1999 onwards the new version of TCAS II progressively replaced V6.04A in all aircraft. This new version complies fully with the ACAS II requirements and includes significant safety, operational and technical improvements beyond the previous version.

TCAS II has been mandatory in the US airspace since 1991. ACAS II became mandatory in Europe on the 1st of January 2000 althoughtransitional arrangements extended until September 30th 2001. ACAS II has a world-wide ICAO mandate from 1 January 2003.

This paper reports the results of TCAS II operation in the ECAC airspace.

2.2. TECHNICAL DESCRIPTION OF TCAS II

TCAS II is an independent airborne system based on SSR technologies. It interrogates and receives via the aircraft transponder Mode C and Mode S messages. The interrogation rate is about 1Hz and the derived range and range rate and the received altitude from Mode C and or Mode-S replies are used to track other aircraft in the vicinity and the logic tests for a potential threat based on this data.

Before TCAS II V7 information on the bearing of the intruder was only used in the pilot display.

Once a potential threat is detected the logic presents it to the pilot as a **Traffic Advisory (TA)**. If the threat becomes imminent then TCAS II proposes an avoidance manoeuvre to the pilot in the vertical sense: this is a **Resolution Advisory (RA)**.

Tracked distance and closure rate - in the slant range and vertical sense - permits the logic to estimate the time **TAU** until collision. The critical TAU thresholds depend on altitude and vary for the TA between 20s and 48s and for the RA between 15s and 35s. The defined TAU thresholds provide variable protective volumes for each altitude band.

If both aircraft involved in an encounter are TCAS equipped, there is an exchange of messages in the Mode S band to ensure that the RAs are complementary.

RAs issued to the pilot are either **Preventive RAs**, instructing the pilot to maintain his present vertical rate or indicate which vertical rates he should avoid or **Corrective RAs** which propose to the pilot an avoidance manoeuvre, based on a **pilot model**. This model assumes that the pilot reacts within 5s after receiving the RA and accelerates with 0,25g into either a climb or descend attitude until he reaches a vertical speed of ± 1500 ft/min or, if that is not sufficient, ± 2500 ft/min. This vertical speed should be maintained until the RA is altered or the **Clear of Conflict** is announced. In the majority of cases, the deviation caused by such a manoeuvre is less than 500 ft. It should be pointed out that the logic aims for a **Vertical Miss Distance** at the Closest Point of Approach in the order of 400 ft (extrapolated trajectories ± standard pilot reactions). The pilot reaction should therefore be prompt and precise to avoid reducing this safety margin. However an overreaction or disregarding a weakening RA provides little additional safety but may lead to an excessive deviation and conflict with another aircraft.

2.3. THE ACAS STANDARDISATION PROCESS

On the 11 of November 1993, ICAO endorsed ACAS. As a result an accident in Japan and the mid air collision near lake Constance **PANS-OPS (Procedure for Air Navigation Services - aircraft OPerationS)** and **PANS-RAC (Procedure for Air Navigation Services - Rules of the Air and air traffiC services)** have been modified and contain the new procedures for pilots (PANS-OPS) (Doc. 8168) and phraseology to be used and procedures to be observed by controllers (PANS-RAC, Doc. 4444). These modifications have been approved by ICAO and have been applied from November 2003 onwards.

3. ACAS IN EUROPEAN AIRSPACE

Since 1991, EUROCONTROL has helped to organise the operational monitoring of ACAS in the European airspace and for European carriers. This work was conducted under the auspices of ICAO; in parallel, the UK and France conducted their own monitoring for their respective airspaces and this forms an integral part of the European monitoring of ACAS.

In 1994, ECAC requested EUROCONTROL to develop a policy for the use of ACAS in Europe. As a consequence, EUROCONTROL established the 'ACAS Policy Task Force' (APTF) to develop a common policy for the introduction of ACAS in Europe. This policy:

- endorsed the mandatory carriage and operation of an airborne collision avoidance system conforming to ICAO SARPs in the airspace of ECAC Member States;
- adopted, in principle, an implementation schedule for mandatory carriage and operation of ACAS II such that:
    - with effect from 1 January 2000, all civil fixed-wing turbine-engined aircraft having a maximum take-off mass exceeding 15,000 kg or maximum approved passenger seating configuration of more than 30 will be required to be equipped with ACAS II and;
    - with effect from 1 January 2005, all civil fixed-wing turbine-engined aircraft having a maximum take-off mass exceeding 5,700 kg or maximum approved passenger seating configuration of more than 19 will be required to be equipped with ACAS II.

The policy proposal was accepted by the EUROCONTROL Committee of Management and the European Air traffic Control Harmonisation and Integration (EATCHIP) Project Board, and by the Transport Ministers of the ECAC Member States. ACAS was established in EATCHIP as an independent domain and the ACAS Implementation Group (AIG) was created to control and co-ordinate the implementation activities.

Subsequently, ACAS has become a programme within the EUROCONTROL Air Traffic Management Programme (EATMP). It is steered by the ACAS Programme Steering Group (APSG).

4. DATA COLLECTION METHODS

The main source of information was provided by pilot reports and controller reports. Different questionnaires were distributed to airline companies and ATC centres and the return of these reports makes up the main body of the database.

Additionally, a procedure was in place requesting the controllers to secure radar data recordings for all reported events. Additional sources of data are Mode S research stations in France, the UK and Germany. Unfortunately, these stations are not in operational use and work only intermittently and therefore the database Mode-S information is limited in time and to the cover of the station.

Incoming pilot reports and controller reports are transcribed and entered in the appropriate tables in the database. Possible correlation with existing events is checked. The event synopsis is entered into the database, and events are categorised with respect to event issues, alert type, and geometry.

Radar recordings in many different formats are collected and processed by the EUROCONTROL TCAS simulation tool that allows the simulated replay of the event for a detailed analysis. Illustrated encounter reports for the reconstructed events are produced and distributed to the ATC centre and airlines implicated in the event.

Several TCAS recorders are owned by EUROCONTROL. They are kept in case special technical investigations are required. These recorders were not used during 2001.

Some airlines have purchased TCAS equipment with a recording capability which allows analysis of the relative positions of the own and intruder aircraft. A limited number of recordings have been examined in detail.

5. STATUS OF THE DATA COLLECTION

The European Evaluation collected not only data of TCAS events occurring in the European airspace but also data of TCAS events occurring elsewhere in the world.

The transition to TCAS II version 7 has taken place with few exceptions remaining in 2001. By the end of 2001 it is assumed that all aircraft subject to Phase 1 of the ACAS mandate now carry TCAS II version 7 and the statistics are expected to show how the logic changes introduced have affected the performance.

Table 1 shows the number of reported TCAS events that took place between 1 January and 31 December 2001. For the remainder of this report, only European data is used in the analyses.

Table 1: Reported events in the European Database

Airspace	*Europe*	*Other airspace*	*USA*	Total
Number	1342	32	54	1428

Not all of the events were RAs and in some events both aircraft had an RA.

Table 2 shows that most reported events were RAs. The following analyses in this report are based on RA data only, unless stated otherwise.

Table 2: Advisory Type of reported events

TA	*RA*	*Unknown*	Total
98	1384	55	1537

The number of reported events decreased 30% over the previous year, with a 20% decrease in the number of reported RAs. The most probable reason for this fall in numbers is the improvements provided by TCASII version 7 logic.

The monthly variation in RAs during this period is depicted in Figure 1. The hourly variation is depicted in Figure 2.

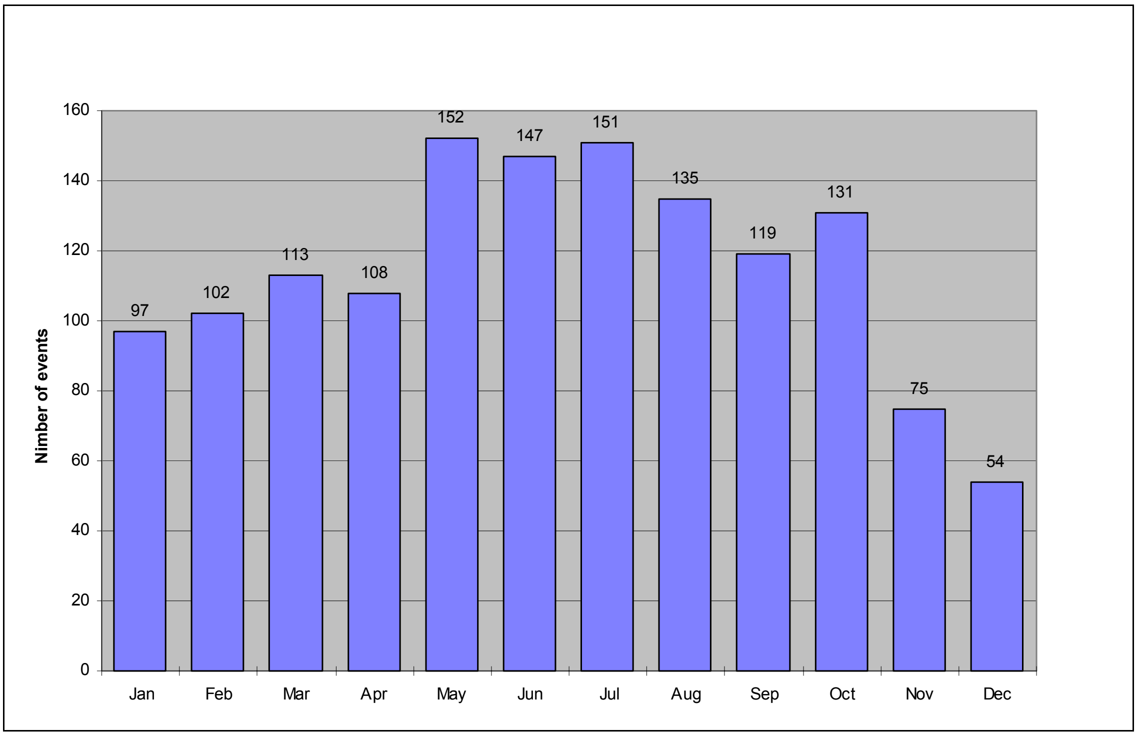

Figure 1: Monthly variation in Number of Ras

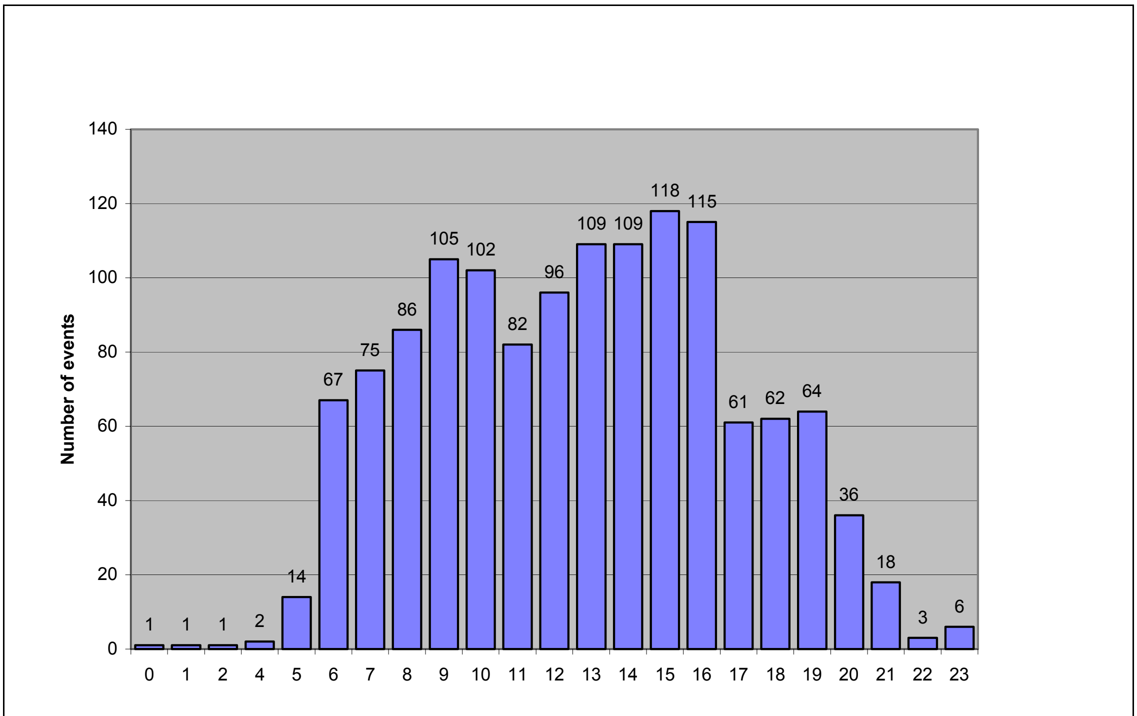

Figure 2: Hourly variation in Number of RAs

Both of these figures show that the number of reported events appears to follow the general traffic fluctuation. There were 51 events that had no time information in the report.

Tables 3 and 4 show the data sources for reported European RA events. The numbers include abbreviated TCAS event reports from participating States, which were generally counted as controller reports. Some events have more than one data source i.e. controller report and radar recording or controller report and pilot report.

Table 3: Number of reports per data source

Number of:	
Pilot Reports	868
Controler Reports	854
Ground radar recording	679
Total	2401

The proportion of controller reported events exceeds that of pilot reported events, for the second year running.

Although more events were supported by controller reports; there is a decrease of 10% compared with the previous year, and a 11% drop in the number of radar recorded events.

Table 4: Proportion of events with data from each data source

Events with:		
Pilot Reports	773	50%
Controler Reports	810	53%
Ground radar recording	368	24%

Standard questionnaire forms were generally used by both pilots and controllers. Beyond the basic description of the events, these questionnaires frequently contain pertinent and lively remarks about the environmental situation and working conditions.

We are fortunate that a relatively high number of radar recordings are available for event analysis. In some countries, the controller secures radar data when filling out the report form and this procedure is encouraged since it provides us with efficient means to analyse the event in depth. From time to time this data is sent to other European ACAS analysis centres.

Table 5 shows the number of radar recordings and ATC reports received from the participating States (reports and radar data received from Maastricht ATC are distributed according to the State in which the event occurred). These reports include both RAs and TAs.

Table 5: Source of Radar Recordings and ATC reports

State	Number of ATC reports	Number of radar recordings
AUSTRIA	5	
BELGIUM	62	3
BULGARIA	1	
CZECHOSLOVAKIA	1	
DENMARK	2	
FRANCE	67	91
GERMANY	11	2
IRELAND	1	
ITALY	2	2
NETHERLANDS	34	32
NORWAY	2	
SWEDEN	42	1
SWITZERLAND	30	14
UK	409	540
UNITED ARAB EMIRATES	4	
Total	**673**	**685**

6. STATISTICAL DESCRIPTION OF EVENTS

This part of the report relies heavily on information provided in the questionnaire by pilots and controllers. Not all of the questions were answered in all of these forms, also some agencies have sent in questionnaires modified to meet their own requirements that are different from the proposed layout. In addition radar information about events was available in some cases. Consequently the following statistics refer to different sample sizes, which are stated in the Figures.

6.1. PHASE AND ALTITUDE DISTRIBUTION OF EVENTS

Table 6 shows the number of events by operational phase based on ATC reports i.e.:

TMA operation: Take-off, Approach, Final

Transition Operation: Initial Climb/Descend, Hold

Cruise Phase: When the aircraft was in level flight at higher altitudes.

Table 6: Controller reported events by operational phase

Cruise	TMA operation	Transition operation	Unknown	Total
50	25	187	407	669

Table 7 is broadly consistent with Table 6, which shows the number of events by flight phase based mainly on pilot reports:

Table 7: Pilot reported events by flight phase

Phase	Number of Ras	% of sample
Take-off	4	0.5%
Climb	347	41.1%
Cruise	113	13.4%
Initial descent	288	34.1%
Hold	13	1.5%
Approach	65	7.7%
Final	14	1.7%
	844	

Figure 3 shows the distribution of RA events in altitude bands for the European airspace. Peaks are evident in altitudes between FL80-130 and FL200-300, reflecting mainly the airspace organisation at these levels, coupled with high vertical rates in standard level-off procedures (approximately 76% of the RAs).

The peak around FL80-130, is also the result of level-offs 1000ft apart between two aircraft, one climbing from, the other descending to major European airports.

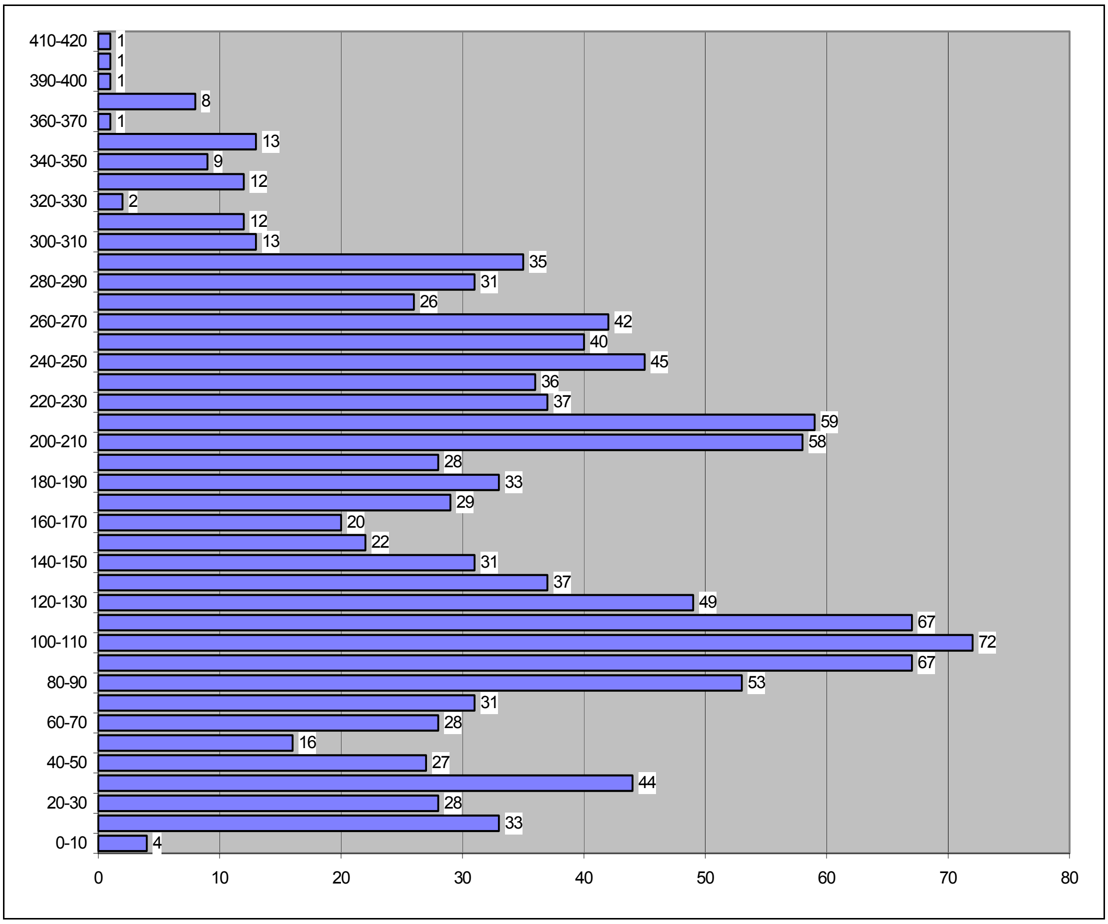

Figure 3: Altitude Distribution of RAs

6.2. PILOT REACTIONS TO RAs

Table 8 shows that in the majority of reported cases (95% - the same as the previous year) the pilot follows an RA. It represents a sustained improvement (from 75%) over the European average during the operational evaluation of TCAS. This may show increased awareness of TCAS among the airlines reporting RAs.

Table 8: Pilots reporting following an RA

Followed RA	2000		2001	
Y	2299	95%	1126	95%
N	113	5%	59	5%

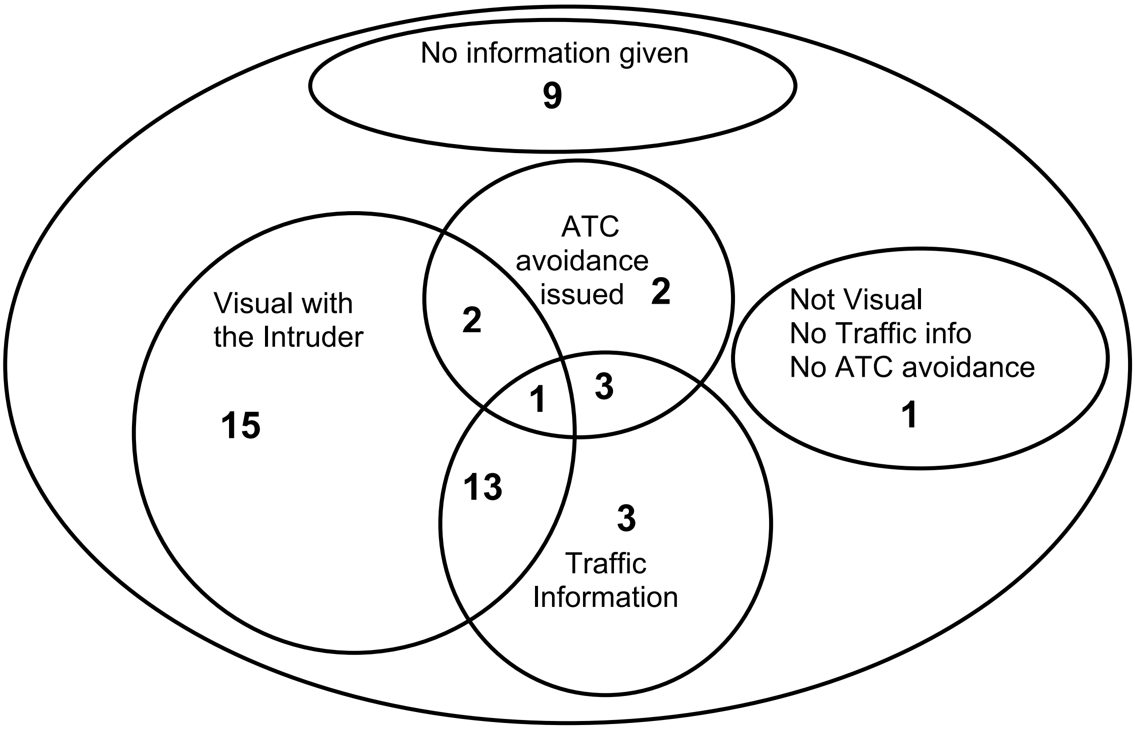

Figure 4: Diagram showing Additional information available to the Pilot when an RA was not followed

Figure 4 shows that the Pilot's decision not to follow an RA is almost always based on additional information either visual with the intruder, traffic information and or ATC avoidance being issued.

There was only 1 pilot who stated that he was not visual with an intruder had no traffic information and had not been given ATC avoiding action but this is an imported report with no explanation available. In 2000 there were 6.

A drop from 5% to 2% of the not followed Ras.

There were 9 RAs not followed where no indication of having or not having additional information was reported. In 2000 there were 26. A drop from 23% to 16% of the not followed RAs.

Table 8 shows the relative data sets for 2000 and 2001.

Figure 5 provides a graphic presentation of intruder information available when the RA was not followed.

There is a larger percentage of pilots not stating if they were visual when not following an RA but far less not following if not visual.

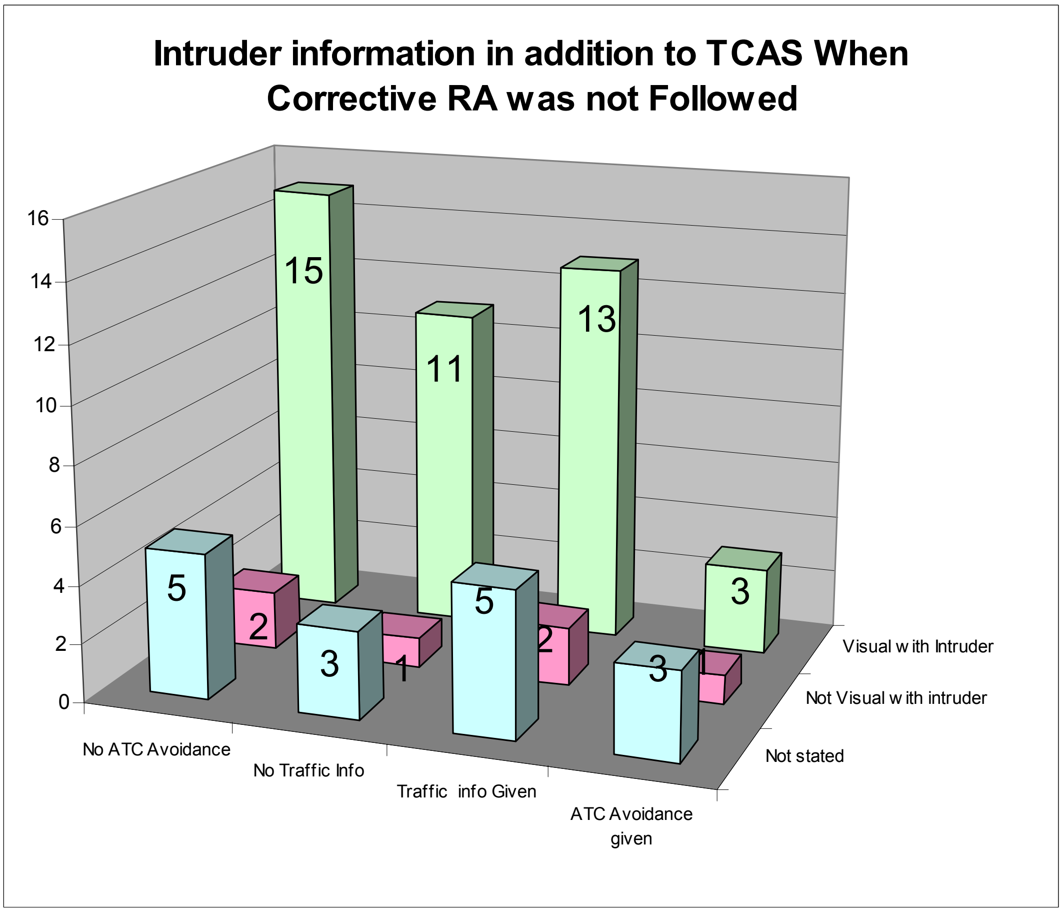

Figure 5: Intruder information graphic presentation

When pilots did follow RAs, Table 9 shows their deviation as a function of altitude band. About 56% of deviations were 500 ft or less and about 12% of deviations were more than 1000 ft, which are better than the previous year (54% and 13% respectively). Most of the larger deviations, above 1000 ft, occurred at FL200 or above as in other years. But this year there is also a significant number below FL100.

Table 9: Deviation from clearance as a function of altitude band

Vertical Deviation	0-100	100-200	200-300	300-400	400-500	Total
0-500	52	64	75	17		208
500-1000	22	38	48	7	1	116
1000-1500	4	9	14	4		31
1500-2000	2	1	3	2		8
2000-2500	3	1	1	1		6
4000-4500			1			1
Total	**83**	**113**	**142**	**31**	**1**	**370**

The deviations are more evenly spread through the FL bands than in previous years.

Figure 6 shows graphically the magnitude of deviations as a function of altitude band. What is noticeable is the more even distribution of deviations across the FL bands.

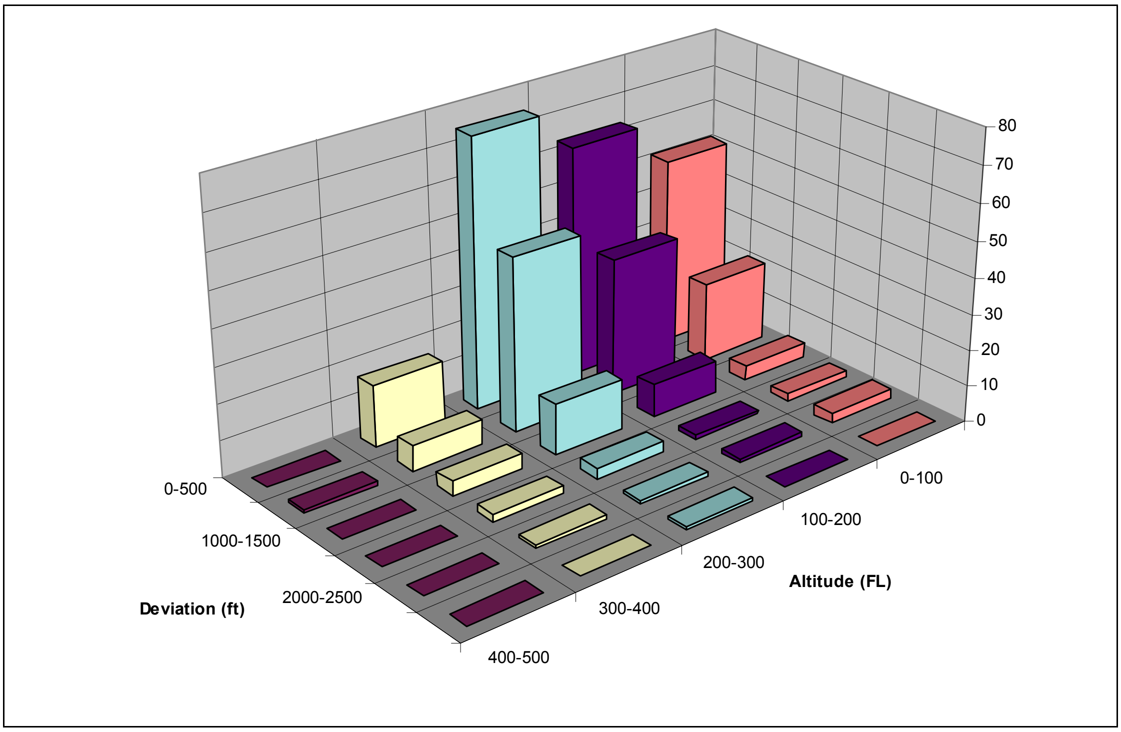

Figure 6: Magnitude of deviations as a function of altitude

The own (i.e. TCAS equipped) aircraft attitude (i.e. climb / descend / level) is the primary information on the bottom line and matched against the same categories for the intruder.

Only 19% of RAs occurred when own aircraft was in level flight, 10% down on the previous year. However 37% of RAs involve a level intruder.

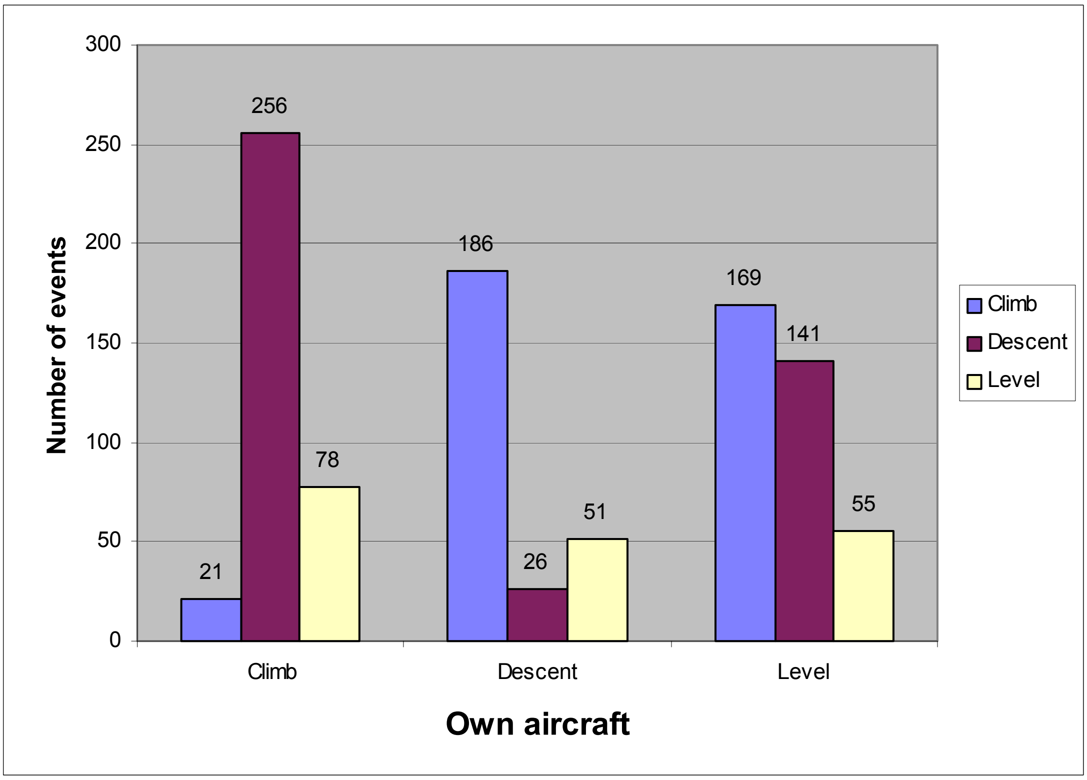

Figure 7: Encounter geometry, own aircraft against intruder

Figure 7 shows the distribution of the aircraft attitude at the issue of TCAS RA, expanded to take the intruder's profile into account.

6.3. CPA MISS DISTANCE DISTRIBUTION

TCAS II version 6.04a triggers alarms even if the aircraft range at CPA is greater than 5 nm. In an attempt to reduce the disruption, TCAS II version 7.0 introduces improved tracking and a horizontal miss distance filter. To assist the assessment of the HMD filter's effectiveness, the miss distance at CPA was derived when radar data was available. The results are shown in Figure 8. and Figure 9. The results show a shift of RAs to smaller HMDs. There are fewer cases of RAs at large HMDs (mostly nuisance Ras) and hence a larger % of RAs at smaller HMDs.

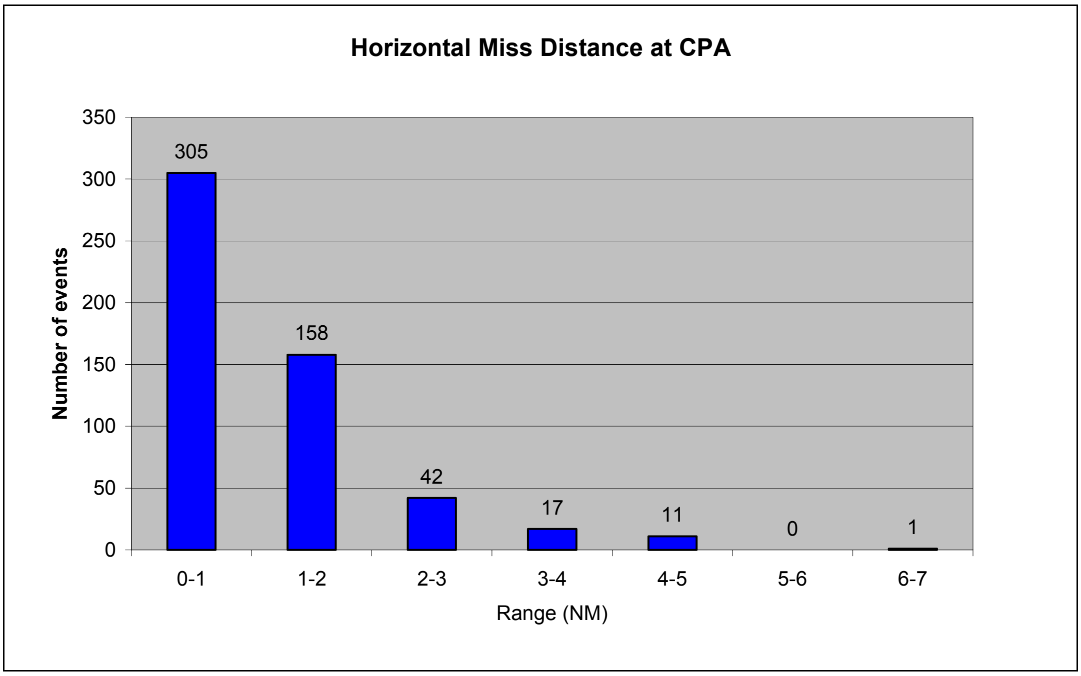

Figure 8: Number of aircraft at a given miss distance at CPA

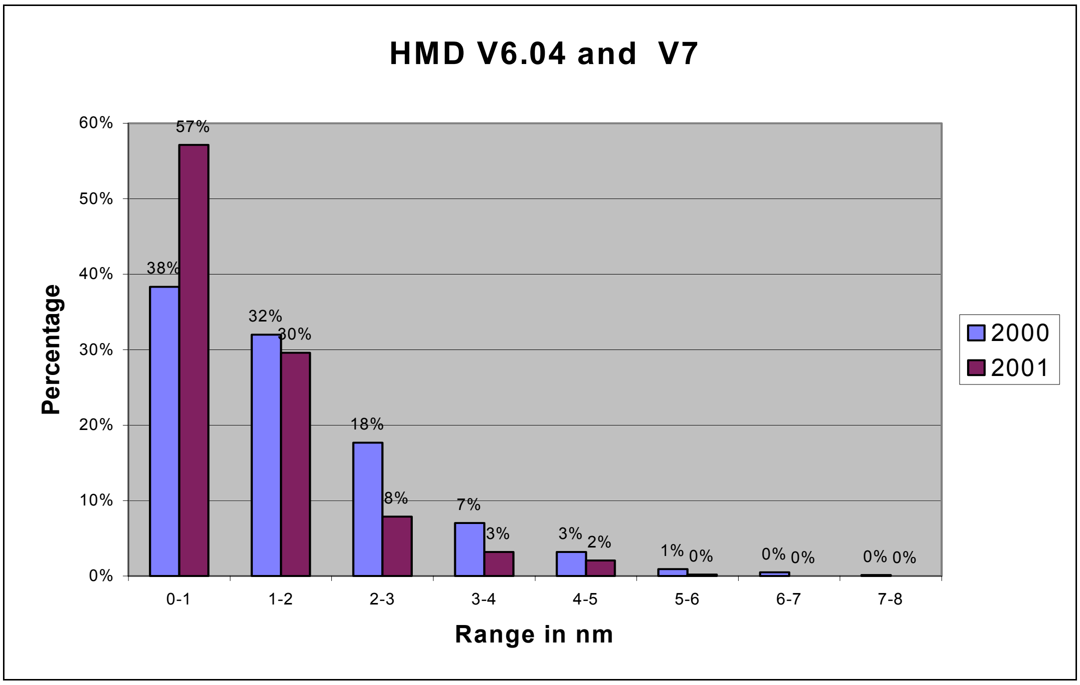

Figure 9: The effect of TCASII V7 on HMD

7. TCAS ASSESSMENT

7.1. CONTROLLER ASSESSMENT

Controllers were asked in the questionnaire to give their opinion of the alert and to give some indications about working conditions. Table 10 shows that only in about 21% of cases (compared with 23% the previous year) did the controller express the opinion that the pilot's action was justified.

Table 10: Controller assessment of pilot action

Justified pilot action	Number
Y	71
N	169
Total	240

Figure 10 shows controller's opinion about the disruptive effect of TCAS alarms and their estimate of the workload at the time the RA was reported.

Only when the workload is low, is the distraction caused by TCAS not often regarded as disruptive (18%, similar to the previous year). It is more disruptive with normal workload (29%, 10% down on the previous year), and is most disruptive with high workload (53%, 6% down on the previous year).

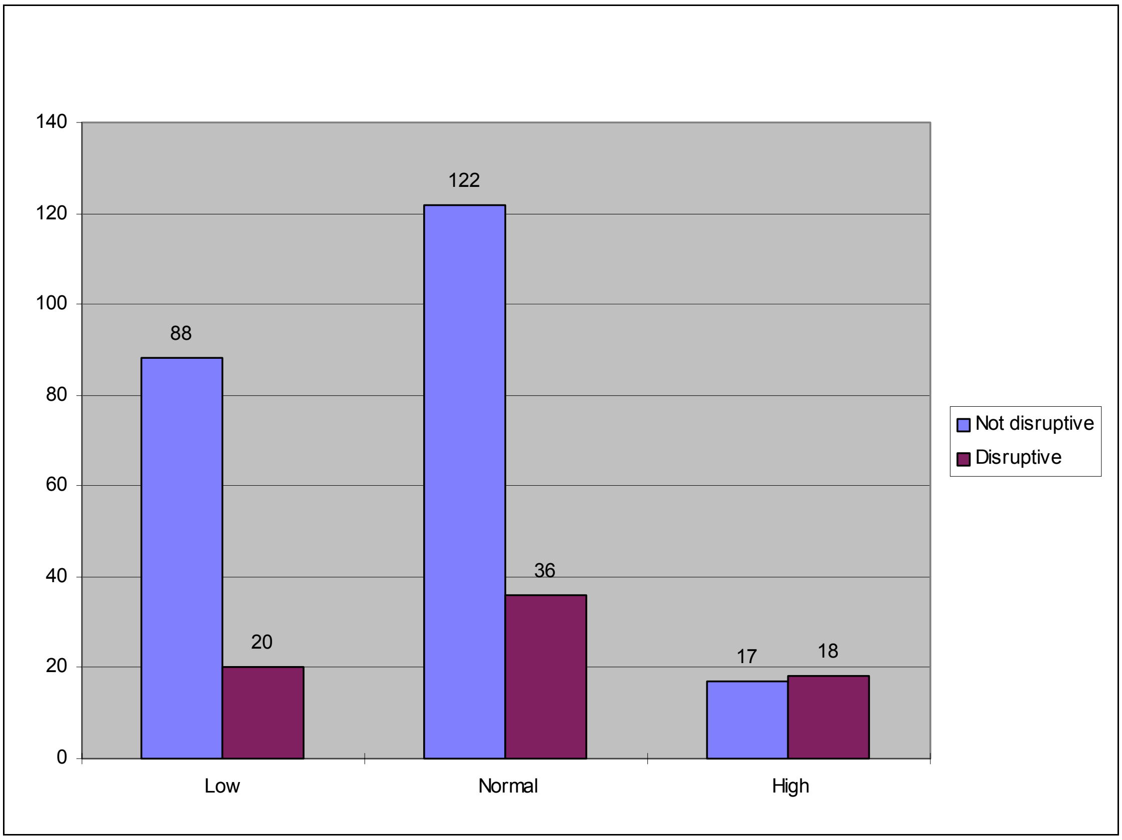

Figure 10: Disruption caused by TCAS events as a function of Workload

7.2. PILOT ASSESSMENT

Pilots gave their opinion of events in 3 categories (necessary / nuisance / useful), and whether or not the RA was followed. The results are shown in Table 11.

Table 11: Pilot Event Appraisal

Pilot apparaisal	Followed	Not followed	%
Nuisance	135	12	36%
Useful	159	12	42%
Necessary	85	2	21%
	379	26	

This shows an improvement on the previous year (a 9% reduction in nuisance alerts, and a 2% increase in useful RAs). A characteristic already noted in previous operational monitoring reports, is again evident, that when pilots expressed an opinion, 21% of events were considered necessary, yet when pilots or controllers reported whether or not an airprox was filed, they said there was an airprox in only 5% of events (See Table 12). The real figure is likely to be even lower.

Table 12: Proportion of events with an airprox

Events with incident reports		
Airprox	69	5.0%

7.3. ASSESSMENT WITH RADAR DATA

Events analysed and supported with radar data were also assessed and categorised as unnecessary, useful, or compatible with respect to ATC separation norms. An additional category, false, was attributed to cases where no real traffic were in the vicinity. (These categories are defined in section 8 of this report). The results are shown in Table 13. The proportion of useful RAs is similar to the previous year. There is a significant reduction of 23% in the number of Unnecessary RAs and a similar increase in the number considered compatible.

Table 13: Assesment with radar data

Events with incident reports	Number	
Unnecessary	115	36%
Useful	99	31%
Compatible	101	32%
False	5	2%

The reduction in unnecessary RAs is most probably due to the logic changes introduced with TCASII version 7.

8. IDENTIFICATION AND ANALYSIS OF OPERATIONAL ISSUES

Early in the TTP program, the FAA developed a system to classify particular characteristics of TCAS II in respect of technical or operational shortcomings.

The European Event Analysis Group adopted the basic FAA categorisation but also added some additional issue classes. However the weight of these issues changed reflecting the different ATC and ATM structure in Europe. Events, where these operational issues were a factor, were categorised throughout the evaluation period.

Frequently, encounters raised more than one issue

Example: a TCAS equipped aircraft climbing towards his assigned FL, 1000 ft below a level intruder, got a 'Descend' RA : which raised the 3 issues 'High Vertical Rate', 'Level-off above/below', 'Reversed Vertical Rate'.

Specific problem areas are identified below :

- Technical problems: linked to system malfunction;
- RAs associated with Airport operations;
- RAs generated due to the High vertical rates of either aircraft;
- High energy levelling off manoeuvres by intruder aircraft, ("Bump-up");
- Holding pattern operation;
- Large deviation of the aircraft following a resolution advisory;
- RAs generated in encounters with large horizontal miss distance;
- Local aerodrome traffic;
- Low altitude advisories;
- Military traffic;
- Non-altitude reporting traffic;
- Non-airborne intruder;
- Reduced separation with 3rd aircraft;
- Visual clearance/acquisition and separation;
- Pilot training.

For each of these issues, which are normally not mutually exclusive, the number of cases for each category (defined below) is shown in Table 14. This table is based on those events which had received such a categorisation.

Advisory appraisal definitions:

- Unnecessary: RA is incompatible with ATC clearance and normal ATC separation would have been maintained without the RA;
- Compatible: RA is compatible with ATC clearance;
- Useful: RA where, without TCAS, normal ATC separation would have been significantly infringed;
- False: RA target unseen by pilot and unknown to ATC.

Table 14: Appraisal of events by issue

Issue category	Unnecessary	Compatible	Useful	False	Total
LEVEL OFF ABOVE/BELOW	654	302	96	1	1053
HIGH VERTICAL RATE (>1500 ft/min)	436	199	172	0	807
REVERSED VERTICAL RATE	420	27	208	0	655
TCAS-TCAS co-ordination	318	103	122	0	543
LARGE DISP (>500'[<290] else >1000')	130	1	92	1	224
MILITARY-OTHER	50	11	104	0	165
LOCAL AERODROME TRAFFIC	16	13	54	2	85
INSUFFICIENT DATA	30	20	16	0	66
LARGE HMD	54	11	0	0	65
LOW ALTITUDE RA (<2500 ft)	8	6	36	2	52
TRAINING	20	1	20	3	44
ALTITUDE STATION KEEPING	4	4	32	0	40
HOLDING PATTERN OPERATION	4	2	22	0	28
PHANTOM INTRUDER	0	0	0	27	27
LOW ALTITUDE TA (<2500 ft)	4	2	20	1	27
REDUCED SEPARATION WITH 3RD A/C	10	0	14	0	24
ATC CONFLICT	0	1	20	0	21
HORIZONTAL TURN	0	0	14	0	14
MISSED APPROACH	0	0	12	0	12
VISUAL CLEARANCE	0	1	8	0	9
ALTITUDE CORRUPTION	8	1	0	0	9
DUAL/CROSSWIND RUNWAYS	2	0	4	0	6
MODE-A TRAFFIC	0	0	4	0	4
NON-AIRBORNE INTRUDER	2	0	0	2	4
TCAS MUTUAL SUPPRESSION BUS INTERFACE	0	0	0	1	1
TCAS FAILURE TO DISPLAY	0	0	0	0	0
	Issues				**3985**

Still the biggest issue (76%, a 5% reduction on the previous year) remains the nuisance level offs, which are highly correlated with high vertical rates and reversed vertical rates. Flight levels separated by 1000ft, with either or both climbing and descending traffic levelling off, leads to a considerable number of these cases.

Events in which RAs were coordinated, i.e., both aircraft operating TCAS, was 39%. This is a marked increase of 16% over the previous year, again reflecting the overall increase in the population of TCAS equipped aircraft.

Large vertical deviations in reaction to some RAs occurred in 16% of issues, a reduction of 6% observed in the previous year.

RAs occurring despite large horizontal separation at CPA accounted for 5% of significant issues (similar to previous year). The reduction in the numbers of RAs achieved by introduction of improved tracking and miss-distance filter of TCAS version 7.0 is not reflected in the issue recording. However reference to CPA miss distance distribution shows the improvement. It should be noted that a manoeuvring aircraft disables the miss distance filter.

Military manoeuvres accounted for about 12% of significant issues, three times the 1999 figure. Possible reasons for this are the increased military activity due to the conflict in Afghanistan, and the increased TCAS equipage on European traffic due to the European Mandate.

Technical problems, usually manifested by phantoms, remain an issue of concern. They represent about 2% of reported RAs (similar to the previous year). Although some of these can be traced to suppression bus or other hardware failures (done by checking for multiple reports from the same airframe) the large majority remain unresolved.

The majority of other problems were associated with TMAs. Some events were in holding patterns, others at low altitudes, with visual clearances, with missed approaches etc.

9. CONCLUSIONS

This report makes an assessment of the 2001 ACAS II monitoring data in Europe.

The European mandate for ACAS II in 2000, has produced an overall increase in the population of TCAS equipped aircraft in Europe. There is a significant reduction in the number of TCAS reports from both controllers and Pilots in 2001 compared with 2000 (45%)...)

The most significant factor in reducing the number of TCAS RA alerts must be attributed to the mandating of TCAS II Version 7 and the improved logic processing.

Theoretically this would account for a reduction by a factor of 2 in the number of RAs. In addition, other factors affecting the number of RAs reported could include lack of enthusiasm for reporting routine events, broken reporting chains when airlines change management, not all member states provide comprehensive recording and or forwarding of reports.

The data suggests that the high level of pilot compliance to RAs, noted in the previous year, is being sustained. This may be linked to improved pilot acceptability of the system suggested by the reduced number of nuisance reports. Controller assessment remains mostly stable. Nevertheless, training for both military and civil pilots and controllers remains important.

High vertical rates associated with level offs remain the major source of nuisance for TCAS. They are a consequence of setting thrust for optimum performance when speed restrictions apply.

Although some phantom RAs can be tracked to hardware problems, most remain unresolved.

10. ACRONYMS & GLOSSARY

ACAS	Airborne Collision Avoidance System.
Clear Of Conflict	An indication to the flight crew that an RA has terminated.
Compatible RA	RA in accordance with ACAS II specification, which is compatible with clearance.
Coordinated RAs	Compatible sense RAs, following the exchange of coordination messages, in an encounter between two TCAS equipped aircraft.
Corrective RA	RA requiring pilot action to adjust vertical speed.
CPA	Closest Point of Approach.
Deviation	Vertical displacement from flight path, in following a Corrective RA.
False RA	RA was based on a false track created by erroneous surveillance data or an onboard system malfunction.
FL	Flight Level.
Ft	Feet.
HMD	Horizontal Miss Distance
	Horizontal Miss Distance Estimated horizontal separation at CPA of a certain traffic.
NM	Nautical Mile.
Nuisance RA	RA in accordance with ACAS II specification, recommending a manoeuvre away from clearance, where normal separation was not or would not have been significantly infringed.
Phantom	A non existing threat aircraft indicated by a False RA.
Pilot Model	Algorithm used to model pilot reaction following an RA; with parameters to model delay, acceleration, and target vertical speed.
Preventive RA	RA indicating vertical speeds to avoid, but not requiring pilot action.
RA	Resolution Advisory
Resolution Advisory	An indication to the flight crew recommending either a manoeuvre to provide separation from all threats, or a manoeuvre restriction to maintain existing separation.
TA	Traffic Advisory
TCAS	Traffic alert and Collision Avoidance System.
Traffic Advisory	An indication to the flight crew that a certain traffic is a potential threat.
Useful RA	RA in accordance with ACAS II specification, where normal separation was or would have been significantly infringed.
Vertical Miss Distance	Estimated vertical separation at CPA of a certain traffic.
VMD	Vertical Miss Distance

Page intentionally left blank

TRADUCTION EN LANGUE FRANÇAISE

RESUME

Le **système anticollision embarqué (ACAS)** Système embarqué qui, au moyen des signaux du transpondeur de radar secondaire de surveillance (SSR) et indépendamment des systèmes sol, renseigne le pilote sur les aéronefs dotés d'un transpondeur SSR qui risquent d'entrer en conflit avec son aéronef.

Depuis 1991, **EUROCONTROL** participe à l'organisation de la surveillance opérationnelle de l'ACAS dans l'espace aérien européen, pour le compte des transporteurs européens. Ces travaux sont menés sous les auspices de l'OACI. Parallèlement, le Royaume-Uni et la France mènent leurs propres travaux de surveillance dans leur espace aérien respectif, et ces travaux font partie intégrante du programme européen de surveillance de l'ACAS.

Le **système d'avertissement de trafic et de prévention des abordages TCAS II** est le seul système commercial qui répond aux exigences de l'**ACAS II**. La dernière version du TCAS II, la version 7, remplace progressivement, depuis fin 1999, la V6.04A dans tous les aéronefs. Cette nouvelle version, entièrement conforme aux exigences de l'ACAS II, comporte des améliorations notables sur les plans opérationnel, technique et de la sécurité.

Le TCAS II est un système embarqué indépendant fondé sur les technologies SSR. Il émet et reçoit des messages Mode S et Mode C via le transpondeur de l'aéronef. La fréquence d'interrogation est de 1 Hz environ ; les distances et variations de distance ainsi calculées ainsi que l'altitude mesurée à partir des réponses Mode S et Mode C permettent de déceler la présence d'autres aéronefs dans le voisinage. La logique détermine sur cette base l'existence d'un danger éventuel.

Lorsqu'un aéronef est détecté par le système de surveillance TCAS et défini comme étant un danger potentiel par la logique CAS, TCAS le signale au pilote en adressant un **avertissement de trafic (TA)**. Si la menace est imminente, le TCAS II propose au pilote une manœuvre d'évitement dans le sens vertical : il s'agit d'un **avis de résolution (RA)**.

Le présent rapport se fonde essentiellement sur les comptes rendus de pilotes et de contrôleurs. Différents questionnaires ont été adressés à des compagnies aériennes et à des centres ATC. Les réponses à ces questionnaires ont servi à constituer la partie la plus importante de la base de données. De plus, il a été demandé aux contrôleurs d'obtenir les enregistrements de données radar afférents à tous les comptes rendus qu'ils ont analysés, et ces données ont été ajoutées à la base de données.

On trouvera ci-après certaines des statistiques essentielles établies à partir des comptes-rendus de 2001. Il convient de noter cependant que tous les événements notifiés n'étaient pas des RA : sur les 1537 comptes-rendus, 1384 portaient sur des RA, 98 sur des TA et 55 sur des événements non identifiés.

La ventilation des événements par phase de vol se fonde principalement sur les comptes-rendus de pilote :

Décollage 4 (0,5 %), montée 347 (41,1 %), croisière 113 (13,4 %), descente initiale 288 (34,1 %), attente 13 (1,5 %), approche 65 (7,7 %), et phase finale 14 (1,7 %).

Il ressort clairement de la ventilation des RA par altitude dans l'espace aérien européen que la majorité des événements se produisent entre les niveaux FL 80 – 140 et FL 200 – 300, en raison principalement de l'organisation de l'espace aérien à ces niveaux. Ce sont les vitesses verticales élevées utilisées dans les procédures standard de stabilisation avec des clairances à 1000 pieds qui provoquent la majorité des RA (environ 76 %).

Dans la plupart des cas signalés (95 %, comme l'année précédente), le pilote se conforme à un RA. La décision du pilote de ne pas suivre un RA est presque toujours motivée par d'autres informations : vision de l'intrus, informations de trafic ou instruction d'évitement donnée par l'ATC.

56 % des pilotes qui se sont conformés à un RA ont dévié de 500 pieds ou moins, et 12 % environ ont dévié de plus de 1000 pieds. C'est une légère augmentation par rapport à l'année précédente (respectivement 54 % et 13 %).

Seulement 30 % des contrôleurs interrogés (contre 21 % l'année précédente) estiment que la manœuvre exécutée par le pilote comme suite à un RA se justifiait. 23 % d'entre eux (6 % de moins que l'année précédente) considèrent la notification des alarmes TCAS comme gênante lorsque la charge de travail est normale, 51 % (5 % de moins que l'année précédente) comme très gênante lorsque la charge de travail est élevée.

Selon les pilotes, 36 % des avertissements constituaient une nuisance (9 % de moins que l'année précédente), 42 % étaient utiles (2 % de plus que l'année précédente) et 21 % nécessaires (5 % de plus que l'année précédente). Dans 5 % des cas seulement, un compte-rendu AIRPROX a été déposé.

Le Groupe européen de surveillance opérationnelle (OMG) a classifié les événements liés à des questions opérationnelles pendant toute la période d'évaluation. Il ressort des ces travaux que le problème principal (76 %, soit une diminution de 5 % par rapport à l'année dernière) demeure celui des stabilisations inutiles, qui sont très étroitement liées aux vitesses verticales élevées et aux vitesses verticales inversées. Un autre problème majeur est celui des écarts verticaux importants comme suite à certains RA, dont la proportion était de 16 %, soit une diminution de la proportion observée l'année précédente.

Il ressort des cas de mauvaise utilisation des TCAS et de non-respect des RA que la formation des pilotes doit demeurer une priorité élevée.

En effet, la surveillance montre que le TCAS améliore la sécurité de l'espace aérien lorsque les avis de résolution sont suivis correctement.

On trouvera à l'Annexe A du présent rapport des exemples "anonymes" d'événements ACAS qui pourront servir à promouvoir la formation et une plus grande prise de conscience dans la communauté aéronautique.

1. INTRODUCTION

Si l'on veut que la mise en œuvre de l'ACAS dans l'espace aérien de la CEAC se déroule dans de bonnes conditions de sécurité et d'exploitation, il faut surveiller les événements ACAS qui surviennent dans cet espace aérien et relayer ces informations au personnel technique et opérationnel qui travaille sur l'ACAS.

Le présent rapport comprend une description et une analyse de la surveillance exercée en 2001, ainsi qu'une analyse de données visant à déterminer si le système ACAS continue d'améliorer la sécurité et est acceptable sur les plans technique et opérationnel. Il fournit donc des enseignements opérationnels et techniques utiles au sujet des performances ACAS.

Les tendances observables par rapport aux résultats précédents y sont également présentées.

2. OBJECTIFS

Le projet "Surveillance de l'ACAS" a pour objectif de fournir au programme de mise en œuvre de l'ACAS des informations permettant de vérifier si ces objectifs sont atteints.

Il vise également à détecter toute anomalie dans le fonctionnement de l'ACAS et à fournir des informations propres à contribuer au redressement de la situation.

3. CONCLUSIONS

On trouvera dans le présent rapport une évaluation des données 2001 de surveillance de l'ACAS II en Europe.

Le fait que, depuis 2000, les aéronefs évoluant en Europe doivent impérativement répondre aux normes ACAS II est à l'origine de l'augmentation du nombre d'aéronefs équipés du système TCAS. Il y a une réduction significative du nombre de rapports transmis tant par les pilotes que par les contrôleurs en 2001 en comparaison de 2000 (45%).

L'élément le plus significatif dans la réduction des RA doit être attribué à l'obligation européenne d'équiper les aéronefs du TCAS II Version 7 et de l'utilisation d'une logique améliorée.

En théorie, cela devrait expliquer une réduction de moitié du nombre de RA's.

De plus, parmi les raisons affectant le nombre de RA rapportés on peut inclure le manque d'enthousiasme à rapporter des évènements routiniers, l'interruption de la transmission des rapports lors de restructuration à l'intérieur des compagnies aériennes ou le fait que les états membres ne fournissent pas tous des enregistrements complets et/ou ne transmettent pas les rapports).

Il ressort des données que le niveau de réaction aux RA reste élevé, comme les années précédentes. Cette tendance peut s'expliquer par le fait que les pilotes acceptent mieux le système, comme le suggère la diminution du nombre de comptes rendus de nuisance. L'évaluation des contrôleurs demeure, en grande partie, inchangée. Toutefois, la formation des pilotes et des contrôleurs militaires et civils reste importante.

Les vitesses verticales élevées associées aux stabilisations demeurent la source principale de nuisance pour le TCAS. Elles sont dues à la poussée exercée en vue d'une optimalisation des performances malgré les limitations de vitesse en vigueur.

Bien que certains RA fantômes puisent être attribués à des problèmes de matériel, la plupart d'entre eux demeurent inexpliqués.

Page intentionally left blank

ANNEXE

Page left blank intentionally

ANNEXE A - EXAMPLES OF TCAS ISSUES

This appendix contains a set of TCAS events from 2001 that illustrate some of the TCAS issues described in the report. The following examples have been selected:

Table A.1: TCAS issues

Event number	Issue
10866	Three a/c Encounter with TCAS v Controller conflict.
12606	TCAS contradicts Controller Solution. One A/C follows TCAS one ATC/Visual.
11897	Level Bust following Monitor V Speed RA.
12661	GA aircraft under approach Excessive deviation.
15400	Phantom Intruder Generated by Military Pair.

Most of these reports show simulations performed using the InCAS tool. On the following page is an explanation of the diagrams depicting the encounters.

For further information on how InCAS is used to analyze radar data and produce these reports, please look at http://www.eurocontrol.fr/ba_saf/acas/InCAS/Index.htm

The event number used in the table above refers to our own reference for each event and has no significance in itself.

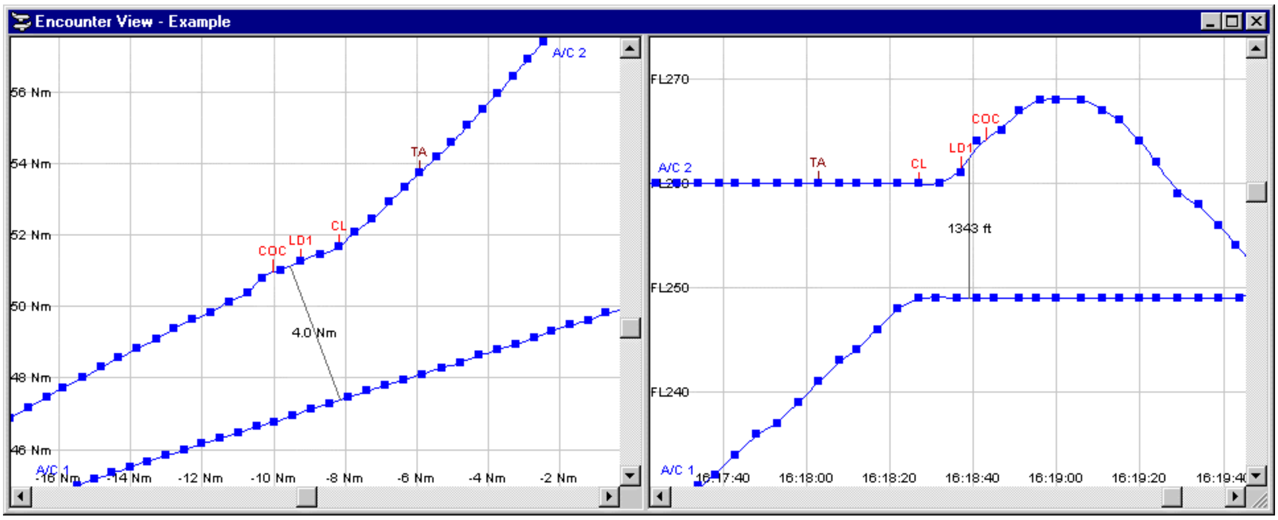

Figure A.1: TCAS simulation report - encounter view key

- The left windowpane shows the horizontal view (scale in NM) of the encounter, and the right windowpane the vertical view (vertical scale in FL, horizontal scale in time-of-day). Cartesian grids are displayed in both views, to assist the visual appreciation of the separations in the encounter.

- The aircraft identifier is always shown at the edge of the view, at the earliest point in the trajectory. Radar Plots are represented by small squares, trajectories by a continuous line passing through or close to the radar plots.
- A line connecting the two aircraft trajectories indicates closest point of approach. In the left pane the line is labelled with the horizontal separation in NM, while in the right pane the vertical separation is shown in ft.

ACAS advisory codes

A two or three-letter label represents an ACAS alarm. A short vertical line connects the label to the trajectory of the own ACAS aircraft, at the point in time corresponding to the start of the alarm. Only changes in the ACAS alarm are shown.

Table A.2: ACAS advisory codes

Code	Advisory
PA	Proximate Advisory
TA	Traffic Advisory
COC	Clear of conflict
LD5 / LD1 / LD2	Limit descent 500 / 1000 / 2000 feet per minute
LC5 / LC1 / LC2	Limit climb 500 / 1000 / 2000 feet per minute
CL / CCL	Climb (1500 fpm) / Crossing Climb
ICL	Increase climb (2500 fpm)
MCL	Maintain climb
RCL	Reverse climb
DCL	Don’t climb
DE / CDE	Descend (1500 fpm) / Crossing Descend
IDE	Increase descent (2500 fpm)
MDE	Maintain descent
RDE	Reverse descent
DDE	Don’t descend

A.1. EVENT 10866 THREE A/C ENCOUNTER WITH TCAS V CONTROLLER CONFLICT

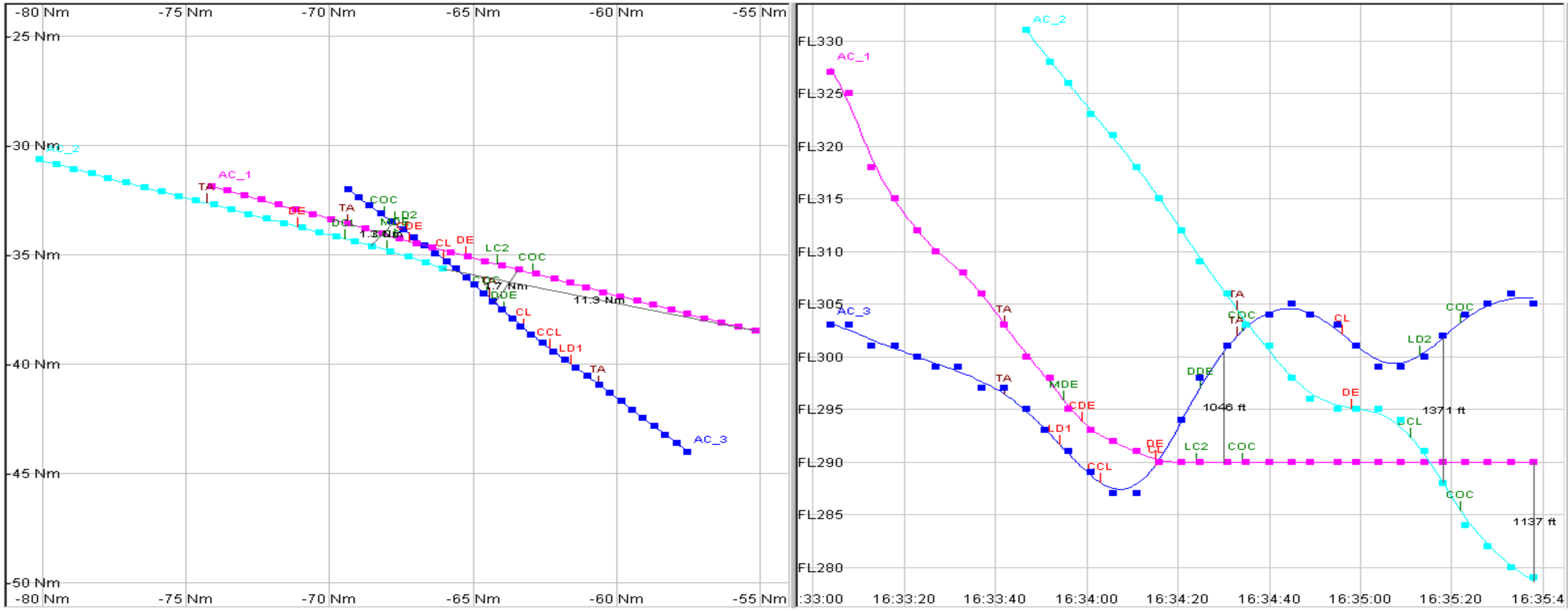

Figure A.2: Event 10866 Three a/c Encounter with TCAS v Controller conflict

Aircraft 3 was descending from FL390 to FL260, at approximately 1000 fpm; in the opposite direction aircraft 1 was descending from FL330 to FL290, at approximately 3000 fpm; aircraft 2 following aircraft 1 was descending from FL370 to FL290, also at 3000 fpm. aircraft 3 was requested to increase descent rate, due to opposite Aircraft 1, who was requested to reduce his descent rate. Aircraft 3 climbed due to TCAS and entered into a second conflict with opposite descending Aircraft 1.

In this case TCAS countered the controller's solution of getting Aircraft 3 below Aircraft 1 before crossing. The pilot of Aircraft 1 responding to the controller's instruction rather than TCAS resolution advisories resulted in greater deviation by Aircraft 3 following his RA. Aircraft 3 had visual contact with crossing aircraft 2 while responding to a Crossing Climb RA. This could have been the reason for a climb rate of 5000fpm being achieved. The controller's subsequent instruction to aircraft 3 to descend brought aircraft 3 into conflict with aircraft 2 when both responded corrective the RAs.

By following all its RAs, aircraft 3 reduced its collision risk, despite a complicated air situation.

A.2. ENCOUNTER 12606 TCAS CONTRADICTS CONTROLLER SOLUTION. ONE A/C FOLLOWS TCAS ONE ATC/VISUAL

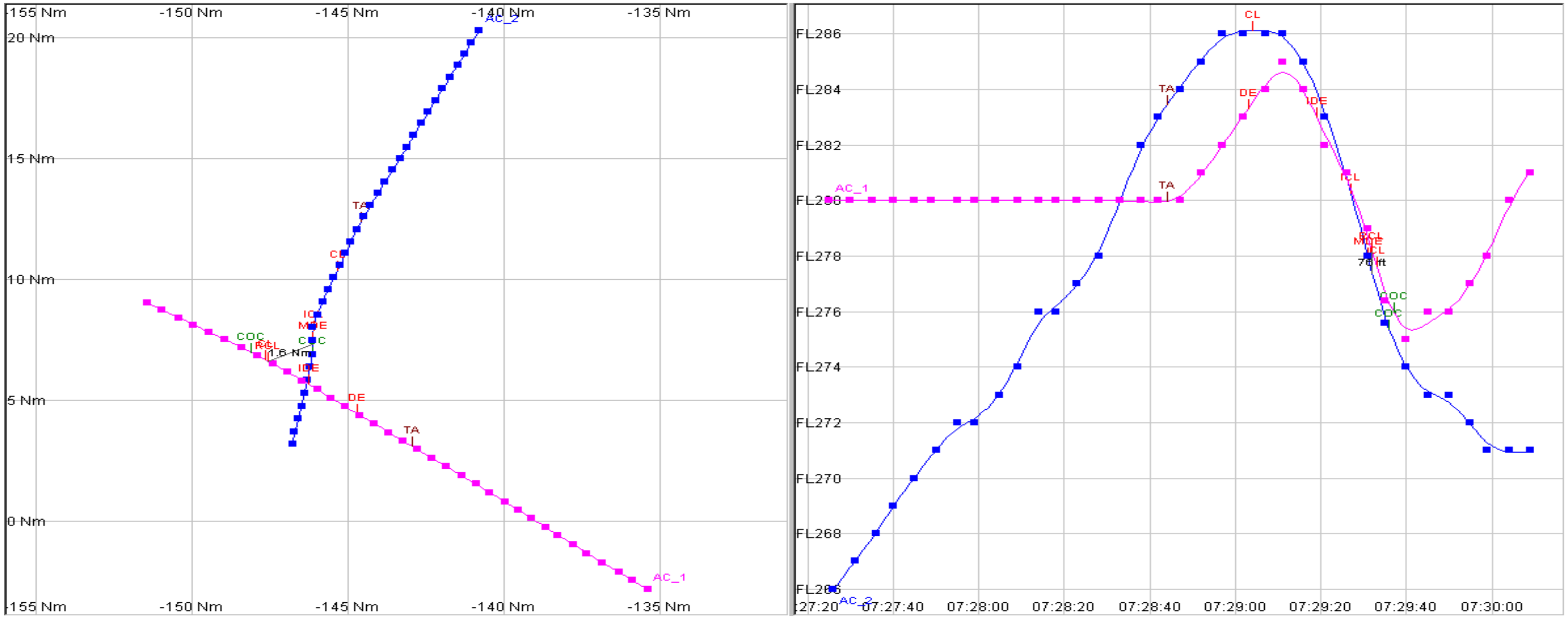

Figure A.3: Encounter 12606 TCAS contradicts Controller Solution. One A/C follows TCAS one ATC/Visual

Aircraft 2 was cleared to climb FL270 and then asked if he was able to climb at 2000 ft/min or more if re-cleared to FL290. The Pilot said he could not and was told to expect further climb later. Aircraft 2 was observed passing FL274 and told to return to FL270. Aircraft 2 was observed still climbing passing FL278 and the controller told aircraft 1 to climb to FL290 and aircraft 2 to maintain FL280. Traffic information was passed to both aircraft, and avoidance turns to the left were also given to both aircraft. Aircraft 2 was observed still climbing at FL284, out climbing aircraft 1at FL282. Aircraft 1 received a descend RA, and reported descending. Both aircraft were then descended one following TCAS and one following controller instructions.

The coordinated TCAS resolution, if followed correctly by both pilots, would have produced almost 800 ft vertical separation. However during the TCAS encounter, aircraft 2 preferred to follow controller instructions and fly a « visual avoidance manoeuver», flying in a vertical sense contrary to his own TCAS indications, and this entirely undermined the coordinated TCAS resolution, effectively reducing the CPA vertical separation to zero. Fortunately, CPA horizontal separation was 1.6nm.

A.3. ENCOUNTER 11897 LEVEL BUST FOLLOWING MONITOR V SPEED RA

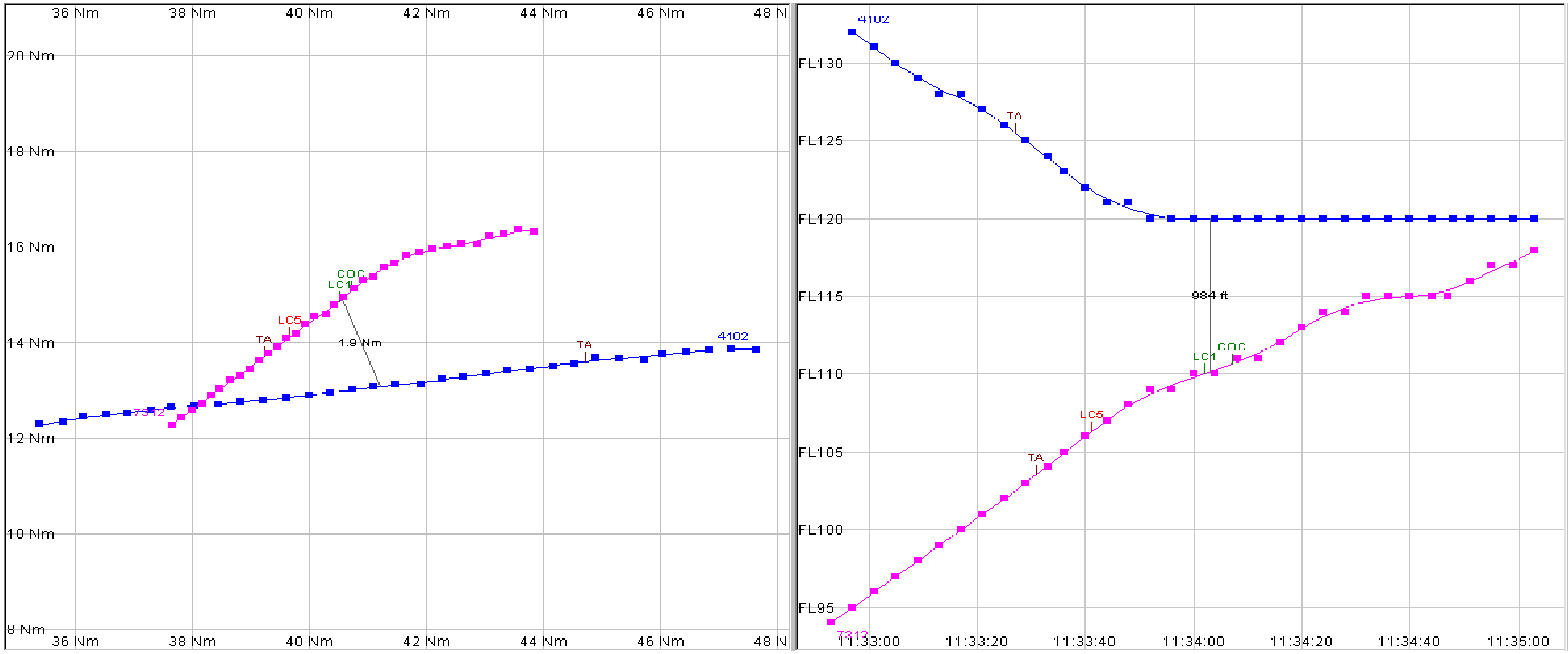

Figure A.4: Encounter 11897 Level Bust following Monitor V Speed RA

On controller instructions 7312 was climbing to Fl 110 on a radar heading. 4102 was descending in the opposite direction to FL120. When 7312 reached FL107 he received an adjust TCAS resolution advisory to adjust vertical speed with TCAS requesting a maximum climb rate of 500fpm. The recommended climb rate was followed by 7312 through the cleared level with the intruder visually monitored passing down the right side. When 7312 reported the RA to ATC re cleared 7312 to FL120.

Pilots comment after the event “I believe the RA came after ASEL which meant that the selection of V.S overrode the altitude selection. At that point we were probably climbing 700-1000 fpm; just decreasing the rate when the V.S. would have locked the pitch rate. TCAS wanted less than 500 fpm, which was easily achieved, but by the time we were clear of conflict and had reviewed our situation, we were 300 feet too high”.

A.4. ENCOUNTER 12661 GA AIRCRAFT UNDER APPROACH EXCESSIVE DEVIATION

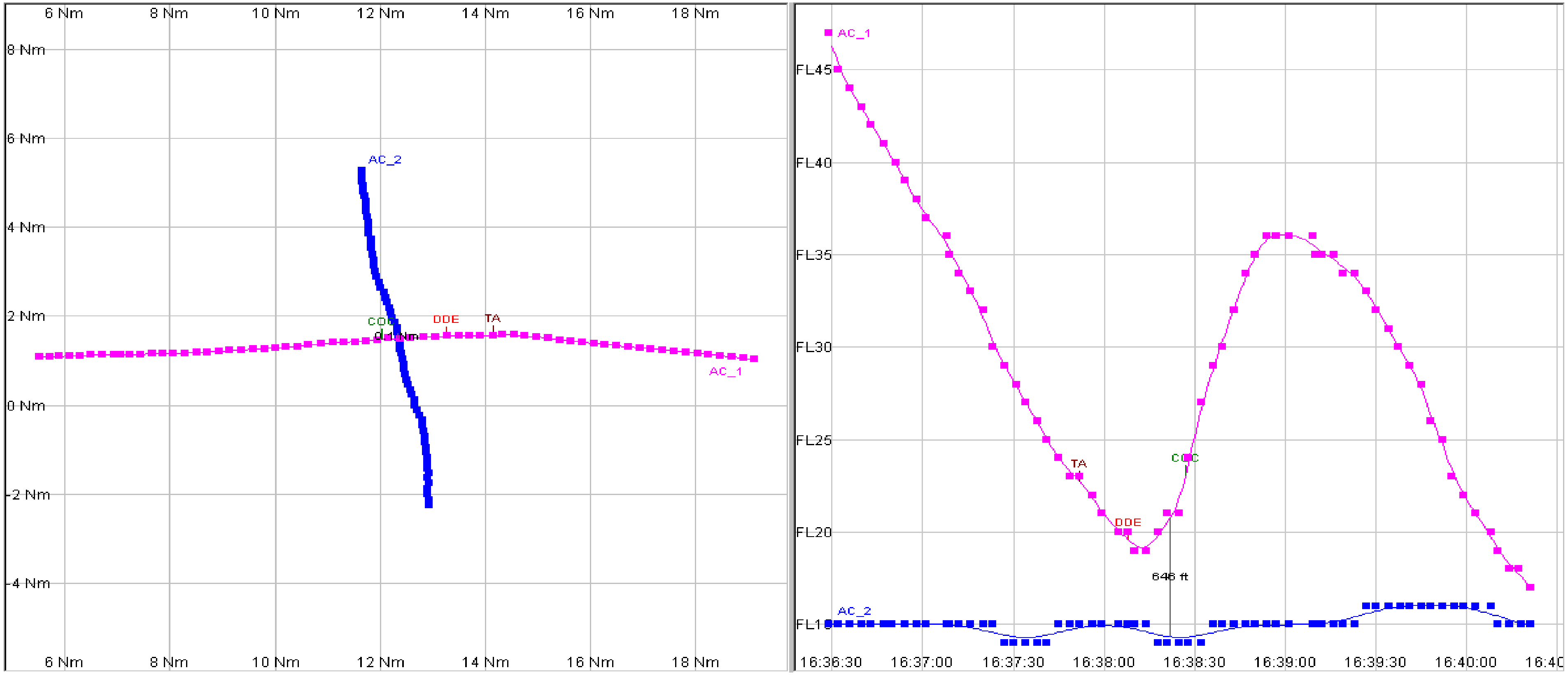

Figure A.5: Encounter 12661 GA aircraft under approach Excessive deviation

Aircraft 1 was established on the ILS glide path. Passing 2000 ft on approach aircraft 1 received an RA. Aircraft 2 was VFR traffic crossing below at 1500 ft. In the simulation, aircraft 1 had an Adjust Vertical Rate RA to stop descending; this would have given a green climb recommendation of 0 to 500fpm. It is also possible that a Climb RA may have occurred in the cockpit and this would have given a green climb recommendation of 1500fpm to 2000fpm. Aircraft 1 actually climbed at 3000fpm to achieve approximately 700 ft vertical separation at CPA, with a horizontal separation of 0.1 Nm. Aircraft 1 continued climbing for approximately 30 seconds after Clear of Conflict, which accounts for the exceptionally large deviation of 1700 ft.

A.5. ENCOUNTER 15400 PHANTOM INTRUDER GENERATED BY MILITARY PAIR

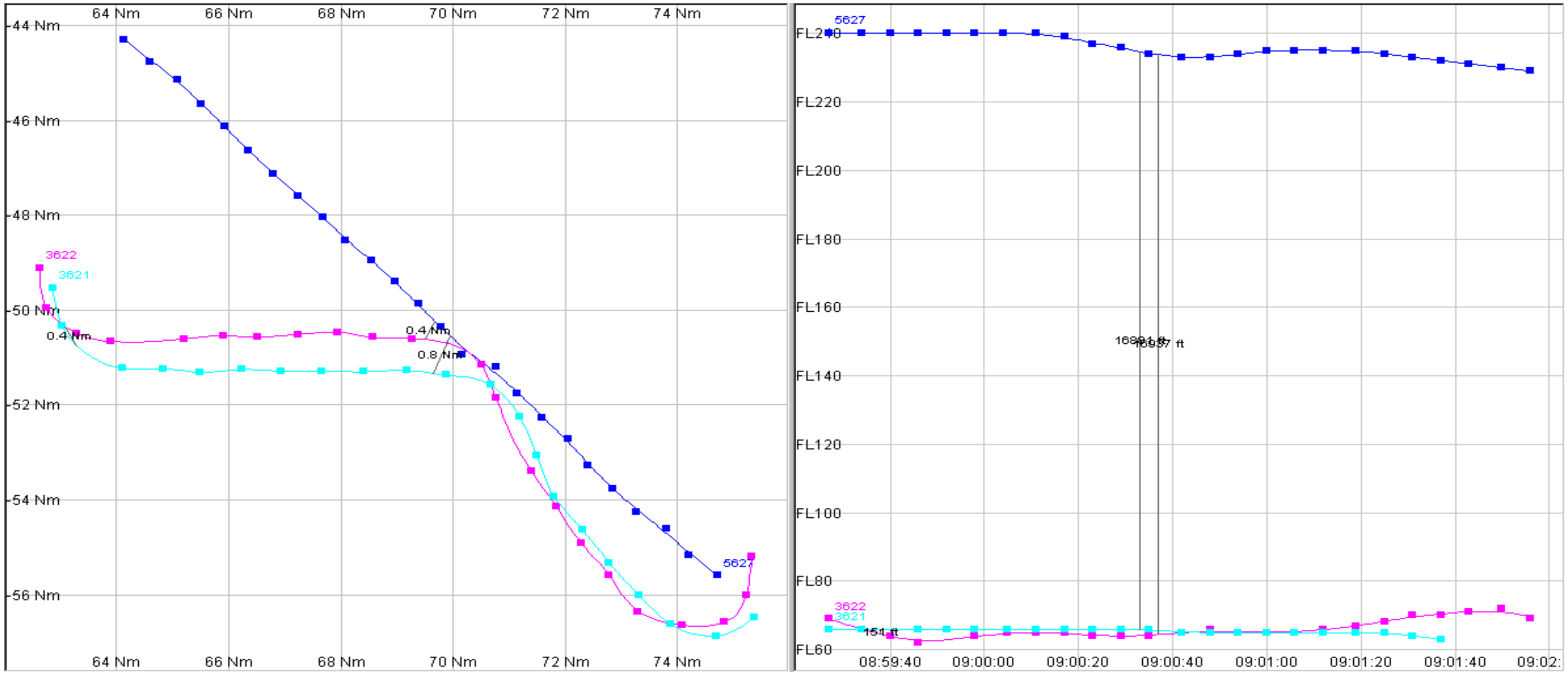

Figure A.6: Encounter 15400 Phantom Intruder Generated by Military Pair

Aircraft 5627 was level at FL240 and reported RA descending. The controller reported no traffic in the vicinity and the pilot of 5627 was given permission for further descent after starting to return to his cleared level.

A secondary radar ModeS TCAS down link message confirmed the pilots report of a short duration descend RA and investigation shows that the military pair at 6600ft and 6500ft generated garble code for 24400ft within the framing pulses of the second aircraft of the pair.

This is one example of how a false track may be generated from garbled Mode C replies. In this case the false track triggered a resolution advisory.