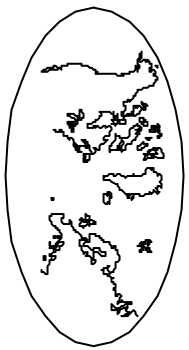
# NORTH ATLANTIC SYSTEMS PLANNING GROUP



NAT SPG/33

# *Summary of Discussions and Conclusions of the*

# *Thirty-Third Meeting of the*

# *North Atlantic Systems Planning Group*

*Paris, 9 - 13 June 1997*

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**AGENDA ITEM 3: AIR NAVIGATION SYSTEM REVIEW**

**INTRODUCTION**

1.1 The Thirty-Third Meeting of the North Atlantic Systems Planning Group (NAT SPG) was held in Paris from 9 to 13 June 1997. The meeting was chaired by **Mr. Myles Murphy**, the Member for Ireland.

1.2 In addition to the International Aircraft Owners and Pilots Association (IAOPA), the International Air Transport Association (IATA), the International Business Aviation Council (IBAC), the International Federation of Air Line Pilots Associations (IFALPA), the International Federation of Air Traffic Controllers Associations (IFATCA), the Group had, as usual, invited the Russian Federation and Spain to attend the meeting as observers. The representative from Inmarsat indicated that he could not attend because of other commitments. A list of participants is at page ii-3.

1.3 The Chairman informed the Group that two colleagues had passed away since its last meeting:

> **Mr. Paul Berger** who had been the Secretary of the NAT SPG from its inception in 1965 until his retirement in 1980. He had played a very important role in establishing the NAT SPG as the first regional planning group in the world.
>
> **Mr. Antonio Claro** was the Portuguese Member in the NAT Traffic Forecasting Group (NAT TFG) and had played an important role in collating information used to produce forecasts for the NAT SPG.

The Group joined in a moment of silence in remembrance of its two colleagues, their dedication to the work and the friendship they provided.

1.4 The Mathematician's Working Group (MWG) had met in Paris from 2 to 6 June 1997 to consider the mathematical and statistical aspects of separation minima safety in the NAT Region and to ensure that the Target Levels of Safety (TLS) were being met. **Mr. Andrew du Boulay**, the rapporteur of the MWG, presented the information that have been developed by the MWG in support of the assessment of current system safety performance in terms of lateral, vertical and longitudinal collision risk.

1.5 The sub-group charged with the scrutiny of navigation performance in the NAT Region, which was chaired by **Mr. Jim Benson** of the United Kingdom and which had met in London, provided the NAT SPG with their report.

1.6 The Aeronautical Communications Sub Group (ACSG) had carried out its work by correspondence and had reviewed matters related to the NAT aeronautical telecommunications infrastructure. **Mr. Phonsie O'Connor** of Ireland, in his capacity of rapporteur, provided the Group with its report.

1.7 The North Atlantic Implementation Management Group (NAT IMG) had met twice since NAT SPG/32 in order to develop the plans for the implementation of Reduced Vertical Separation Minimum (RVSM) and for the implementation of the ICAO Communications Navigation Surveillance/Air Traffic Management (CNS/ATM) systems in the NAT Region. **Mr. Myles Murphy**, the Chairman of the NAT IMG, provided the NAT SPG with a progress report.

1.8 The NAT Operations Managers (OPS MNG) had met in Santa Maria from 11-15 November 1996 in order to address short term operational issues. **Mr. Dinis Resendes** of Portugal, acting as rapporteur in accordance with the new working methods of the OPS MNGs, provided the NAT SPG with an update concerning their activities.

1.9 **Mr. Christian Eigl**, the ICAO Representative, European (EUR) and North Atlantic (NAT) Office, was the Secretary of the Meeting and was assisted by Messrs Jacques Vanier, Robert Kruger, Technical Officers (TO) for Air Traffic Management (ATM) and for Communications

Navigation Surveillance (CNS) respectively from the EUR NAT Office of ICAO and by Mrs Olga Recasens, Chief of the Joint Financing Section from ICAO Headquarters.

1.10 In his opening remarks, the Chairman informed the Group that Mr. George Ennis had replaced Mr. John Nordbø as the Member for the United Kingdom. He also welcomed Mr. Ron Chafe as the observer from IBAC.

1.11 Both the Chairman and the Secretary gave a brief overview of their participation in the first meeting of the ICAO CNS/ATM Implementation Advisory Group (ALLPIRG) which had been held in Montreal in April 1997. The Group noted with appreciation that the establishment of a Programme Co-ordination Office (PCO) by the NAT IMG had been very well received by the ALLPIRG, in particular the focus that the PCO gave to CNS/ATM planning.

1.12 The Secretary of the meeting informed the Group that, because of budgetary and other considerations, the NAT SPG contributory bodies would have to meet more often in Paris in order to ensure that the ICAO EUR/NAT Office would be able to continue to provide the level of service that the NAT SPG expected.

**LIST OF PARTICIPANTS/LISTE DES PARTICIPANTS**

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**LIST OF CONCLUSIONS**

**LIST OF ABBREVIATIONS**

| | |
|---|---|
| *AAD* | Assigned Altitude Deviation |
| *ACAS* | Airborne Collision Avoidance System |
| *ACARS* | Aircraft Communication Addressing and Reporting System |
| *ACC* | Area Control Centre |
| *ACSG* | Aeronautical Communications Sub-Group |
| *ADS* | Automatic Dependent Surveillance |
| *ADSP* | Automatic Dependent Surveillance Panel |
| *AFTN* | Aeronautical Fixed Telecommunications Network |
| *AIC* | Aeronautical Information Circular |
| *AIDC* | Air Traffic Services (ATS) Inter-facility Data Communications |
| *AIP* | Aeronautical Information Publication |
| *AIS* | Aeronautical Information Services |
| *AMSS* | Aeronautical Mobile-Satellite Service |
| *ANP* | Air Navigation Plan |
| *ASE* | Altimetry System Error |
| *ATC* | Air Traffic Control |
| *ATCC* | Area and Terminal Control Centre |
| *ATMG* | Air Traffic Management Group |
| *ATMIP* | Air Traffic Management Implementation Plan |
| *ATN* | Aeronautical Telecommunications Network |
| *ATS* | Air Traffic Services |
| *BOTA* | Brest Oceanic Transition Area |
| *CAA* | Civil Aviation Authority |
| *CADAG* | Communications, Automation and Data Link Applications Group |
| *CMA* | Central Monitoring Agency |
| *CNS/ATM* | Communications, Navigation and Surveillance/Air Traffic Management |
| *CPDLC* | Controller Pilot Data Link Communications |
| *CRM* | Collision Risk Model |
| *CTA* | Control Area |
| *DPP* | Development Programme Plan |
| *DFDR* | Digital Flight Data Recorder |
| *DR* | Dead Reckoning |
| *EATCHIP* | European Air Traffic Control Harmonization and Integration Programme |
| *ELT* | Emergency Locator Transmitter |
| *FAA* | Federal Aviation Administration |
| *FANS* | Special Committee on Future Air Navigation Systems |
| *FASID* | Facilities and Services Implementation Document |
| *FDPS* | Flight Data Processing System |
| *FIR* | Flight Information Region |
| *FMS* | Flight Management System |
| *GAATS* | Gander Automated Air Traffic System |
| *GAT* | General Air Traffic |
| *GLONASS* | Global Orbiting Navigation Satellite System |
| *GMS* | Global Positioning System Monitoring System |
| *GMU* | Global Positioning System Monitoring Unit |
| *GNE* | Gross Navigation Error |
| *GNSS* | Global Navigation Satellite System |
| *GP* | General Purpose |
| *GPS* | Global Positioning System |
| *HF* | High Frequency |
| *HMU* | Height Monitoring Unit |
| *ICD* | Interface Control Document |
| *ID* | Implementation Document |
| *IGA* | International General Aviation |
| *IMG* | Implementation Management Group |
| *INS* | Inertial Navigation System |
| *IRS* | Inertial Reference System |
| *JAA* | Joint Aviation Authorities |
| *MASPS* | Minimum Aircraft System Performance Specification |
| *MIG* | Mathematicians Implementation Group |
| *MNPS* | Minimum Navigation Performance Specifications |

| | |
|---|---|
| *MOPS* | Minimum Operational Performance Standards |
| *MSSR* | Monopulse Secondary Surveillance Radar |
| *MWG* | Mathematicians Working Group |
| *NICE* | NAT Implementation Management Group Cost Effectiveness |
| *NOCAR* | North Atlantic Oceanic Concept and Requirements document |
| *OAC* | Oceanic Area Control Centre |
| *OAG* | Official Airline Guide |
| *OCA* | Oceanic Control Area |
| *OCD* | Oceanic Clearance Delivery |
| *ODAPS* | Oceanic Display and Planning System |
| *OLDI* | On Line Data Interchange |
| *OPS MGS* | NAT Operations Managers |
| *OTS* | Organized Track System |
| *PCO* | Programme Coordination Office |
| *RAIM* | Receiver Autonomous Integrity Monitoring |
| *R&D* | Research and Development |
| *RHSM* | Reduced Horizontal Separation Minima |
| *RNP* | Required Navigation Performance |
| *RSSIG* | Reduced Separation Standards Implementation Group |
| *RT* | Radio Telecommunication |
| *RTCA* | Radio Technical Commission for Aeronautics |
| *RVSM* | Reduced Vertical Separation Minimum |
| *SAR* | Search and Rescue |
| *SARPS* | Standards and Recommended Practices (ICAO) |
| *SATCOM* | Satellite Communications |
| *SOTA* | Shannon Oceanic Transition Area |
| *SUPPS* | Regional Supplementary Procedures |
| *TCAS* | Traffic Alert and Collision Avoidance System |
| *NAT TFG* | NAT Traffic Forecasting Group |
| *TA* | Traffic Advisors |
| *TLS* | Target Level of Safety |
| *TVE* | Total Vertical Error |
| *UIR* | Upper Information Region |
| *VHF* | Very High Frequency |
| *WAAS* | Wide Area Augmentation System (WAAS) |
| *WATRS* | West Atlantic Route Structure |
| *WWW* | World Wide Web |

**AGENDA ITEM 1: DEVELOPMENTS**

## 1.1 Introduction

1.1.1 Under this Agenda Item, the Group considered the following specific subjects:

a) Adjacent Regions;

b) NAT provider States; and

c) Technology.

## 1.2 Adjacent Regions

1.2.1 The Group was provided with information on the implementation of an oceanic controller system that incorporated visual display and data link capabilities, in Tahiti FIR. The system, called Visualisation des Vols Océaniques (VIVO), was installed in two phases: the first providing graphical oceanic flight display and the second including pilot-controller data link.

1.2.2 The resulting performance improvements included message transmission times of less than one minute in 95% of cases and the elimination of misunderstandings between pilot and controller resulting from the poor quality of High Frequency (HF) communications. This system contributed to improved safety and eased the workload for pilots and controllers in the Tahiti oceanic environment.

## 1.3 NAT provider States

1.3.1 The Group was informed that Ireland had commissioned a new Monopulse Secondary Surveillance Radar (MSSR) station which completed the constellation of six radars in the Shannon Area Control Center (ACC) multiradar tracking system. This was in line with the European Air Traffic Control Harmonization and Integration Programme (EATCHIP) requirements for radar coverage, particularly at low levels in the Northwest of Ireland. It also provided redundancy for existing en-route radars and extensive coverage of the Shannon reduced vertical separation minimum (RVSM) Transition Area.

## 1.4 Technology

*Developments concerning the Global Orbiting Navigation Satellite System (GLONASS)*

1.4.1 The Group was provided with information concerning developments of the combined use of GLONASS and Global Positioning System (GPS) and was also informed that the CNS/ATM System Implementation Plan adopted in the Russian Federation envisaged the use of combined multi-channel receivers, operating on GLONASS/GPS signals, for navigation. Research carried out by the Russian Federation and some other countries had demonstrated that the use of the combined GLONASS/GPS receivers met current Required Navigation Performance (RNP) for en-route operations, including Minimum Navigation Performance Specifications (MNPS) airspace, without the need for wide area augmentation systems for this phase of flight. The possibility of providing civil users with a second frequency was under consideration. This would significantly improve navigation positioning accuracy.

1.4.2 Issues pertaining to the combined use of GLONASS/GPS were being addressed, including work by the American Institute of Navigation, by a group of Russian and American experts in order to define more accurately the co-ordinate transformation parameters for the WGS-84 and PZ-90 systems used by GPS and GLONASS respectively.

1.4.3 Russian industrial organizations had developed several types of third generation multi-channel combined GLONASS/GPS receivers that conformed to ARINC standards and used Receiver Autonomous Integrity Monitoring (RAIM) algorithms to reject failed navigation satellites. These receivers were being tested and preparation for certification was under way.

1.4.4 The Russian Federal Aviation Authority was preparing documentation, including airworthiness norms and operation guidance material, required for the use of GLONASS/GPS satellite navigation receivers as a primary means of navigation for the en-route phase of flight. After the trial period has been completed the above documents would be submitted to the NAT SPG for its consideration.

1.4.5 The Group felt that these new receivers could indeed be useful in planning future navigation requirements for the NAT Region. However, the lack of Standards and Recommended Practices (SARPs) could delay their wide-spread use. Accordingly, it was agreed that ICAO should be requested to urgently developed SARPs related to combined GLONASS/GPS receivers.

**CONCLUSION 33/1 - STANDARDS AND RECOMMENDED PRACTICES (SARPS) FOR THE USE OF COMBINED GLOBAL ORBITING NAVIGATION SATELLITE SYSTEM (GLONASS) AND GLOBAL POSITIONING SYSTEM (GPS)**

**That ICAO be requested to urgently develop SARPs for the use of combined GLONASS/GPS receivers.**

1.4.6 In view of these developments, the Group felt that the Russian Federation should be more involved with planning activities affecting navigation performance. In particular, it was indicated that they should take a more active role in the Reduced Separation Standards Implementation Group (RSSIG). The observer from the Russian Federation indicated that this matter would be looked into within his administration.

*Gander Automated Air Traffic System (GAATS)*

1.4.7 The Group was informed of Canada's present and future plans for the GAATS which included software upgrades to enable conflict prediction/detection algorithms to conform to the fourth version of the *Application of Separation Minima North Atlantic Region document* and the *NAT Common Co-ordination Interface Control Document (NAT ICD) (Version 1.2.2)*. The upgrade would also provide enhanced data link between oceanic controllers and the International Flight Service stations. Plans were also outlined for the incremental implementation of Automatic Dependence Surveillance (ADS) and Controller Pilot Data Link Communications (CPDLC) functionality and electronic strips using a GAATS workstation which was being developed.

*Portuguese Oceanic ATS System*

1.4.8 The Group was also informed of progress concerning the development of the Portuguese Oceanic Air Traffic Services (ATS) System, which included the construction of a new Oceanic Area Control Center (OAC) building in Santa Maria and contracts for data processing and communications systems. The new OAC was expected to be fully operational before the end of 1998. The second phase, the evolution of the system for the use of CNS technologies, was being discussed with service providers to ensure timely introduction in coordination with other NAT ATS service providers.

# AGENDA ITEM 2: PLANNING AND IMPLEMENTATION

## 2.1 Introduction

2.1.1 Under this Agenda Item, the Group considered the following specific subjects:

a) Report of the NAT Traffic Forecasting Group

b) Report of the NAT Implementation Management Group

c) Implementation planning

## 2.2 Report of the NAT Traffic Forecasting Group

2.2.1 The 30th Meeting of the NAT TFG was held at the ICAO European and North Atlantic Office in Paris from 8 to 17 April 1997. The major task was to update the NAT annual and peak period forecasts for the 1997 to 2002 period and to update the long-term forecasts for 2005, 2010 and 2015. To this end, estimates of annual 1996 passengers and flights were used as the base in developing the annual forecasts. The NAT TFG revised its previous estimate of 1994 passengers from 44.8 to 43.5 million (down 2.9%) and aircraft from 253,200 to 251,400 (down 0.7%). The July and November 1996 sample data supplied by the OAC served as the basis for the peak period forecasts. The traffic flow between North America and the Caribbean had also been forecasted.

2.2.2 All five Oceanic/Area Control Centres (OAC/ACC) had submitted their sample data which were processed by the United Kingdom Civil Aviation Authority (CAA) and distributed to the NAT TFG. Overall the forecast errors for 1995 and 1996 suggested that the "base" forecasts had tended to under-estimate both passengers and flights in the medium term. The outturn however was within the forecasted range but nearer to the optimistic forecasts in respect of both passengers and more importantly flight numbers. Since the 1995 medium term forecast suggested that longer term forecasts were perhaps a little low, a major reassessment was made.

2.2.3 It was recalled that, prior to 1989, commercial air carrier passengers and aircraft movements were compiled from data provided by IATA. Since 1989, the NAT TFG has had to base its annual estimates of passengers and aircraft movements on a number of different (and not necessarily comparable) data sources. These data sources included the NAT Provider States, 1996 airline statistics compiled by NAT TFG members, Canadian Aviation Statistics Centre's Statement 6 preliminary counts, the United States Immigration and Naturalization and the Department of Transportation (DOT) T-100 data, flight data from the Official Airline Guide (OAG), Eurocontrol and Gander OAC.

*General Observations*

2.2.4 The NAT TFG, taking due account of the uncertainty surrounding its estimate of the 1996 traffic, was of the opinion that some of the relationships used in its forecasting models may be changing. Because of this, a much broader view than in the past was taken when developing the forecasts. The high and low cases were formed by changing the estimates of available capacity arising from changes in growth in other markets and the competitive strategies of the major airlines.

*Estimated number of movements*

2.2.5 The medium term forecasts of both passengers and aircraft movements were similar to those prepared by NAT TFG/29. The year 2000 passenger forecast was 1.7% higher (60.5 versus 59.5 million) while the year 2000 aircraft movement forecast was 1.6% higher (333,300 versus 327,900).

2.2.6 In actual terms, the forecast was for the number of passengers to increase by almost 17 million between 1996 (estimated at 49.2 million) and 2002 (66.2 million), an average annual growth rate of 5.1% The equivalent increase in the number of flights was just over 78,300 (4.2% annually), from an estimated 279,000 in 1996 to 357,300 in 2002.

2.2.7 In the pessimistic scenario, the average annual growth rates for passengers and flights were 3.1% and 2.8%, respectively. For the optimistic case the equivalent figures were 5.9% annually for passengers and 4.9% annually for aircraft movements. The range between the 2002 optimistic and pessimistic forecasts was 10.5 million passengers and 43,700 flights.

2.2.8 It was stressed that the optimistic and pessimistic scenarios were developed to reflect not only the uncertainties as to economic development but also those associated with the major supply factors, e.g. airline fleet changes, route generation, and airline marketing strategies.

2.2.9 Charter operations were estimated to have totalled approximately 15,000 in 1996. All-cargo flights were estimated to be approximately 14,600 in 1996. International General Aviation (IGA) activity on the North Atlantic totalled approximately 10,100 in 1996, an increase of 16% over 1995. Military activity was estimated to have totalled 12,800 in 1996, an increase of 13% over the previous year. It has been assumed that the above user categories would remain at a constant percentage of the North Atlantic total throughout the six-year forecast period.

2.2.10 As regards military operations, the July sample week contained a large increase of 45.1% over the previous year. However, the November figures showed a 31.6% decrease, which constituted a return to the 1994 levels. This served to underline the volatility in this market segment.

2.2.11 When reviewing the above statistics, it was pointed out that it appeared that insufficient detail was given to IGA traffic and in particular business aviation and the types of aircraft used by that sector of the industry. This concern would be brought to the attention of the NAT TFG.

2.2.12 The aircraft types by routes were summarised into nine categories. These groupings were developed by considering two factors: speed and preferred flight level. In 1995, the proportion of twin-engined flights fell slightly, the first decrease since the introduction of this category. However, the 1996 sample data showed the twins recapturing their lost market share with interest. In absolute terms there were very healthy increases during the two 1996 sample week periods (up 16.0% in July and 18.3% in November).

2.2.13 There was a corresponding downturn in the proportion of wide-bodies, resulting from decreasing numbers of B747s, despite a rise in the numbers of DC10s, A340s and MD11s. It was noted that, although this category was declining as a proportion of total civil flights, the absolute number of flights was still increasing (up 6.1% and 8.0% in July and November respectively).

2.2.14 The narrow-body (B707, DC8) aircraft were assumed to be completely phased out by 2002 leaving commercial traffic to be split between wide-bodies and twins, apart from the Concorde. Wide-bodies benefited from a forecast of increasing numbers of A340s, but this was more than offset by the decline in services operated on DC10/L1011s. The increase in twins stemmed from a rapid growth in the use of the B777, while the smaller twins were merely expected to maintain share over the medium-term.

2.2.15 It was clear that understanding the changes in the proportion of wide-bodies and twins required analysis of these aircraft types on an individual basis. In view of this, the NAT TFG would consider the possible need for a sub-categorisation of these aircraft types.

2.2.16 In addition to the figures shown in the **Appendix A** to the report on Agenda Item 2, which depict the actual and projected traffic growth, the NAT TFG had also produced the medium-term forecasts up to 2002 shown in **Table 1** below.

*Long-term forecasts*

2.2.17 At its 25th Meeting (June 1990) the NAT TFG had prepared long-term annual passenger and aircraft movement forecasts for the years 2000, 2005, and 2010. In summary, the base case passenger and flight forecasts for the year 2010 were as follows:

a) the number of passengers was forecasted to increase from 44.8 million in 1994 to 74.4 million in 2010, an increase of 66.1%; and

b) the number of flights was forecasted to increase from 253,200 in 1994 to 403,500 in 2010, an increase of 59.4%.

2.2.18 The new long-term forecasts are given in **Table 2** below as well as in **Appendix B** to the Report on Agenda Item 2. These revised forecasts of both passenger and aircraft movements are higher than those prepared at the 25th meeting. The 2010 passenger forecast is 18.3% higher (88.0 versus 74.4 million) while the 2010 aircraft movement forecast is 8.3% higher (437,000 versus 403,500).

2.2.19 In actual terms, the long-term forecast was for the number of passengers to more than double between 1996 (estimated at 49.2 million) and 2015 (99.6 million), an average annual growth rate of 3.8%. The equivalent increase in the number of flights was 198,200 over the 19-year period, which represented an average annual growth rate of 2.9%, from an estimated 279,000 in 1996 to 477,200 in 2015.

2.2.20 In the pessimistic long-term scenario, the average annual growth rates for passengers and flights were 2.2% and 1.5% respectively. For the optimistic case, the equivalent figures were 4.5% annually for passengers and 3.6% annually for aircraft movements. The range between the 2015 optimistic and pessimistic forecast was 38.5 million passengers and 176,300 flights. These ranges may appear high, but were not extreme when compared with historical experience and given the uncertainty in the determining factors.

**Table 1**

**Forecasts of Aircraft Movements In The Icao North Atlantic Region**
**(Thousands)**

| SCENARIO | ACTUAL | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
| OPTIMISTIC | | | | | | | 296.8 | 312.3 | 327.9 | 343.3 | 358.7 | 372.8 |
| BASELINE | 213.0 | 228.2 | 247.5 | 251.4 | 261.0 | 279.0 | 296.8 | 312.3 | 322.5 | 333.3 | 345.3 | 357.3 |
| PESSIMISTIC | | | | | | | 292.0 | 302.0 | 308.2 | 314.6 | 322.0 | 329.1 |

**Percentage change in aircraft movements**

| SCENARIO | ACTUAL | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1992/91 | 1993/92 | 1994/93 | 1995/94 | 1996/95 | 1997/96 | 1998/97 | 1999/98 | 2000/99 | 2001/00 | 2002/01 |
| OPTIMISTIC | | | | | | 6.4% | 5.2% | 5.0% | 4.7% | 4.5% | 3.9% |
| BASELINE | 7.1% | 8.5% | 1.6% | 3.8% | 6.9% | 6.4% | 5.2% | 3.3% | 3.3% | 3.6% | 3.5% |
| PESSIMISTIC | | | | | | 4.6% | 3.4% | 2.0% | 2.1% | 2.3% | 2.2% |

**Table 2: Long-Term Forecast (in thousands)**

| SCENARIO | ACTUAL | FORECAST | | | | |
|---|---|---|---|---|---|---|
| | 1996 | 1997 | 2002 | 2005 | 2010 | 2015 |
| OPTIMISTIC | | 296.8 | 372.8 | 407.2 | 468.8 | 545.7 |
| BASELINE | 279.0 | 296.8 | 357.3 | 389.2 | 437.0 | 477.2 |
| PESSIMISTIC | | 292.0 | 329.1 | 341.5 | 357.3 | 369.4 |

*Range of Uncertainty*

2.2.21 There was considerable uncertainty surrounding the economic conditions in the major traffic generating countries, but the main areas of concern were the supply side aspects of the market. In particular, the level of competition, the route networks and the consequential mix of aircraft types. The forecasts presented reflected the differences in these factors rather more than those regarding economic development.

2.2.22 In overall terms the range between the optimistic and pessimistic scenarios for the forecasts of aircraft movements in 2015 was 176,300. This represented 63% of current day levels, which was virtually the same in percentage terms as the range given in the 1990 long term forecasts.

2.2.23 The equivalent comparison for the passenger forecasts was 78% and 68% respectively, representing the greater uncertainty in the passenger forecasts. This arose because it was thought that the major airlines may have considerable influence on what the level of demand may be.

*Other issues*

2.2.24 As regards the Caribbean-North American traffic axis, data were received from New York OAC for both the July and November sample periods. The analysis of this data suggested that the counts of traffic crossing 30ºW may have been too low in those years when New York did not report. Some flights were only reported by New York despite operating on city pairs which should normally have been picked up by at least one of the other OACs. The Group noted that the NAT TFG planned to raise this issue with the various OACs in the very near future.

2.2.25 The Group also noted that data was still required every year even though the NAT TFG would only meet biannually. The information was required on a yearly basis by other groups and to ensure the completeness and accuracy of important data series used in statistical models. It would not be practical to gather and process the data once every two years.

2.2.26 Finally, the Group noted that the revised forecasts would be included in Part II of the NAT Facilities and Services Implementation Document (FASID) at the first opportunity.

## 2.3 Report of the NAT Implementation Management Group

2.3.1 The Group noted that the NAT IMG had met twice since NAT SPG/32. The Air Traffic Management Group (ATMG) and the Communications Automation and Data Link Applications Group (CADAG) had also met twice. The RSSIG had met once. As indicated in paragraph 2.3.3 below, a Mathematicians Implementation Group (MIG) had been established as a sub group of the NAT IMG and it had met once. The reports of all the meetings had been sent to all regular participants of the NAT SPG.

2.3.2 In accordance with the mandate given to the NAT IMG by NAT SPG/32

(Conclusion 32/9 refers), the NAT IMG and its contributory bodies had spent a considerable amount of time insuring that the implementation of RVSM in MNPS airspace was carried out in a safe and efficient manner. The other major task addressed by the NAT IMG was the development of the *Air Traffic Management Implementation Plan for the NAT Region to 2015* (ATMIP). Furthermore, a significant amount of the work associated with the establishment of the NAT IMG Cost Effectiveness (NICE) programme had also been completed. The PCO which was well established, has been providing valuable input to the development of the ATMIP, documentation in general as well as developing a business planning model. As regards the establishment of the PCO, the Group expressed its appreciation to the United Kingdom for the amount and quality of resources that they had made available to the NAT IMG and its contributory bodies.

*Organizational changes*

2.3.3 The Group noted that, in the context of examining the resources required to carry out the safety assessments which were pre-requisites for the reductions in separation minima, the NAT IMG had established a Mathematicians Implementation Group which would develop the necessary tools to carry out the safety assessments. The MIG, which included operational expertise, would have its work programme established for it by the NAT IMG. It was also felt that membership in the NAT SPG MWG and the MIG should be as similar as possible.

2.3.4 As a consequence of the foregoing and keeping in mind the terms of reference of the NAT IMG, the Group agreed that the MWG would concentrate on the safety assessments of the current system whereas the MIG would address medium to long term planning issues (paragraph 3.2.68 refers). As a result of the foregoing, it was recognised that the NAT SPG handbook would have to be amended to reflect the above.

*Planning process and documentation*

2.3.5 The Group noted that in follow up to NAT SPG/32 Conclusion 32/6, the NAT IMG had tasked the PCO with developing a business process model, rationalising NAT related documentation and developing a document change management mechanism. This task has been completed and the next step was to complete the baseline documents, in particular the business objectives and the system concept description documents. The Group noted that the ATMIP and the Development Programme Plan (DPP), which was based on the ATMIP, were fairly mature as regards the next phase of separation minima reductions. The Group also noted that all planning activities of the NAT IMG and its working groups were based on the agreed business process model and documentation structure.

2.3.6 The Group was informed that, in carrying out the above task, the NAT IMG had ensured that all major activities that had been identified in the NAT Implementation document (NAT ID) had been taken account of in the ATMIP. In the light of the new documentation structure and planning process, the Group agreed that the NAT ID had been overtaken and that it should be considered obsolete.

**CONCLUSION 33/2 - THE NAT IMPLEMENTATION DOCUMENT (NAT ID)**

> **That the NAT ID, which had been endorsed by NAT SPG/27 (Conclusion 27/18), has been overtaken and is no longer required as a NAT planning document**

2.3.7 The Group noted with appreciation that, in order to improve the flow of information to all concerned, the PCO had agreed to set up a World Wide Web (WWW) site which would contain relevant planning information. The web site should be up and running at the beginning of the third quarter of 1997. It would provide a useful tool to carry out work between meetings and would therefore help all concerned in containing costs.

*Fourth Edition of the Application of Separation Minima Document*

2.3.8 The Group noted that, in follow up to NAT SPG/32 Conclusion 32/7, the *Fourth Edition of the Application of Separation Minima Document*, which included all of the latest amendments to the NAT Regional Supplementary Procedures (SUPPs) relating to separation minima that had been approved, had been published by NAV CANADA and distributed to all concerned. It was also noted that prior to publication, the United Kingdom had modelled the software engineer's section and, as a result, several discrepancies had been uncovered in Parts one and two. These discrepancies were resolved and the document was updated accordingly before publication. The modelling tool will be used in the future to validate changes to separation minima. The Group expressed its appreciation to NAV CANADA for the quality of the publication as well as to the United Kingdom for having carried out the modelling work.

*The implementation of Reduced Vertical Separation Minimum*

2.3.9 The Group was informed that, in follow up to NAT SPG/32 Conclusion 32/9, the NAT IMG had met in December 1996 to make the go/no go decision for the implementation of RVSM. It was recalled that the decision was to be based on a satisfactory safety assessment and that sufficient aircraft would be approved to justify the implementation of Phase 1 RVSM from FL 330 to FL 370 inclusive.

2.3.10 The Group was informed that data had been provided by the users that had forecasted that potentially 84% of NAT flights would be operated by RVSM approved commercial aircraft by May 1997. The airlines' predictions for November 1996 had been borne out by Central Monitoring Agency (CMA) statistics that had indicated that 659 aircraft had been airworthiness approved against a prediction of 646. Recognising that some aircraft types would face difficulties in obtaining an RVSM approval, the NAT IMG, nevertheless had felt confident that the information provided by the users had indicated that sufficient numbers of aircraft would be approved by 27 March 1997 to proceed with implementation.

2.3.11 In addition, the safety assessment, which had been based on an analysis of height monitoring data collected between 21 December 1995 and 31 October 1996 as well as on large height deviations reported to the CMA from 21 January 1995 to September 1996 inclusive, had been examined. Based on the data, the risk due to technical errors in Phase 1 RVSM operations was estimated to be between $0.01 \times 10^{-9}$ and $0.22 \times 10^{-9}$ fatal accidents per flight hour. This was well within the safety constraint of $2.5 \times 10^{-9}$ fatal accidents per flight hour. Another element of risk that was set against the TLS was that of operational errors. Because a small number of operational errors within a short time frame could have a significant impact on the estimate of system risk, it had been deemed necessary to assess these errors over a longer period of time such that the trend would be the important indicator. This approach had been adopted by the NAT IMG with the objective of maintaining or improving safety performance in the RVSM environment compared to the current environment.

2.3.12 In view of the serious effect operational errors had on the level of risk, the NAT IMG had also agreed that a vigorous programme be put in place to mitigate these errors. In addition, the system safety analysis would be continued in order to monitor the effect of technical performance and, in particular, operational errors on the system risk as compared to the TLS. To achieve this, the NAT IMG had agreed to:

a) introduce a requirement for an additional radiotelephony (RT) call when reaching a new level - as well as the existing read-back requirement;

b) improve the quantification of actual time spent at wrong flight levels and task the CMA to take follow-up action on operational errors in order to improve estimation of time spent at incorrect levels. OAC would support the CMA in this endeavour;

c) mandate full reporting of all instances of height deviations; and

d) develop an education and awareness programme for provider and user States to emphasise the impact that operational errors have on system safety. All States of registry would be informed of the content of the programme.

2.3.13 To ensure that all NAT users were properly informed, the NAT IMG had undertaken to develop an information package that would be distributed to all concerned by the ICAO European and North Atlantic Office as soon as the material has been prepared and agreed to. The representatives from IGA expressed the wish to be associated with this activity.

2.3.14 In addition to the foregoing, the Group was informed that some aircraft, for which no service bulletin had been issued, had indicated that they were RVSM approved and were therefore cleared to operate in RVSM airspace. The Group agreed that this compromised safety and that some measures needed to be taken. Accordingly, it was agreed that any aircraft type which had not had an RVSM service bulletin or a non-group approval issued would be tactically monitored and excluded from the airspace. In arriving at this decision, the Group was cognizant of the NAT SUPPs relating to this issue as well as the fact that an aircraft type could obtain a non-group approval. Therefore, should any aircraft type for which a service bulletin has not been issued, prove that it is RVSM approved that aircraft type would no longer be excluded from the airspace provided the pilot in command states that the aircraft has been RVSM approved. The Group also agreed that before implementing the above policy, NAT provider States would have to ensure that it would not cause any legal difficulties. With this in mind, it was agreed that NAT provider States, after consultation with their respective legal departments, co-ordinate a common implementation date for the exclusion of known non-approved aircraft from RVSM airspace. In addition, the users agreed to bring this matter to the attention of their members as it was a safety critical issue.

**CONCLUSION 33/3 - EXCLUSION OF KNOWN NON-APPROVED VERTICAL SEPARATION MINIMUM (RVSM) AIRCRAFT FROM RVSM AIRSPACE**

**That:**

**a) States devise a mechanism to exclude from RVSM airspace aircraft for which a service bulletin has not been issued and which have not received a non-group RVSM approval;**

**b) States, in consultation with users, co-ordinate a common implementation date for the above; and**

**c) user organizations inform their members that, for safety reasons, they should not flight plan to operate in RVSM airspace if they have not been RVSM approved.**

2.3.15 The Group was informed that the implementation of RVSM on 27 March 1997 had been accomplished safely and with a general improvement in the service level provided to NAT traffic. In fact, it was pointed out that implementation had been smoother than anticipated. However, two issues were identified that would require attention - namely the number of Traffic Alert and Collision Avoidance System (TCAS) Traffic Advisories (TA) and the perceived effects of wake turbulence. As regards the TAs, the United States was co-ordinating the publication of Aeronautical Information Services (AIS) material that would provide guidelines to pilots on how to mitigate nuisance TAs.

2.3.16 Concerning reports of wake turbulence in an RVSM environment, this matter had been addressed from a theoretical point of view in the lead up to the implementation of RVSM. However, it may be necessary to focus on the experience gained so far with RVSM and a Research and Development (R&D) programme may be required to assess the extent of the problem. In this context, the representatives from IFALPA, IATA and IBAC agreed to inform their respective organizations of the importance of reporting all instances of wake turbulence to the CMA.

2.3.17 As regards nuisance TAs, the Group was presented the latest information stemming from the Radio Technical Commission for Aeronautics (RTCA) Special Committee 147 (SC-147) concerning the need to collect empirical data, under controlled conditions and in a timely manner concerning the interaction of RVSM and TCAS. The Group appreciated the information but felt that it was premature to embark on an R & D programme that would have to be funded somehow without adequate background information. Therefore it was agreed that the Member for the United States should further document the proposal, including all associated costs, and present the information to the NAT IMG at the first opportunity.

2.3.18 The representative from IFALPA stressed the need to develop region wide procedures to mitigate against some of the problems caused by nuisance TAs and wake turbulence. As indicated above, the NAT IMG had already begun a consultation process to develop such procedures. Unfortunately, a consensus had not yet been reached on how best to resolve these issues. Accordingly, it was agreed that the United States would undertake to co-ordinate with all concerned appropriate procedures to mitigate the effects of nuisance TAs and wake turbulence. Once a consensus has been reached, all States concerned would publish the information in their national AIS documentation.

**CONCLUSION 33/4 - STUDY ON THE EFFECTS OF AIRBORNE COLLISION AVOIDANCE SYSTEMS (ACAS) IN A REDUCED SEPARATION MINIMUM (RVSM) ENVIRONMENT**

**That the Member for the United States document for the NAT Implementation Management Group, including associated costs, the need to carry out an in-depth study on the effects of ACAS in an RVSM environment.**

**CONCLUSION 33/5 - PROCEDURES TO MITIGATE NUISANCE TRAFFIC ADVISORIES (TA) AND WAKE TURBULENCE**

**That:**

**a) the United States co-ordinate with States and users concerned the development of NAT Regional procedures to mitigate the effects of nuisance TAs and wake turbulence;**

**b) user organizations inform their pilots to report all instances of wake turbulence to the central monitoring agency; and**

**c) States promulgate the information as soon as a consensus has been agreed.**

2.3.19 It was noted that initial monitoring results had shown that the technical risk of collision was much lower than had been anticipated. In the context of measuring risk, the NAT IMG had suggested and the Group agreed that this task be transferred from the MIG to the NAT SPG MWG at the beginning of Phase 2 RVSM. Also, in follow up to NAT SPG/32 Conclusion 32/8, efforts had begun to assess the risk due to military formation flights in RVSM airspace. In the meantime, the current practice of providing 2000 ft vertical separation to formation flights would be maintained.

2.3.20 As regards further extension of RVSM airspace, it was noted that the NAT IMG had agreed that it would determine an implementation date for Phase 2 RVSM at NAT IMG/10 planned to be held in December 1997. The implementation date would be based on the experience gained from the summer period and the extent of the change would be based on the number of approved aircraft. To this end, Canada and the United Kingdom had agreed to carry out a data collection, along the same lines as the one carried out for Phase 1 RVSM, during the months of July, August and September 1997. The collected data would be analyzed and the results presented to NAT IMG/10. It was also agreed that the first quarter of 1998 was the earliest opportunity to implement Phase 2 RVSM and that planning should be based on that window of opportunity taking into account that a four month lead time should be sufficient to carry out the necessary co-ordination and that the time of year was less of a limiting factor than was the case for Phase 1 RVSM.

2.3.21 The Group noted that, following consultation with NAT SPG Members by the

Chairman of the NAT IMG, it had been decided in December 1996 that the implementation of RVSM should proceed on 27 March 1997. The Chairman expressed the appreciation of the NAT SPG to all individuals who had worked on this project for so many years which culminated in this historic decision. In particular, the NAT SPG wished to extend its appreciation directly to the air traffic control facilities, the pilot community and flight service stations involved in the implementation of RVSM for their efforts which resulted in a virtually flawless implementation of RVSM. Special mention was made regarding the work carried out by all of the individuals concerned who demonstrated superb professionalism, pride and commitment to service which reflects great credit on those facilities and their administrations.

*RVSM financial considerations*

2.3.22 The Group was informed that a two month delay had been introduced in carrying out the Factory Acceptance Test (FAT) for the production Height Monitoring Units (HMU). Although the delay in implementation would not have an effect on operations, it could have an impact on the financing. The prototype HMU has been available 70 % of the time and every effort was being made to ensure that it would be operational at the current, or better performance levels until the production HMUs were commissioned in April 1998. In this context, the Group was apprised of the latest financial considerations concerning the procurement of the HMUs as well as with ICAO's contract with ARINC concerning the GPS based Monitoring System (GMS).

*Air Traffic Management Implementation Plan for the NAT Region to 2015*

2.3.23 The Group recalled that, at its last meeting, it had been informed that a *Hybrid ATM Plan* was being developed and that NAT SPG/32 had agreed that it would replace Part 2 of the NAT ID. This document has been renamed the *Air Traffic Management Implementation Plan for the NAT Region to 2015* and, as indicated in paragraph 2.3.5 above, now forms part of the core planning documentation for the NAT Region. Although it was still in draft form, (Draft Version 0.6) some sections were fairly mature; however, it was felt that it was too early to release the document.

*NAT IMG Cost Effectiveness programme*

2.3.24 The Group was informed that work relating to the NICE programme was well advanced and that results were expected by the end of 1997. It was pointed out that, because the free flight "pot of gold" simulation should be validated towards the end of the summer of 1997, initial results should therefore be available for NAT IMG/10 in December 1997.

*Reduced Horizontal Separation Minima (RHSM)*

2.3.25 The Group noted that since RVSM has been successfully implemented, the efforts of the NAT IMG and its contributory bodies would be shifted to reductions in horizontal separation minima, beginning with longitudinal separation. To this end, a draft Collision Risk Model (CRM), that allowed for an analytical assessment of the effects of lateral errors on the longitudinal separation of a pair of aircraft on intersecting tracks, was being developed. This draft CRM appeared to be appropriate as it would allow airspace planners to analyze separation minima reductions and provide flexibility in the order of their implementation. As the CRM was a pre-requisite to further reductions in separation minima, it was paramount that sufficient resources be made available to complete the work in a timely manner. Any delay in developing the CRM would have an effect on the timing of all separation minima reductions and therefore on the overall programme.

2.3.26 Another important consideration that needed to be agreed to was the TLS to be used to sustain the reductions in longitudinal separation minima. It was recalled that the NAT Air Navigation Plan (ANP) (Page 5.1-0-4, paragraph 34) states that "Each reduction in separation minima should be preceded by a verification trial and implemented in the context of an agreed TLS." The NAT IMG suggested that a TLS of $5x10^{-9}$ fatal accidents per flight hour be applied for assessing the feasibility of reducing longitudinal separation. The Group noted the information and agreed that a new TLS was indeed necessary. However, not all States could commit to a TLS of

$5.0x10^{-9}$ fatal accidents per flight hour. Recognising that the MIG needed to work to a specific value, it was agreed
that the NAT IMG should use the aforementioned value for planning purposes and report their results to NAT SPG/34.

**CONCLUSION 33/6 - TARGET LEVEL OF SAFETY (TLS) TO SUPPORT REDUCTIONS IN LONGITUDINAL SEPARATION MINIMA**

**That a TLS of $5.0x10^{-9}$ fatal accidents per flight hour be used for planning purposes in carrying out the work required to sustain reductions in longitudinal separation minima.**

2.3.27 The Group was informed that the planned reductions to 5 minutes/30 nautical miles, would involve an extremely complex interrelation of technical, safety and benefit/cost issues in their implementation. Such implementation would also require significant investments by States, service providers and users. Therefore, the pace at which the development programme could progress would be determined, inter alia, on availability of resources and technology and on commercial issues not necessarily confined to operations in the NAT Region.

*Data link applications*

2.3.28 Data link applications were considered to be enablers for some separation minima reductions. With this in mind, much of the work of the NAT IMG and its contributory bodies would be directed at ensuring that the necessary safety assessments, testing and validation trials were carried out. The Group noted that this activity would take up a considerable amount of resources within the NAT IMG as well as within administrations and airspace user organizations.

2.3.29 The Group endorsed the NAT IMG decision to accommodate Future Air Navigation Systems (FANS) 1/A equipped aircraft in the planning process although the agreed end system remained SARPs compliant avionics using the Aeronautical Telecommunications Network (ATN). This decision was predicated on the fact that aircraft were equipping with FANS 1/A avionics and it therefore appeared prudent to ensure that ground systems should support these aircraft. However, in arriving at this decision, it was stressed that the level of services that may be provided to FANS 1/A equipped aircraft operating in the NAT Region needed to be determined.

*Oceanic conferences*

2.3.30 Recalling that annual conferences had been held in Honolulu since 1996 to discuss CNS/ATM planning activities for the North Atlantic and Asia/Pacific Regions, the NAT IMG had strongly endorsed the notion that such conferences should be rotated yearly from a Pacific to a North Atlantic venue. The Group agreed with the proposal that an International Oceanic Airspace Conference be held in London in 1999.

**CONCLUSION 33/7 - OCEANIC COMMUNICATIONS NAVIGATION SURVEILLANCE/ AIR TRAFFIC MANAGEMENT (CNS/ATM) PLANNING CONFERENCE**

**That:**

**a) biennial Oceanic CNS/ATM planning conferences be held in Europe to discuss Oceanic planning for all ICAO Regions; and**

**b) the Member from the United Kingdom make arrangements within his administration to convene such a conference in 1999.**

## 2.4 Implementation Planning

*Implementation of RVSM in the NAT Region*

2.4.1 Several States and international organizations had provided information concerning their experience with the implementation of RVSM. All had indicated that implementation had been very smooth. The initial reactions had been very positive and providers and users mentioned that the increased airspace capacity and flexibility had provided a significant bonus. The Group was also provided with information concerning transition areas.

2.4.2 The Group examined information on the status of RVSM approvals in general and for IGA aircraft in particular. From the information, it was evident that the rate of RVSM approvals for IGA aircraft lagged far behind those for most commercial aircraft. With this in mind, the Group was presented the results of two studies carried out by IBAC which gave the number of IGA operations, flight level utilisation and the types of aircraft used. The presentation showed that there was a significant percentage of IGA operations in the airspace at and above FL 390. The study's objective was to document the concerns of the business aviation community regarding further expansion of RVSM airspace, particularly above FL 370, because of the penalties that may be imposed on IGA. A second study showed the results of a detailed analysis of traffic demand in the NAT during 1996. It provided comprehensive details of the geographic and time distribution of 1996 NAT traffic and based upon this study suggestions were made as to how some of the penalties that IGA might incur could be mitigated. IBAC, with IAOPA's endorsement, recommended that any expansion of RVSM airspace be withheld, particularly above FL 370 until the year 2000 or the year of EUR RVSM implementation, whichever came first. In making this recommendation IBAC made it clear that it was not opposing RVSM but needed more time for the Business Aviation community to have aircraft RVSM approved.

2.4.3 The Group expressed its gratitude to the representative from IBAC for the work that his organization had carried out. However, in view of the fact that the NAT SPG had already tasked the NAT IMG with planning for the implementation of future phases of RVSM (Conclusion 32/9 refers) and considering that the NAT SPG had agreed that IBAC be invited to participate in the NAT IMG meetings when discussing further implementation of RVSM (paragraph 5.2.1 refers), it was felt that the information would be best dealt with by the NAT IMG when deciding on the expansion of RVSM airspace. Therefore, the Group did not endorse IBAC's recommendation. In this context, the Chairman assured the representative from IBAC that their concerns would be duly taken into account by the NAT IMG before any decision on the expansion of RVSM airspace was agreed to.

2.4.4 The Group was informed that Portugal planned to implement an RVSM transition area in the Santa Maria FIR South of 27° North in order to improve operations between New York and Santa Maria OACs as well as to improve services to the users. It was however stressed that the necessary co-ordination with adjacent Flight Information Regions (FIR) would be carried out prior to implementation. It was noted that mixed traffic (RVSM and non RVSM approved) would be allowed in the transition area, especially as it was a low traffic density area.

2.4.5 The Group was informed that the United States were planning to implement RVSM in the West Atlantic Route Structure (WATRS) and that they were seeking the NAT SPG's endorsement to proceed. Although States and international organizations could agree with the idea of implementing RVSM in the WATRS area, the Group could not endorse the plan as it felt that several issues needed to be resolved first. In particular, the representative from IFALPA indicated that his organization would want to be involved in the discussions leading up to the development of an implementation plan, especially in view of the strong convective activities in the area concerned. Again, considering that the NAT SPG had delegated to the NAT IMG the task of overseeing the implementation of RVSM, the Group felt that implementation plans should be processed through that group first.

2.4.6 The Group was presented with a proposal for continuous monitoring based on optical quick access recorders which were used to monitor aircraft systems and performance.

Considering that continuous monitoring was on the work programme of the NAT IMG, the Group felt that the NAT IMG, through the RSSIG, was the most appropriate forum to address this matter.

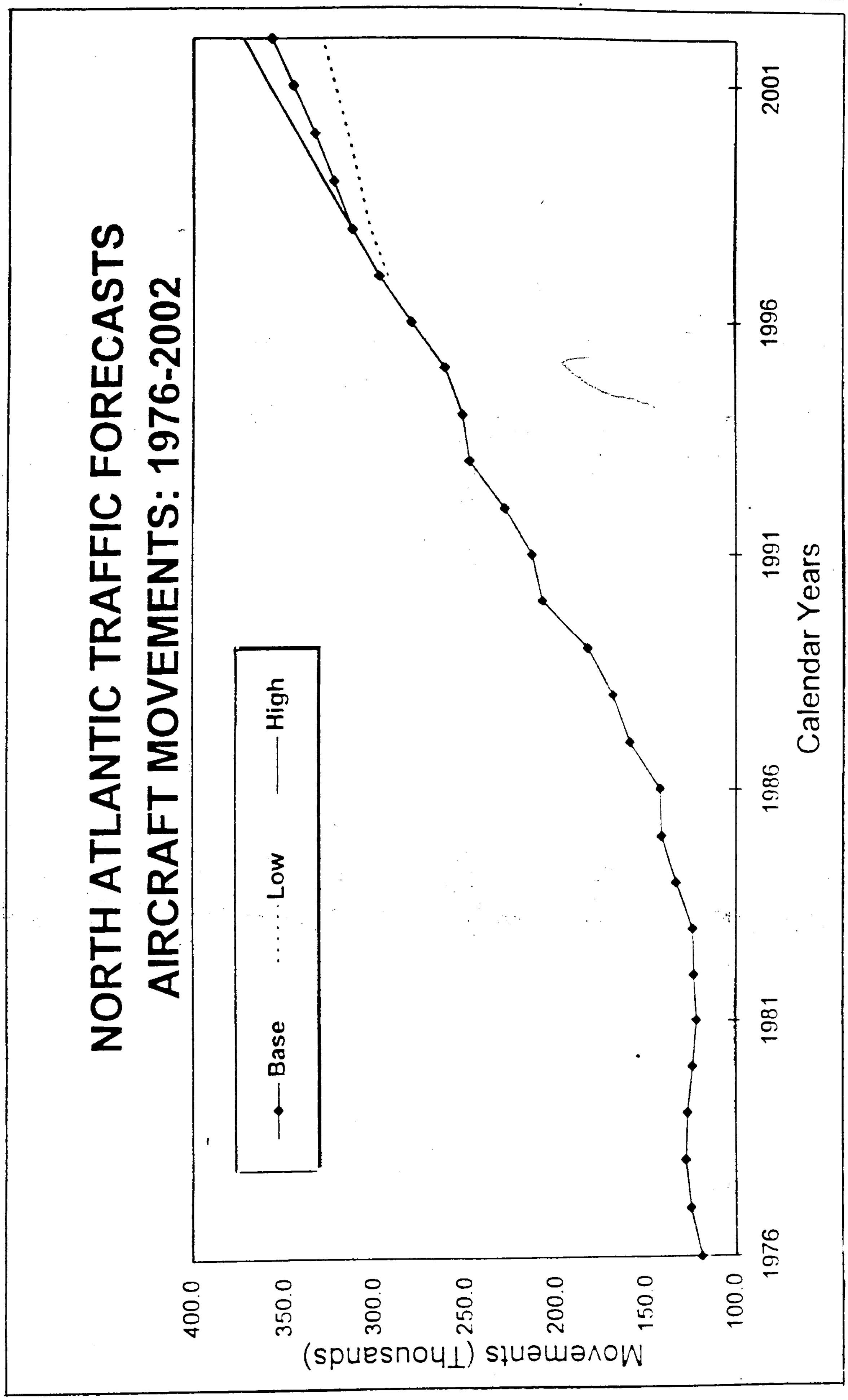
*Wide Area Augmentation System (WAAS)*

2.5 The Group was provided with information that the Icelandic Civil Aviation Administration (ICAA) had initiated a comprehensive trials programme in the GPS arena especially with regard to ensuring the integrity of GPS navigation in MNPS airspace. A part of this programme was participation in the Federal Aviation Administration (FAA) WAAS programme which was now undergoing pre-operational trials before the planned commissioning of the WAAS in 1998.

2.6 The goal was to increase the position accuracy to 7 NM and to ensure system failure warning within 6 seconds. ICAA's rationale for participation in the WAAS pre-operational trials was to increase integrity of the GPS system for trans-oceanic flights. This could be accomplished by operating a reference station in Iceland. The Group agreed that the WAAS was one of the possibilities for ensuring adequate Global Navigation Satellite System (GNSS) performance for transoceanic flights.

**CONCLUSION 33/8 - ICELANDIC PARTICIPATION IN WIDE AREA AUGMENTATION SYSTEM (WAAS) TRIALS**

**That the NAT SPG endorse the participation of Iceland in trials on the concept of using WAAS to facilitate the employment of Global Navigation Satellite System (GNSS) in the North Atlantic Region.**


NORTH ATLANTIC TRAFFIC FORECASTS
AIRCRAFT MOVEMENTS: 1976-2002
Base
Low
High
Movements (Thousands)
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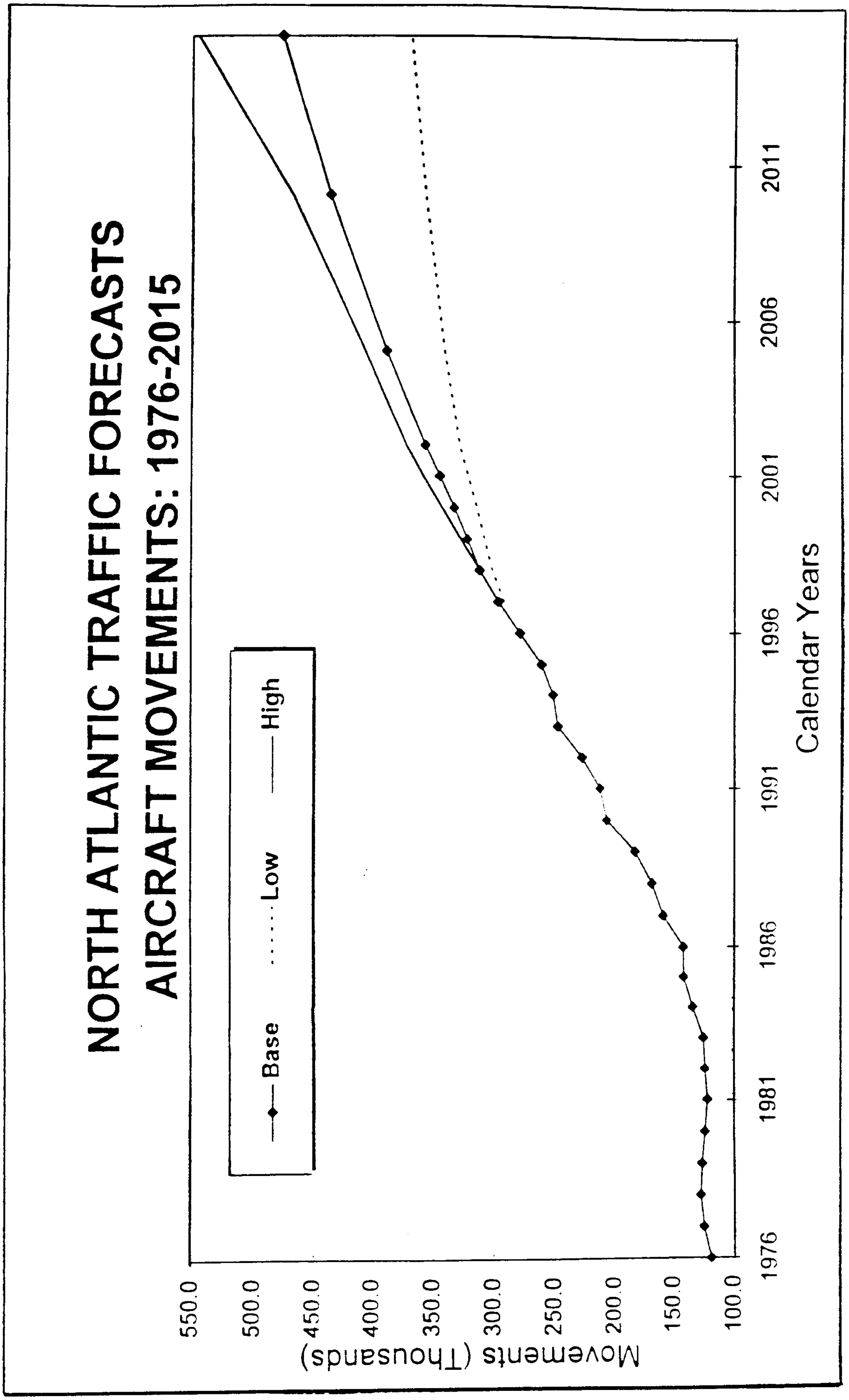
350.0
300.0
250.0
200.0
150.0
100.0
1976
1981
1986
1991
1996
2001
Calendar Years


NORTH ATLANTIC TRAFFIC FORECASTS
AIRCRAFT MOVEMENTS: 1976-2015
Base
Low
High
Movements (Thousands)
550.0
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
1976
1981
1986
1991
1996
2001
2006
2011
Calendar Years

**AGENDA ITEM 3: AIR NAVIGATION SYSTEM REVIEW**

## 3.1 Introduction

3.1.1 Under this Agenda Item, the Group considered the following subjects:

a) Review of system safety performance; and

b) Review of systems operations

## 3.2 Review of system safety performance

**SCRUTINY MATTERS**

*General*

3.2.1 When considering scrutiny matters, the Group reviewed the following specific subjects:

a) the lateral navigation performance accuracy achieved in the NAT Region during the period 1 January 1996 to 31 December 1996; and

b) methods of improving the observed standard of navigation performance in the NAT Region.

*Lateral navigation performance accuracy achieved in the NAT Region during the period 1 January 1996 to 31 December 1996*

3.2.2 The Group completed a scrutiny of observed gross navigation errors (GNEs) in the NAT Region and found that a total of 36 (42)* errors were reported during the period under review. Of these errors, 14 (14)* occurred outside MNPS airspace and were classified as Table 'Charlie' errors. From the remaining 22 (28)*, 11 (10)* were not eligible for inclusion in the risk analysis as defined at NAT SPG/17 (amended by NAT SPG/23) and were classified as Table 'Bravo' errors. The remaining 11 (18)* errors, which form the basis of the scrutiny, were classified as Table 'Alpha' errors.

3.2.3 The Group was pleased to note a significant reduction in the number of Table 'Alpha' and "Bravo" errors compared with the previous 12 month period. Taking into account the 5.6 % increase in the level of traffic using MNPS airspace, and the fact that there had only been a slight increase in the risk bearing effect of the errors over the previous 12 month period, the Group considered that the number of GNEs in MNPS airspace did not give cause for concern.

3.2.4 The breakdown of the 11 Table 'Alpha' errors is shown below in Table 1 below.

**Table 1: Breakdown of Risk Bearing Effect of Table 'Alpha' Errors**

| CLASSIFICATION* | ETA ERRORS | RISK BEARING ERROR WEIGHTING |
|---|---|---|

* *Figures in brackets refer to the previous 12 month period*

| | | TOTAL MNPS TRAFFIC | OTS TRAFFIC | RANDOM TRAFFIC |
|---|---|---|---|---|
| A<br>B<br>C1/C2/C3<br>D<br>E<br>F<br>UNCLASSIFIED | 2** (1)<br>1 (1)<br>6 (10)<br>1 (0)<br>1 (0)<br>2 (5)<br>0 (1) | 0<br>0<br>2.16<br>0<br>0.85<br>0.95<br>0 | 0<br>0<br>0<br>0<br>0.85<br>0.4<br>0 | 0<br>0<br>2.16<br>0<br>0<br>0.55<br>0 |
| TOTAL | 11 | 3.96 | 1.25 | 2.71 |
| TOTAL IN LAST PERIOD | 18 | 3.91 | 1.72 | 2.19 |
| OBSERVED TRAFFIC '96 | | 238,684 | 139,991 | 98,693 |
| OBSERVED TRAFFIC '95 | | 226,113 | 135,316 | 90,767 |

* A — Aircraft not certified for MNPS Operations.
B — ATC System Loop error.
C1/C2/C3 — Equipment Control/Waypoint Insertion/Wrong Information
D — Other navigation errors, including equipment failure notified to ATC in time for action.
E — Other navigation errors, including equipment failure notified to ATC too late for action.
F — Other navigation errors including equipment failure of which notification was not received by ATC.

**Note: Not the primary cause of observed error

3.2.5 The breakdown of the 11 Table 'Alpha' errors points to 5 areas of particular note namely:

a) a significant decrease in the number of waypoint insertion/equipment control errors [6(10)] accounting for around 55% of the reported Table 'Alpha' errors which compares to a similar percentage figure in the previous reporting period;

b) four equipment failure errors (20% reduction on previous period):1 x OMEGA, 1 x OMEGA/GPS, 1 x GPS, 1 x INS;

c) an increase from 1 to 2 of those errors occurring to a non-approved user;

d) only one error attributable to a glass cockpit aircraft; and

e) two errors attributable to military aircraft both of which were risk bearing.

3.2.6 The Group noted that there had not been a reduction in the percentage of Table 'Alpha' errors attributed to waypoint insertion/equipment control errors but also recognised that this was probably as low a figure as could reasonably be expected to be achieved. Furthermore, it noted that if the 5.6 % increase in traffic compared to the previous period was taken into account, the effect was a net reduction in these type of errors per flight and an overall reduction in the risk.

3.2.7 It was noted that there was a small reduction in the number of errors attributed to equipment failures. However, one of these errors was very large at 220 NM and displayed the crew's inability to perform correct Dead Reckoning (DR) navigation. The Group was particularly pleased to note that the number of OMEGA failures remained low at only two.

3.2.8 The Group was disappointed to note an increase in the number of classification A errors from one to two both of which were risk bearing. ATC centres should therefore be encouraged to remain vigilant in performing tactical monitoring.

3.2.9 In reviewing the 11 (10) Table 'Bravo' errors the Group noted a very small increase in the number of these errors over the previous year. Table 2 shows a breakdown of the Table 'Bravo' errors into the established error classifications.

**Table 2: Breakdown of Table 'Bravo' Errors**

| ERROR CLASSIFICATION | NUMBER OF ERRORS |
|---|---|
| A | [2]* (2)** |
| B | 2 (3) |
| C1/C2/C3 | 5 (3) |
| D | 0 (1) |
| E | 2 (0) |
| F | 1 (0) |
| UNCLASSIFIED | 1 (1) |
| TOTAL | 11 (10) |

* Not the primary cause of observed error

** Figures in brackets refer to the previous 12 month period

3.2.10 The Group noted that there was no significant increase in the total number of errors but was disappointed to note the small rise in the number of errors attributable to crew error. It also noted with interest a specific incident involving Shanwick not passing a reclearance to Reykjavik which resulted in an aircraft being where it was supposed to be but not where it was expected by Reykjavik. The Group was informed that this was not an isolated incident but that appropriate action had been taken at Shanwick to remedy the situation.

3.2.11 The Group, while considering the Table 'Charlie' errors, was pleased to note that the number of errors reported occurring outside MNPS airspace had not shown an increase over the previous 12 month monitoring period. Table 3 shows a comparison of the Table 'Charlie' errors over the last 10 years.

**Table 3: Table 'Charlie' errors for the last 10 monitoring years**

| MONITORING YEAR | NUMBER OF ERRORS |
|---|---|
| 1987/88 | 63 |
| 1988/89 | 40 |
| 1989/90 | 31 |
| 1990/91 | 22 |
| 1991/92 | 17 |
| 1992/93 | 10 |
| 1993/94 | 15 |
| 1994 | 7 |
| 1995 | 14 |
| 1996 | 14 |

3.2.12 The Group noted that of the 14 errors, 3 occurred above MNPS airspace whilst 11 occurred below - this proportion was similar to previous years.

3.2.13 In accordance with monitoring procedures, follow-up action was taken for any reported error in excess of 50 NM. The Group noted that this had to be done for 5 of the 14 reported occurrences. Of the causes of all the Table Charlie errors, around 65% were attributable to waypoint insertion or equipment control errors.

3.2.14 The Group was grateful to the representative for IAOPA for the compiled statistical information for the NAT Region under this agenda item. It was pleased to note an improvement in the number of flights per GNE from 5994 in 1995 to 7133 in 1996. Studying the breakdown of flights per GNE in the categories Public Transport (PT), military and IGA, the Group noted that the figure for PT was significantly better than at any other time since monitoring began and stood at 16,275 flights per GNE as compared to the best previous figure of 12,229 in 1994. However, whilst the figure for military operations was better than the previous 12 month period at 1475 flights per GNE, it was still only of the same order as that which was being achieved in the late 1980s. For IGA, the Group noted a decrease in the number of flights per GNE - 572 - compared with the previous year's figure of 719. This was considered not to be significant though it was noted that there had been very little real improvement over the last 4 years in the performance of IGA aircraft in regard to the number of GNE incidents involving them.

3.2.15 In summary of the above and using flights per GNE as a measure, the lateral navigation performance for PT operations improved over the year. Military operations improved slightly but were still very high compared with PT operations, and the number of flights per GNE for IGA operations was similar to recent years.

3.2.16 In noting the foregoing information, the Group recommended that States or organizations representing these classes of user (IGA and Military) should take steps to encourage better operations and navigation performance through enhanced pilot training programmes for flights in the NAT Region.

**CONCLUSION 33/9 - IMPROVEMENT IN NAVIGATION PERFORMANCE OF INTERNATIONAL GENERAL AVIATION (IGA) AND MILITARY**

**That States with significant military operations in the NAT Region, the International Air craft Owners and Pilots Association and the Internationale Business Aircraft Council take the necessary steps to encourage their NAT users to improve the level of navigation performance when operating in the NAT Region.**

3.2.17 As in previous years the Group considered the valuable part played by ACCs in containing the number of GNEs through timely intervention to prevent incorrect routing. Without such interventions, it was likely that the number of risk bearing GNEs would have been such that the TLS would have been breached.

3.2.18 During the monitoring period, Gander and Shanwick ACCs advised the CMA of 73 (62) occasions when action was taken to prevent a GNE. The Group noted that this was a slightly higher number than that reported during the previous 12 month period. The statistics in the following list of probable causes were considered to be worthy of note:

a) thirty four confirmed cases of crew error with at least 11 instances being the result of the crew following a flight planned route instead of an issued cleared route;

b) twenty instances of ATC loop error; and

c) the remainder were broadly categorised as cause unconfirmed or crew error through poor flight deck co-ordination.

3.2.19 With respect to the continued application of the 10 minutes longitudinal separation, the Group noted that 4 reports of erosions of 10 minutes longitudinal separation had been received by the CMA during the monitoring year (compared to 4 last year). These had been notified to the MIG for its consideration in the context of the reduced longitudinal separation study.

*Methods of Improving the Observed Standard of Navigation Performance*

3.2.20 Overall, during the period of the report, there was not a significant increase - 13 versus 12 - in the number of Table “Alpha” and Table “Bravo” errors involving human error in the form of waypoint insertion and equipment control errors. There was, however, a very significant reduction in the number of errors occurring after a reclearance and it was considered that the change in wording on the track message as a result of NAT SPG 31 may have had some effect. To that end the Group agreed that the message should be retained.

3.2.21 In the course of the scrutiny of errors, the Group identified the following as significant contributory factors in either the risk of a GNE being committed or to increasing the overall system risk:

a) failure of crews to cross-check clearances with information entered and stored in the navigation systems;

b) failure of crews to make position reports based on the navigation system positions and instead reading directly from the flight plan;

c) confusion surrounding the use of reporting point “THANC” in conjunction with the reporting point “BANCS” and the acknowledgement “thanks”; and

d) poor R/T phraseology combined with no direct pilot /controller interface accounting for 2 GNEs.

3.2.22 The Group noted that all that could be done had been done with regards to reminding crews about cross-checking procedures and reporting from the navigation system and not the flight plan. As for the confusion surrounding the use of THANC as a reporting point, the Group agreed that consideration should be given to re-naming it. The Group also agreed that controllers/radio operators and aircrew be reminded of the need to use standard R/T phraseology.

*Monitoring of height deviations*

3.2.23 The CMA received forty nine reports of height deviations in the NAT Region and of these, around 40% were considered to be risk bearing. It was encouraging to note that in all reported cases of contingency action, crews followed the correct procedures. The Group was informed that the NAT IMG had implemented a range of measures with the aim of reducing the number of operational errors in the NAT.

*Methods of improving the current monitoring procedures*

3.2.24 The Group concluded that the current monitoring methods were adequate to allow GNEs to be investigated effectively. Furthermore, the Group noted that continued publicity and tactical monitoring had reaped benefits in that only a very small number of non-MNPS approved aircraft had attempted to enter MNPS Airspace. However, the Group was disappointed to note that 4 GNEs had been attributed to aircraft that did not have MNPS approval.

3.2.25 On the subject of the monitoring of height deviations in excess of 300 ft, it had been noted that ACCs were not always using the format agreed by NAT SPG/32. This was causing the CMA to have to waste valuable time following up incidents. The Group agreed to remind States concerned of the need to use the agreed reporting format.

**CONCLUSION 33/10 - METHODS TO IMPROVE MONITORING PROCEDURES**

**That:**

**a) the note at the bottom of the track message be retained;**

**b) controllers/radio operators and aircrew be reminded by States and user organizations of the need to use standard Radio Telephony phraseology;**

**c) the reporting point "THANC" be re-named;**

**d) the MNPS Manual be amended to reflect clearly the importance of crews making position reports using information from the navigation system and not the flight plan; and**

**e) Area Control Centre Managers encourage the use of the agreed format for the reporting of height deviations in excess of 300 feet.**

**MATHEMATICAL MATTERS**

3.2.26 To assist the NAT SPG in reviewing system safety performance, the NAT MWG was convened with the principal objectives of:

a) providing the NAT SPG with estimates of lateral and vertical collision risk for the 1996 calendar year;

b) determining *preliminary* estimates of lateral and vertical collision risk for the 1997 calendar year in order to provide an early indication of the effects of the implementation of the Phase 1 RVSM operational trial from 27th March 1997;

c) reviewing the procedures for the on-going monitoring and reporting of GNEs, erosions of longitudinal separation and large height deviations; and

d) drafting amendments to the MWG Terms of Reference for approval by NAT SPG, in the light of the creation of the MIG by the NAT IMG.

*1996 lateral collision risk estimate*

3.2.27 The Group determined the lateral occupancy estimates for the 1996 monitoring year based on the traffic weighted average of the United Kingdom 20°W estimates, the Canadian 40°W estimates and the traffic weighted average of both 30°W estimates. The estimates were based on data for the 4th and 15th days of each month. The 1996 estimates together with the estimates for the previous four monitoring years are shown in Table 4.

**Table 4: Lateral Occupancy Estimates for the years from 1992/3 to 1996**

| | | Monitoring Year | | | | |
|---|---|---|---|---|---|---|
| Direction | Traffic | 1992/3 | 1993/4 | 1994/5 | 1995 | 1996 |
| Same | OTS | 1.335 | 1.397 | 1.452 | 1.448 | 1.491 |
| | Random | 0.350 | 0.291 | 0.262 | 0.274 | 0.274 |
| | Comb | 0.980 | 1.002 | 1.056 | 1.026 | 1.043 |
| Opposite | OTS | 0.002 | 0.002 | 0.001 | 0.002 | 0.003 |
| | Random | 0.008 | 0.010 | 0.006 | 0.012 | 0.013 |
| | Comb | 0.004 | 0.005 | 0.003 | 0.006 | 0.007 |

3.2.28 For same direction traffic, it can be seen that the occupancy for OTS traffic in 1996 had increased compared to 1995 whilst that for random traffic had remained the same. The general trend in same direction occupancy for the total traffic sample remained an increasing one. For opposite direction traffic there had been very little change in occupancy throughout the five year period. The data on occupancies for the five year period is also portrayed graphically in Figure 1 of **Appendix A** to the report on Agenda Item 3. Note that the data extends back to 1987 and that occupancy is expressed in "standard units" that combine both same and opposite direction lateral estimates, weighted according to the then current kinematic factors of the Reich model. With occupancy expressed in standard units, the trend has remained an increasing one.

3.2.29 As in previous years, small differences had been noted in the United Kingdom and Canadian occupancy estimates at 30 W. Information was presented which analyzed the differences in the databases used to calculate occupancies for two sample days in 1996. The analysis was able to successfully show the reasons for all the differences. They were in all but one case on each day due to valid differences in the input data rather than ways in which the United Kingdom and Canadian estimates were obtained. The Group felt that this long standing issue could now be closed.

3.2.30 Before determining the 1996 lateral risk estimate, the Group reviewed the report of the Scrutiny Group and examined each of the MNPS GNEs reported in 1996 to ensure that they had been appropriately categorised for risk assessment purposes. The Group noted that the issue of how to incorporate errors detected at the Reykjavik window into the risk assessment process had not been resolved. It was recommended that this should be added to the NAT MIG work programme but that it was not a priority item since the associated effect on the estimated risk was likely to be small. Consideration was also given for the incorporation in the risk assessment of errors detected at the Santa Maria and New York windows.

3.2.31 In carrying out this review, the Group agreed that the CMA add the following clarification to the description of Error Class "D" GNEs (Other with failure notified to ATC in time for action) as follows:

> "GNEs in this class will not normally be risk bearing unless ATC, given sufficient time and information, failed to prevent the magnitude of the error from increasing beyond 50 NM."

3.2.32 Other points of note not specifically mentioned in the Scrutiny Report were:

a) the continued decrease in OMEGA equipment failure errors possibly coupled with the beginnings of a small increase in problems associated with the use of GPS;

b) the potential value of increased automation (through, for example, datalink) to reduce the occurrence of waypoint insertion errors that continue to occur;

c) the possible need for a procedure to ensure that if a pilot is able to, or is requested to, make a position report on VHF to a domestic controller (say at 50$^o$W) that the information be automatically passed onto the oceanic controller; and

d) the need to provide advice to pilots on when to adopt contingency procedures when experiencing height deviations due to turbulence in an RVSM environment.

3.2.33 Previously, OMEGA was a preferred navigation method selected by a segment of the NAT population that may have been less sophisticated than the typical NAT user. A history of large error performance supports this view, with a greater proportion of those errors being attributed to that equipment than its relative proportion in the overall population. With the coming withdrawal of OMEGA from use, this segment of users seems to be selecting GPS as the navigation system of choice. This may lead to a transference of training and maintenance problems, not directly associated with the provision of GPS services in general, to the practice of GPS navigation. An examination of the larger error data in the NAT CMA (Tables Alpha, Bravo and Charlie) shows a few instances of this behaviour. This is not a problem with the GPS navigation system per se, rather it reflects the performance associated with a small segment of the user population. States are requested to encourage their operators to install, maintain and use GPS equipment in accordance with its manufacturers instructions and consistent with some navigational practice.

3.2.34 Having reviewed the Scrutiny Report, the Group then determined the lateral risk estimate for 1996. The 1996 estimate together with the estimates for the previous four monitoring years are shown in Table 5. The data is also portrayed graphically in Figure 2 of Appendix A to the report on Agenda Item 3. When compared to 1995, the 1996 risk estimate for Organized Track System (OTS) traffic had decreased whilst that for random traffic had increased. Overall the collision risk for all MNPS traffic had also decreased. All the estimates were below the TLS of $2 \times 10^{-8}$ fatal accidents per flight hour.

**Table 5: Lateral Risk Estimates for the years from 1992/3 to 1996**

(All figures are in fatal accidents per flight hour and should be multiplied by $10^{-8}$)

| Risk | 1992/3 | 1993/4 | 1994/5 | 1995* | 1996 |
|---|---|---|---|---|---|
| OTS | 0.33 | 1.43 | 0.59 | 0.90 | 0.65 |
| Random | 0.69 | 0.34 | 0.56 | 0.45 | 0.52 |
| All MNPS | 0.49 | 0.98 | 0.58 | 0.69 | 0.59 |

* From 1995 onwards, updated values for the estimation of aircraft sizes were used for the kinematic factors

3.2.35 Based on the error classes used by the Scrutiny Group, the proportions of human error (Types B, C1 and C2), non-approved users (Type A) and equipment error (Types D, E, F) were examined graphically for the years 1987 to 1996 and are shown in Figure 3 of Appendix A to the report on Agenda Item 3. This year has shown a re-emergence of type A errors (caused by non-approved users) with 2 errors notified to the CMA. Errors caused by equipment failure (either not notified to ATC or notified to ATC too late for action) account for a large proportion of the estimated risk while errors due to human failure account for the rest.

*1996 vertical collision risk estimate*

3.2.36 As for lateral occupancies, the Group also determined the vertical occupancy estimates for the 1996 monitoring year based on the traffic weighted average of the United Kingdom 20°W estimates, the Canadian 40°W estimates and the traffic weighted average of both 30°W estimates. The estimates were based on data for the 4th and 15th days of each month. The 1996 estimates together with the estimates for 1995 are shown in Table 6.

**Table 6: Vertical Occupancy Estimates for 1995 and 1996**

| Direction | Traffic | 1995 | 1996 |
|---|---|---|---|
| Same | OTS | 1.497 | 1.517 |
| | Random | 0.247 | 0.217 |
| | Comb | 1.048 | 1.038 |
| Opposite | OTS | 0.004 | 0.006 |
| | Random | 0.035 | 0.042 |
| | Comb | 0.015 | 0.019 |

3.2.37 Table 6 shows that same direction OTS occupancy had increased while that for random traffic had decreased. This was despite a small rise in the proportion of random traffic in MNPS airspace. The lower random same direction occupancy values together with higher proportions of random traffic had led to the combined same direction occupancy estimate decreasing. Opposite direction occupancy had increased slightly compared to 1995.

3.2.38 Vertical collision risk in a non-RVSM environment was determined primarily from the estimate of time spent by aircraft at uncleared levels during the monitoring year. Table 7 shows the total number (not necessarily risk bearing) of large height deviations reported to the CMA and the estimate of time spent at uncleared levels for 1996 and the previous four monitoring years.

**Table 7: Large Height Deviations and Time Spent at Wrong Levels**

**for the Years 1992 - 1996**

| | 1992/3 | 1993/4 | 1994/5 | 1995 | 1996 |
|---|---|---|---|---|---|
| Number of Reported Deviations | 35 | 43 | 39 | 29* | 49* |
| Time at Uncleared Levels (mins) | 320 | 187 | 153 | 60 | 182 |

*includes reports of turbulence and relevant TCAS events

3.2.39 Table 7 also shows that the number of reports had increased since 1995 perhaps indicating a greater awareness of the need for such information in the run up to RVSM. The table also shows that up until the end of 1995, the estimate for the time spent at uncleared levels had been decreasing. Some of this improvement had been attributed to the fact that more reports included estimates of the time spent at uncleared levels. These estimates were generally smaller than the conservative estimates which had to be made in the past in the absence of such information. The downward trend was reversed in 1996. A large part of this was due to two reported height deviations occurring in July 1996 for which a considerable amount of time at uncleared levels had to be estimated.

3.2.40 Based on the large height deviations reported in 1996, the Group then determined the vertical collision risk estimates. The 1996 estimates together with the estimates for 1995 are shown in Table 8. Previous years estimates have not been included since the methodology employed was slightly different and some of the key parameter values have been revised. For both the 1995 and 1996 estimates, a value 0.0263, for the lateral overlap probability, Py(0), has been used based on results from the 1995 Core Navigation Summary.

**Table 8: Vertical Collision Risk Estimates Comparison with 1995***

| | 1995 | 1996 |
|---|---|---|
| OTS | $3.58 \times 10^{-9}$ | $6.47 \times 10^{-9}$ |
| Random | $2.25 \times 10^{-9}$ | $9.82 \times 10^{-9}$ |
| Combined | $2.95 \times 10^{-9}$ | $8.05 \times 10^{-9}$ |

* *Previous years estimates have not been included since the methodology employed was slightly different and some of the key parameter values have been revised.*

3.2.41 Table 8 shows that all the 1996 risk estimates are within the non-RVSM TLS of $2 \times 10^{-8}$ fatal accidents per flight hour but are higher than the RVSM TLS of $5 \times 10^{-9}$ fatal accidents per flight hour. The risk was higher for random flights in 1996 due to the greater reported number of risk bearing large height deviations by random flights in this monitoring period compared to OTS flights. Comparison of 1996 to 1995 values shows nearly three fold increases in the combined collision risk estimates. These increases were primarily due to the two reported errors in July 1996, one at FL 350 and one at FL 390, where the time spent at uncleared levels had to be estimated, in the absence of other information, as 55 minutes. The value of 55 minutes was based on the typical time between waypoints (i.e. the time before an error would be routinely discovered through a position report) + the time taken to correct the error minus the time taken to change levels.

3.2.42 *Preliminary* estimates of the increased 1996 vertical collision risk were presented by the MWG to the NAT IMG in December 1996. As a consequence, the NAT IMG implemented a range of measures to combat operational errors and also to lessen the detection time when errors do occur. In particular, there was now a requirement for an additional R/T call whenever a new level was reached. Such a procedure should reduce the number of long duration errors where aircraft fly at uncleared flight levels undetected. It was too early to say whether the measures implemented by the NAT IMG have been effective.

*Effects of RVSM on occupancies*

3.2.43 The Group was provided with estimates of the lateral and vertical occupancy values at 30$^{o}$W from the Gander GAATS database for the first 20 days of RVSM operation. These occupancies were compared against the combined United Kingdom and Canadian occupancies estimates for the first three months of 1997 (i.e. prior to the implementation of RVSM). Occupancies were determined separately for the Phase 1 RVSM Levels (i.e. FL 330 to FL 370) and also for the MNPS levels above RVSM (FL390 to FL 410) and below RVSM (FL 290 to FL 310). In addition, for lateral occupancies, the overall occupancy estimates were determined for the whole of MNPS airspace (FL290 to FL410). Overall vertical occupancy estimates were not determined because of the different vertical separation minimum in the Phase 1 RVSM band of MNPS airspace. The results of the occupancy determinations are shown in Tables 9 to 12. It should be noted that Tables 9 and 10 show same direction lateral and vertical occupancies while Tables 11 and 12 show opposite direction occupancies.

3.2.44 The tables show that within the RVSM levels, lateral same direction occupancies have significantly decreased whereas vertical same direction occupancies have decreased only slightly. This may in part be due to the reduction in the typical number of OTS tracks since the implementation of RVSM which tends to concentrate the OTS traffic on a small number of core tracks, resulting in a smaller decrease in vertical occupancy. For opposite direction traffic, the initial estimates show decreases for both lateral and vertical occupancies.

3.2.45 Below the RVSM levels, lateral and vertical same direction occupancies have increased slightly which is presumably due to non-approved users having to fly below RVSM airspace. For opposite direction traffic, lateral occupancies have increased, whereas vertical occupancies have decreased.

3.2.46 Above the RVSM levels, the trends are almost exactly reversed. Same direction lateral and vertical occupancies have decreased, whereas opposite direction vertical occupancies have increased. However, for lateral opposite direction occupancies, an increase has been seen both above and below the RVSM levels. Despite this, lateral occupancies overall (i.e. all MNPS airspace) have decreased since the implementation of RVSM.

**Table 9: Comparison of 1997 Same Direction Lateral Occupancies - Pre and Post RVSM**

| | 1997 PRE-RVSM | | | 1997 POST-RVSM | | |
|---|---|---|---|---|---|---|
| | OTS | Random | Combined | OTS | Random | Combined |
| Full MNPS airspace* | 1.299 | 0.291 | 0.884 | 1.004 | 0.189 | 0.677 |
| Above RVSM | 0.605 | 0.047 | 0.327 | 0.412 | 0.046 | 0.227 |
| RVSM Levels | 1.420 | 0.352 | 1.026 | 1.017 | 0.198 | 0.721 |
| Below RVSM | 0.911 | 0.221 | 0.520 | 1.160 | 0.215 | 0.679 |

**Table 10: Comparison of 1997 Same Direction Vertical Occupancies - Pre and Post RVSM**

| | 1997 PRE-RVSM | | | 1997 POST-RVSM | | |
|---|---|---|---|---|---|---|
| | OTS | Random | Combined | OTS | Random | Combined |
| Above RVSM | 0.491 | 0.073 | 0.310 | 0.368 | 0.056 | 0.241 |
| RVSM Levels | 1.248 | 0.219 | 0.869 | 1.229 | 0.206 | 0.859 |
| Below RVSM | 0.627 | 0.134 | 0.407 | 0.687 | 0.112 | 0.424 |

**Table 11: Comparison of 1997 Opposite Direction Lateral Occupancies - Pre and Post RVSM**

| | 1997 PRE-RVSM | | | 1997 POST-RVSM | | |
|---|---|---|---|---|---|---|
| | OTS | Random | Combined | OTS | Random | Combined |
| Full MNPS airspace* | 0.005 | 0.013 | 0.008 | 0.003 | 0.011 | 0.006 |
| Above RVSM | 0.004 | 0.004 | 0.004 | 0.007 | 0.020 | 0.013 |
| RVSM Levels | 0.005 | 0.018 | 0.010 | 0.002 | 0.008 | 0.004 |
| Below RVSM | 0.001 | 0.001 | 0.001 | 0.004 | 0.017 | 0.010 |

**Table 12: Comparison of 1997 Opposite Direction Vertical Occupancies - Pre and Post RVSM**

| | 1997 PRE-RVSM | | | 1997 POST-RVSM | | |
|---|---|---|---|---|---|---|
| | OTS | Random | Combined | OTS | Random | Combined |
| Above RVSM | 0.002 | 0.012 | 0.006 | 0.001 | 0.016 | 0.007 |
| RVSM Levels | 0.003 | 0.027 | 0.012 | 0.001 | 0.014 | 0.006 |
| Below RVSM | 0.021 | 0.047 | 0.032 | 0.007 | 0.024 | 0.015 |

* These values have not been included within the vertical occupancy tables because it is not appropriate to estimate vertical combined occupancies for airspaces with different vertical separation minima

*Preliminary 1997 Risk Estimates*

3.2.47 Table 13 shows the *preliminary* 1997 lateral risk estimates prior to and post implementation of RVSM. The risk is based on the occupancies presented above and a 12 month moving average error rate i.e. the pre-RVSM risk estimate is based on 12 months of errors between April 1996 and March 1997 with the post-RVSM estimate being based on 12 months of errors between June 1996 and May 1997. Table 13 shows a decrease in risk arising from the implementation of RVSM primarily due to the decrease in lateral occupancies overall brought about through the introduction of the additional flight levels in RVSM. All estimates are below the current lateral TLS of $2 \times 10^{-8}$ fatal accidents per flight hour.

**Table 13: Preliminary Lateral Risk Estimates for MNPS Airspace - pre and post RVSM**

(All figures are in fatal accidents per flight hour and should be multiplied by $10^{-8}$)

| Risk | Pre RVSM | Post RVSM |
|---|---|---|
| OTS | 0.73 | 0.38 |
| Random | 1.04 | 0.58 |
| All MNPS | 0.88 | 0.48 |

3.2.48 Table 14 shows the *preliminary* 1997 vertical risk estimates prior to and post implementation of RVSM. Again, the risk is based on the occupancies presented above and a 12 month moving average error rate i.e. the pre-RVSM risk estimate was based on 12 months of errors between April 1996 and March 1997 with the post-RVSM estimate being based on 12 months of errors between June 1996 and May 1997. Note, there have been no reported vertical operational errors in the first two months of RVSM. Nevertheless, the post-RVSM risk estimate is based on the assumption that the previous typical rate of operational errors would continue.

**Table 14: Preliminary Vertical Collision Risk Estimates - Comparison Pre and Post RVSM (Large Height Deviations Only)**

(All Figures are in Fatal Accidents Per Flight Hour and should be Multiplied by $10^{-9}$)

| | 1997 Pre-RVSM | 1997 Post-RVSM | |
|---|---|---|---|
| | FL290 - FL410 | RVSM Levels | Non-RVSM Levels |
| OTS | 8.34 | 9.77 | 0.11 |
| Random | 8.17 | 2.52 | 6.48 |
| Combined | 8.26 | 6.41 | 4.01 |

3.2.49 Table 14 shows a decrease in risk due to large height deviations with the implementation of RVSM again primarily due to a decrease in vertical occupancies. However, the current estimate for Phase 1 RVSM was still above the RVSM TLS of 5 x $10^{-9}$ fatal accidents per flight hour. This was due to the fact that a single error at FL 350 of assumed duration of 55 minutes that occurred in July 1996 was still present in the 12 month moving average (paragraph 3.2.41 refers). This is shown in Figure 4 of Appendix A to the report on Agenda Item 3. By August 1997, and assuming the new measures implemented by NAT IMG to combat operational errors were effective, it was anticipated that the RVSM risk estimate should decrease below the TLS. However, it was too early to say whether the TLS would be met by the end of the Phase 1 RVSM operational trial. This is shown in Figure 5 of Appendix A to the report on Agenda Item 3, which is a sequential test chart depicting the error rate between June 1996 and May 1997. The rate of reported errors decreased between October 1996 and January 1997 but then a number of reported errors in February and March 1997 brought the rate back up again with the result that the test chart remained within the "continue monitoring" phase i.e. there was, as yet, insufficient information to say whether or not the TLS was being met.

3.2.50 Finally Table 15 shows the *preliminary* total vertical risk estimate for Phase 1 RVSM due to both technical risk, i.e. height keeping performance, and risk due to large height deviations. The technical risk estimate was determined by the NAT MIG. It can be seen that the total risk was dominated by the contribution made by large height deviations.

**Table 15: Preliminary Total Vertical Collision Risk Estimate for FLs 330 to 370 of the Phase 1 RVSM Operational Trial**

| Cause | Risk estimate (fatal accidents per flight hour) |
|---|---|
| Large Height Deviations | 6.41 x $10^{-9}$ |
| Technical Risk | 0.12 x $10^{-9}$* |
| Total | 6.53 x $10^{-9}$ |

* estimated at NAT MIG/1

*Review of On-going Monitoring Procedures*

<u>Lateral</u>

3.2.51 The three key parameters which affected the lateral collision risk estimate were:

a) lateral occupancies;

b) the accuracy with which aircraft on adjacent tracks at the same flight level maintained their assigned flight levels; and

c) the rate of reported GNEs.

3.2.52 Risk estimates were made on an annual basis with monthly updates being provided by the CMA.

3.2.53 The Group reviewed the graphs which had been provided to the CMA each month in order to assess lateral risk on an on-going basis. Since lateral occupancies were significantly affected by the implementation of RVSM, it was agreed that monthly lateral risk estimates would be based on cumulative average occupancies starting April 1997 until a 12 month moving average could be achieved or such time that Phase 2 RVSM was implemented when occupancies would be further re-evaluated.

3.2.54 For the 1997 annual risk assessment prior to RVSM, the lateral risk estimate would be based on the average 12 months of occupancies between April 1996 and March 1997 using FL 280 to FL 390 in MNPS airspace. For the post-RVSM estimate, the average occupancy for FL 290 to FL 410 in MNPS airspace for the nine month period April 1997 to December 1997 would be used.

3.2.55 In addition to effects on occupancies, the presence of a large proportion of Minimum Aircraft System Performance Specification (MASPS) approved aircraft had improved the average height keeping performance of aircraft within MNPS airspace. This meant that the new value, 0.50, for the probability of vertical overlap, Pz(0), would be used in all lateral risk assessments from January 1997.

3.2.56 Since there was no evidence to suggest that lateral error rates would be affected by the introduction of RVSM, error rates would be based on a 12 month moving average for both the annual risk assessment and the monthly updates.

Longitudinal

3.2.57 The Group reviewed a recent event reported to the CMA in which a suspected 10 minute time keeping error was made at consecutive reporting points by an aircraft in oceanic airspace. The occurrence of such an error reinforces the conclusions drawn from previous time-keeping studies performed by the Group and verified the need for the improvements in time-keeping procedures being developed by the NAT IMG. Various issues regarding the implementation of improved time-keeping were raised and these would be further discussed by the NAT IMG and its working groups.

3.2.58 An on-going estimate of longitudinal collision risk is not currently provided. While data collections were effective at determining core performance of distributions, rates of unusual occurrences needed to be evaluated on a long term basis. In anticipation of the need to produce longitudinal risk estimates in the future and to build up a database of significant events, the Group reviewed the types of events which would need to be recorded. At the time there was only a requirement for OACs to provide reports when longitudinal separation was reduced to 7 minutes or less where the lead aircraft was not faster. Suggestions for the types of event that would need to be reported in the future and the information required were made to the Group.

3.2.59 The Group recognised the extra burden that the reporting of these events might place on both OACs and the CMA but felt that the need was justified. The estimation of collision risk was a very powerful tool in verifying overall system safety prior to changes in separation minima and in providing on-going monitoring afterwards. Similar measures taken in the past to improve reporting of errors in the lateral and vertical dimensions had very successfully provided means to identify where safety improvements could be made.

**CONCLUSION 33/11 - ASSESSMENT OF LONGITUDINAL RISK**

**That:**

**a) the Rapporteur of the Mathematicians' Working Group coordinate with the Operations Managers of the NAT Oceanic Area Control Centres and the Central Monitoring Agency to determine the type and amount of data required to carry out the longitudinal risk assessment;**

**b) all States support a collection of the data identified above; and**

**c) automatic means of data collection be used when possible.**

Vertical

3.2.60 During the RVSM operational trial, monitoring of altimetry system errors and large height deviations was continuing. As of May 1997, 1201 aircraft had been notified to the CMA as being airworthiness approved of which 889 (74%) had been monitored by either the prototype HMU at Strumble or by the GPS-based Height Monitoring System (GMS). A large number of United States military aircraft had also participated in the monitoring programme.

3.2.61 A summary of the altimetry system errors seen is given in Tables 16 and 17. The greatest magnitude error so far monitored for an approved airframe was -231 ft for a Boeing 767 which was still in compliance with the MASPS. In contrast, some non-approved airframes have exhibited much larger errors, the biggest for a NAT flight being 437 ft for an IL62. Instances of large errors were being followed up by the CMA. Post-processing of data has also indicated that a number of flights may have been made in RVSM airspace by non-approved users and these were being followed up by the CMA.

**Table 16: Altimetry System Error/Total Vertical Error Results for Approved Aircraft**
(Based on HMU data up to 09/05/1997 and
GPS based Monitoring Unit (GMU) data received by 29/05/1997)

| Measurements | Unique Airframes Identified | Aircraft Types | Mean | SD | Min | Max | |
|---|---|---|---|---|---|---|---|
| 5859 | 889 | 22 | -2.877 | 49.883 | -231 | 216 | ASE |
| | | | -0.151 | 21.597 | -200 | 200 | AAD |
| | | | -3.024 | 50.553 | -231 | 216 | TVE |

**Table 17: ASE/TVE Results for All Identified Aircraft**
(Based on HMU data up to 09/05/1997 and GMU data received by 29/05/1997)

| Measurements | Unique Airframes Identified | Aircraft Types | Mean | SD | Min | Max | |
|---|---|---|---|---|---|---|---|
| 13839 | 2227 | 66 | -5.073 | 61.592 | -351 | 437 | ASE |
| | | | -0.136 | 29.089 | -300 | 200 | AAD |
| | | | -5.215 | 62.619 | -297 | 426 | TVE |

3.2.62 Some information was provided to the Group on the typical results of cross-cockpit altimetry system checks. This indicated, for the aircraft type monitored, good adherence to the exact flight level as indicated by the Captain's altimeter and very good correlation between the two main altimeters. In this sample, standby altimeters (without air data correction) for the aircraft type generally gave consistently higher readings of about 400 ft.

*1995 Core Navigation Study*

3.2.63 The Group was presented with the results from the core navigation study for aircraft exiting the Ocean at the Canadian boundary. The standard deviation of cross-track errors was determined as either 1.08 NM, 1.27 NM or 1.65 NM depending on which flights were used within the calculation. The Group recommended that the value of 1.27 NM be adopted since this included all cross track errors measured at less than 25 NM but not those errors where it was suspected that aircraft were deliberately changing to a direct route at the time of monitoring. Table 18 shows the four values for the standard deviation of cross track errors as determined on the United Kingdom and Canadian sides of the ocean during the 1995 Core Navigation Study.

**Table 18: Standard Deviation of Cross Track Errors of Aircraft Entering and Exiting NAT MNPS Airspace**

| Entering Ocean | Exiting Ocean | Direction |
|---|---|---|
| 0.87NM | 1.27NM | Westbound |
| 1.21NM | 2.79NM | Eastbound |

3.2.64 Table 18 shows that, as expected, the standard deviation of cross-track errors was higher on exiting the ocean compared to entry due to the gradual increase of drift errors of inertial systems as aircraft traverse the ocean. Table 18 also indicates an apparently better performance for Westbound than Eastbound. This variation had been seen in past core navigation studies where Canadian data had given consistently lower cross track error standard deviations than equivalent United Kingdom studies. The reasons for the variation were not clear although the Group speculated that Inertial Navigation Systems (INS), because of their dependence on the determination of accelerations were more affected in an easterly direction when aircraft were travelling the same way that the Earth was turning.

3.2.65 The Group was also presented with an update to the NAT operator survey of aircraft navigation systems being performed by the FAA Technical Centre. A further 10 operators had responded since the last update bringing the number of respondents to 37. However, the Group was disappointed to note that a number of the larger operators had still not responded. The Group felt that the information provided by the survey together with the cross-track error data provided by the 1995 core navigation study should be analyzed further with a view to providing information on lateral navigation accuracy by equipment fit. It was also felt useful to continue the work comparing the cross-track errors from the 1995 survey of individual flights as they enter and exit the ocean with the aim of obtaining a better estimate for Py(0), a parameter that can have a significant effect on the estimation of vertical and longitudinal collision risk.

3.2.66 With regard to future core navigation studies, the Group felt that there was no need to perform another one until such time that there was likely to be a large enough proportion of GNSS equipped aircraft in the monitoring sample to allow the characterisation of GNSS oceanic performance.

*Target Levels of Safety*

3.2.67 In the light of the updated traffic forecasts provided by the NAT TFG, the Group was presented with a table which converts current and proposed TLSs expressed in units of fatal accidents per flight hour into units of years between mid-air collisions. The latter units were more meaningful to decision makers and the table (Table 19) is presented here for information. TLSs are usually directly influenced by the choice of the period for which the system will be in place (sometimes referred to as the planning horizon). The table clearly illustrates the importance of reducing the TLS in order to keep pace with ever increasing traffic levels.

3.2.68 It was also important to remember that TLSs were targets and that the risk estimation process was separate from TLS determination. Actual risk estimates were expected to be below these target values (paragraph 2.3.26 also refers).

**Table 19: Target Levels of Safety and their conversion into years per mid-air collision**

| Type | TLS (Accidents/Flight Hour) | | | | Years per Mid-Air Collision* | | |
|---|---|---|---|---|---|---|---|
| | SINGLE DIMENSION | | | | 1985 Traffic | 1997 Traffic | 2010 Traffic |
| Current Lateral | $2 \times 10^{-8}$ | | | | 205 | 100 | 65 |
| RVSM | $5 \times 10^{-9}$ | | | | 810 | 385 | 260 |
| | ALL DIMENSIONS | | | | | | |
| | Lateral | Longitudinal | Vertical | Total | 1985 Traffic | 1997 Traffic | 2010 Traffic |
| Pre-RVSM | $2 \times 10^{-8}$ | $2 \times 10^{-8}$ | $2 \times 10^{-8}$ | $6 \times 10^{-8}$ | 70 | 30 | 20 |
| Post-RVSM | $2 \times 10^{-8}$ | $2 \times 10^{-8}$ | $5 \times 10^{-9}$ | $4.5 \times 10^{-8}$ | 90 | 45 | 30 |
| Post- 10min-7min | $2 \times 10^{-8}$ | $5 \times 10^{-9}$ | $5 \times 10^{-9}$ | $3 \times 10^{-8}$ | 135 | 65 | 45 |
| Post-60NM to 30NM | $5 \times 10^{-9}$ | $5 \times 10^{-9}$ | $5 \times 10^{-9}$ | $1.5 \times 10^{-8}$ | 270 | 130 | 85 |

***Notes**

- Entries are rounded to nearest 5 years.
  1 collision = 2 accidents
- Traffic Levels used were from TFG Baseline Forecasts (1997)
  1985: 140800 NAT Flights
  1997: 296800 NAT Flights
  2010: 437000 NAT Flights
- Assumes each flight spends 3.5 hours on average in the NAT
- TLS planning horizons, i.e. period for which it is suggested that the TLS is valid
  $2 \times 10^{-8}$: 1980 - 1995
  $5 \times 10^{-9}$: 1995 - 2010

*MWG Terms of Reference and work programme*

3.2.69 In light of the creation of the MIG by the NAT IMG (paragraph under Agenda Item 2.3 refers), the MWG was primarily concerned with the on-going assessment of lateral and vertical (and eventually longitudinal) collision risk. As a result, the Group reviewed the MWG Terms of Reference. A copy of the agreed Terms of Reference is given in **Appendix B** to the Report on Agenda Item 3 and will be included in the NAT SPG Handbook.

3.2.70 The Group agreed that the MWG should continue to provide inputs to the CMA on a monthly basis. The next annual risk assessments would be performed in May 1998 for which a meeting of the MWG would be required immediately prior to NAT SPG/34. The Group also felt that the MWG should continue its work analysing the results from the 1995 core navigation study (paragraph 3.2.65 refers).

## 3.3 Review of systems operations

**AIR TRAFFIC MANAGEMENT**

*North Atlantic Operations Managers' Meeting*

3.3.1 The Group was presented with an overview of the report of the 27th meeting of the NAT OPS MNGs which had been held in Santa Maria from 11 to 15 November 1996. Most of the issues that were brought to the attention of the NAT SPG have been documented in other parts of this report. However, as regards the decision by Canada to discontinue its inspections of IGA traffic planning to cross the NAT, the Group felt that Canada should review the decision bearing in mind the positive effects that the inspections have had on reducing Search and Rescue (SAR) activities. In this context, the United States reminded the Group that it was preparing a new edition of the IGA Manual and the decision by Canada would have to be taken into account prior to finalising the manual. Canada and the United States agreed to carry out the necessary co-ordination on this matter.

**CONCLUSION 33/12 - INSPECTIONS OF INTERNATIONAL GENERAL AVIATION (IGA) BY THE CANADIAN ADMINISTRATION**

**That:**

**a) Canada review its policy of discontinuing inspections of IGA traffic planning to cross the North Atlantic; and**

**b) Canada and the United States carry out the necessary co-ordination to ensure that the NAT IGA Manual is updated in the light of the decision made by Canada regarding inspections of IGA flights.**

3.3.2 Concerning the terms of reference and organization of the OPS MNGs meetings, the Group felt that the time taken to provide the NAT SPG with the report of the OPS MNGs meeting, in this case seven months, was excessive when considering the fact that they were expected to examine and report on short term (12 months) issues. With this in mind, the Group agreed that the report of the NAT OPS MNGs meetings should be sent to the ICAO European and North Atlantic Office within 30 days of the end of the meeting and that the NAT SPG Secretary would then be responsible for its distribution to all concerned.

3.3.3 The Group also discussed the location of meetings as well as the participation of user organizations. In this context, it was pointed out that meetings held in locations that were difficult to get to caused concerns for the users who normally only participated for one day. This situation added significant travel time with the concomitant result on resources, both financial and human. It was agreed that convening the NAT OPS MNGs meetings concurrently with the NAT Users Conference would alleviate to a large extent this problem. With this in mind, and recalling that a Users Conference would be held in New York from 2 to 5 September 1997, it was agreed that the next NAT OPS MNGs meeting be held in New York in conjunction with the User's Conference and the actual dates of the meeting would be provided by 1 August 1997. As regards the venue for subsequent meetings, it was also agreed that they be convened so as to be held at NAT Oceanic ATC facilities those years when no NAT Users Conference was being held.

3.3.4 Turning to the terms of reference of the NAT OPS MNGs, the Group agreed that, in so far as the NAT SPG was concerned, more emphasis should be put on identifying deficiencies and shortcomings and proposing solutions to resolve them. This new task would be in addition to the regular co-ordinating activities carried out by the NAT OPS MNGs. The report to the NAT SPG should be limited to only those issues of direct interest to the NAT SPG and should specifically highlight any deficiencies and shortcomings. Issues of a day to day nature associated with managing NAT traffic should not be brought to the attention of the NAT SPG unless specific action would be required or that it was considered important that the NAT SPG be aware of the issue. With this in mind, the Group agreed to the revised terms of reference and working methods shown in **Appendix C** to the Report on Agenda Item 3 and further agreed that the NAT SPG handbook be amended accordingly.

**CONCLUSION 33/13 - REVISED TERMS OF REFERENCE FOR THE NAT OPERATIONS MANAGERS (NAT OPS MNG) MEETINGS**

**That:**

**a) the terms of reference and working methods of the NAT OPS MNGs meetings be amended in accordance with the Appendix C to the Report on Agenda Item 3; and**

**b) the NAT SPG Handbook be amended to reflect a) above.**

**COMMUNICATIONS**

*Matters arising from NAT SPG/32*

3.3.5 The Group was informed that the situation regarding Shannon VOLMET had not changed since NAT SPG/32. Approaches that had been made to the original supplier of the system have failed and it has not been possible to have the required software upgrade implemented. A decision has therefore been taken to replace the existing system. The United States has implemented the amended broadcast plan as agreed at NAT SPG/31.

3.3.6 The Group recalled that it agreed that the practice of reading back the weather data contained in position reports be dispensed with as a means of reducing HF on-air time (Conclusion 32/20 refers). This decision has been implemented by most provider States. The Group had also considered dropping the practice of reading back the "NEXT" forward reporting point. However, as no consensus could be reached, it was agreed that this matter be referred to the NAT OPS MNGs for consideration. The issues was examined at the NAT OPS MNG/27 meeting and they recommended that the read back of next + 1 position reports should be continued. Accordingly, no further action was taken.

*HF & General Purpose/Very High Frequency (GP/VHF) data collection for 1996*

3.3.7 States concerned had prepared detailed statistical reports for 1996 based on the results of HF and GP/VHF data collection exercises conducted in accordance with NAT SPG Conclusion 30/26. The results, which were consolidated in a single report compiled by Portugal, provided information concerning individual station performance and a global overview of network operations. It was noted that the network had produced 3.28 million messages in 1996, up from 3.04 million messages in 1995, an increase of 7.9 percent. Distribution was approximately 80 percent HF with the remainder on GP/VHF. These statistics included both readback and intercept messages. As in previous years, the data indicated that some HF frequencies were exceeding capacity limits during peak traffic periods. The Group agreed to continue reporting HF and GP/VHF surveys, and to compile a separate report for Busiest Day, confined to redback messages only. The Group expressed its appreciation to Portugal for the quality and scope of the report and acknowledged its usefulness to the administrations involved.

**CONCLUSION 33/14 - HIGH FREQUENCY (HF) & GENERAL PURPOSE/VERY HIGH FREQUENCY (GP/VHF) DATA COLLECTION FOR 1997**

**That States concerned:**

**a) continue to conduct an annual HF and GP/VHF data collection exercise and present the information in the format outlined at Appendix C to the Report on Agenda Item 2 of NAT SPG/29 with the exception of reporting the busiest day by individual aeronautical communications stations; and**

**b) confine busiest day reporting to read back only traffic.**

*Effects of RVSM on HF Communications*

3.3.8 The Group recalled that the introduction of the Phase 1 RVSM in the NAT Region had been expected to impact significantly on HF communications exchanges, with increased requests for level changes. However, a recent poll of the HF aeronautical stations had indicated that so far, the effects were not giving rise for concern. The Group noted that this situation would be monitored during the peak traffic months to determine if any future action would be required.

*Network management*

3.3.9 Concern had been expressed about the overloading on some frequencies during peak traffic periods. The Group felt that acquisition of new frequencies was necessary and that consideration should be given to sharing frequencies with other areas. Canada had been asked to pursue this matter and had engaged the services of a commercial communications company. The report, prepared by Canada, identified frequencies listed in International Telecommunication Union (ITU) Appendix 27 Aer2 which were shared by a number of areas depending on geographical location. The Group noted that the report would be distributed to HF provider States for consideration.

3.3.10 The Group noted that additional capacity had been provided by Canada with the implementation of family NAT - D at Gander. The additional frequencies were used on a tactical basis, as and when the need arose or when propagation on other families was not satisfactory.

3.3.11 Some aeronautical stations expressed concern about the distribution of traffic on HF frequencies. Indeed, it was claimed that traffic was being inappropriately assigned by some stations causing congestion on frequencies which were already saturated. As a result, Canada reviewed its use of family NAT - A as an off-load frequency; in addition, Portugal and the United States were to conduct a similar exercise. The initial results were inconclusive and the status quo remained.

3.3.12 The Group noted that Denmark had informed Canada that facilities in place in Frederiksdal and Prins Christian Sund were configured to obtain the best combined coverage pattern around the tip of Greenland. This pattern could be altered but what would be gained in one direction would be lost in another. The Group also recalled that Denmark and Iceland had agreed to review the possibility of further alleviating HF congestion by implementing additional VHF stations in Greenland remotely controlled from Iceland. The result of the study would be presented to NAT SPG/34.

**CONCLUSION 33/15 - INSTALLING ADDITIONAL VERY HIGH FREQUENCY (VHF) STATIONS IN GREENLAND**

**That Denmark and Iceland:**

**a) study the possibility of installing additional VHF stations in Greenland remotely controller from Iceland so as to reduce high frequency congestion; and**

**b) report their findings to NAT SPG/34.**

*Harmful interference on HF*

3.3.13 Provider States submitted reports on harmful interference to HF frequencies experienced at the various stations during 1996. The overall conclusion was that, while interference at some stations had increased, operations were not adversely affected. The Group noted that States would continue to collect such information and report to future NAT SPG meetings.

*HF data link (HFDL)*

3.3.14 The Group was informed that the development of the ARINC GlobaLink system was continuing following successful waypoint position reporting trials carried out in the NAT Region in 1995/96 using stations located in Canada, Iceland and Sweden. The Irish Aviation Authority has entered into an agreement with ARINC for evaluation of systems aimed at participation in the ARINC HFDL network. The system was expected to be operational for aircraft operational control purposes in the NAT Region by mid 1998.

*Intercept procedures*

3.3.15 The Group recalled that it had discussed whether to discontinue HF intercept procedures at NAT SPG/31 (Conclusion 31/11 refers). The NAT OPS MNGs, at their 27th meeting, reviewed this matter and had recommended that there was no longer an operational requirement to continue the intercept procedure. On the basis of this recommendation, the Group agreed that provider States co-ordinate amongst themselves in order to discontinue HF intercepts. To this end, the Rapporteur of the Aeronautical Communications Sub-Group (ACSG) would act as the focal point to establish a date for the suspension of HF intercepts.

**CONCLUSION 33/16 - DISCONTINUATION OF HIGH FREQUENCY (HF) INTERCEPT PROCEDURES**

**That all NAT provider States co-ordinate amongst themselves in order to discontinue the HF intercept procedures.**

**SYSTEM EFFICIENCY**

*Determination of the performance of the NAT air navigation system and the services provided to airspace users by ATC*

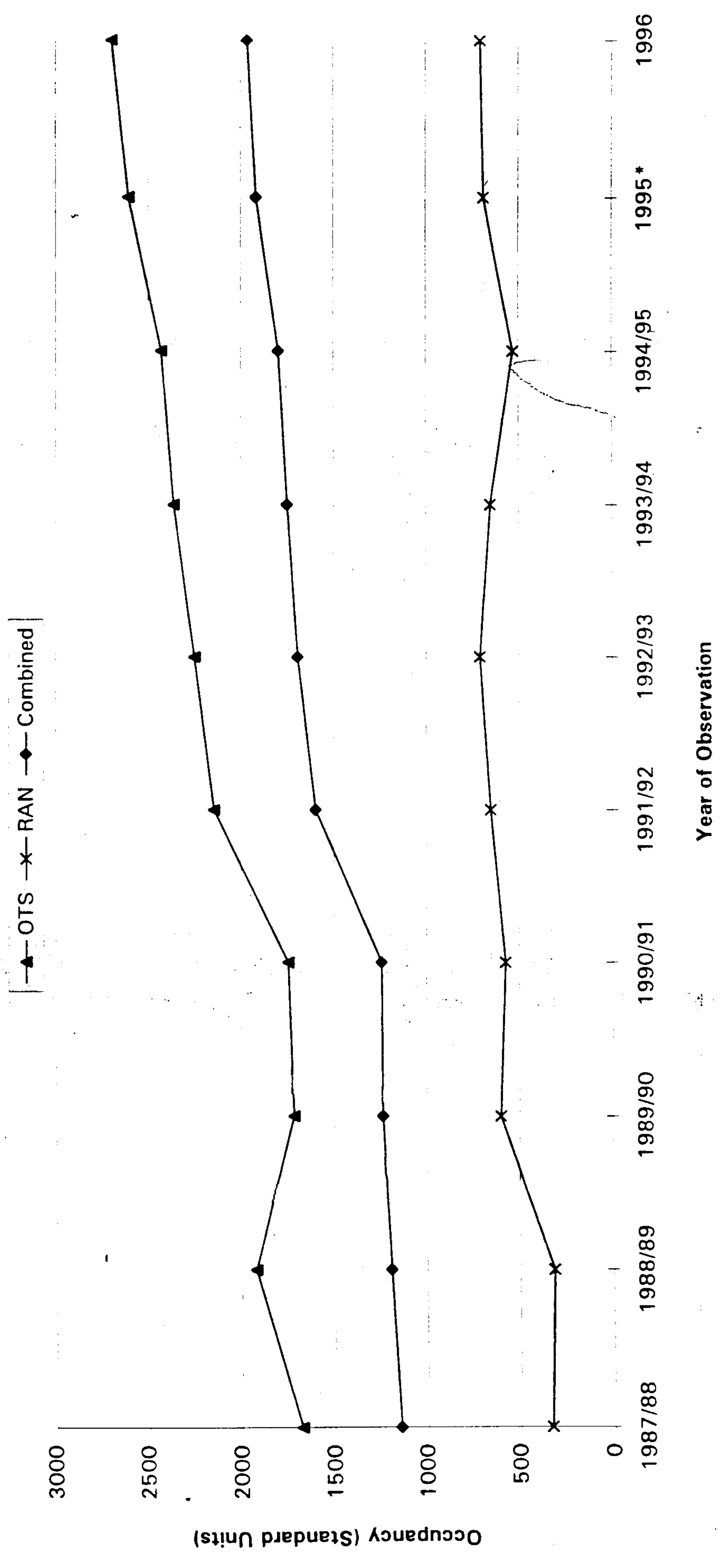
3.3.16 As at previous meetings, the Group was presented with information on the efficiency of NAT air navigation services in the format agreed to at NAT SPG/24 (Conclusion 24/11 refers). It was noted that nothing untoward was reported. The Group did note with appreciation the data presented by the representative from IAOPA on the distribution of traffic in Shanwick Oceanic Control Area (OCA) as well as the information presented by Canada on the effects of the implementation of RVSM on operations.

3.3.17 The Group was asked to consider whether the current statistics gathered by States on a yearly basis were still a useful tool for evaluating system efficiency. The consensus was that until another method of carrying out an evaluation of system efficiency was determined, States should continue to collect the data. However, recalling that the NAT IMG was developing tools to evaluate Key Performance Indicators (KPI), the Group agreed that it would be appropriate for them to examine this matter and report to NAT SPG/34.

**CONCLUSION 33/17 - EVALUATION OF SYSTEM EFFICIENCY**

**That the NAT Implementation Management Group examine ways and means to improve the method of evaluating the system efficiency of the NAT air navigation system.**

**Figure 1: North Atlantic MNPS Airspace Occupancy Expressed in Standard Units**




* From 1995 onwards, updated values for the estimates of aircraft sizes were used for the kinematic factors

**Figure 2: North Atlantic Lateral Risk Estimates for the years 1992 to 1996**

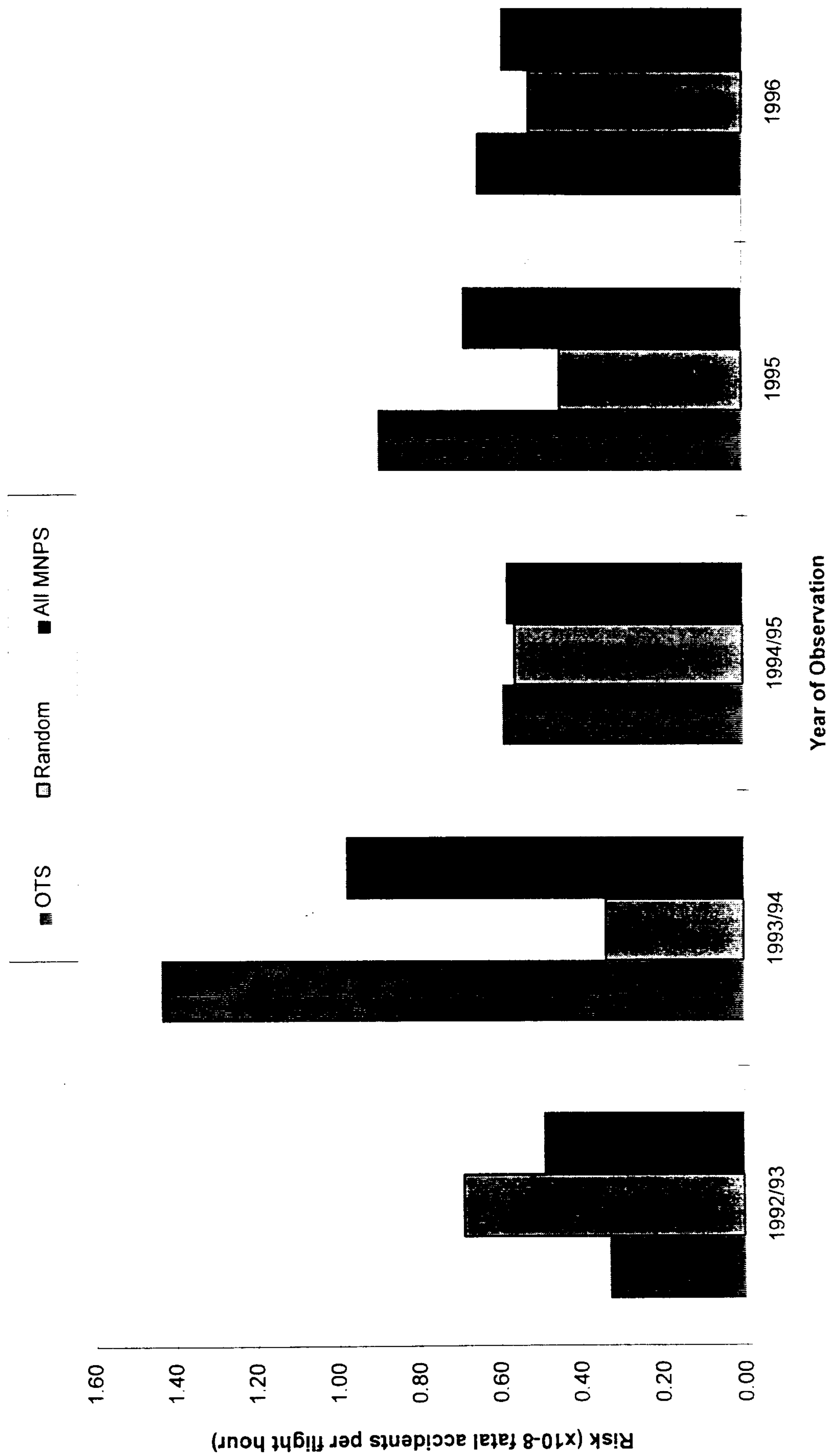
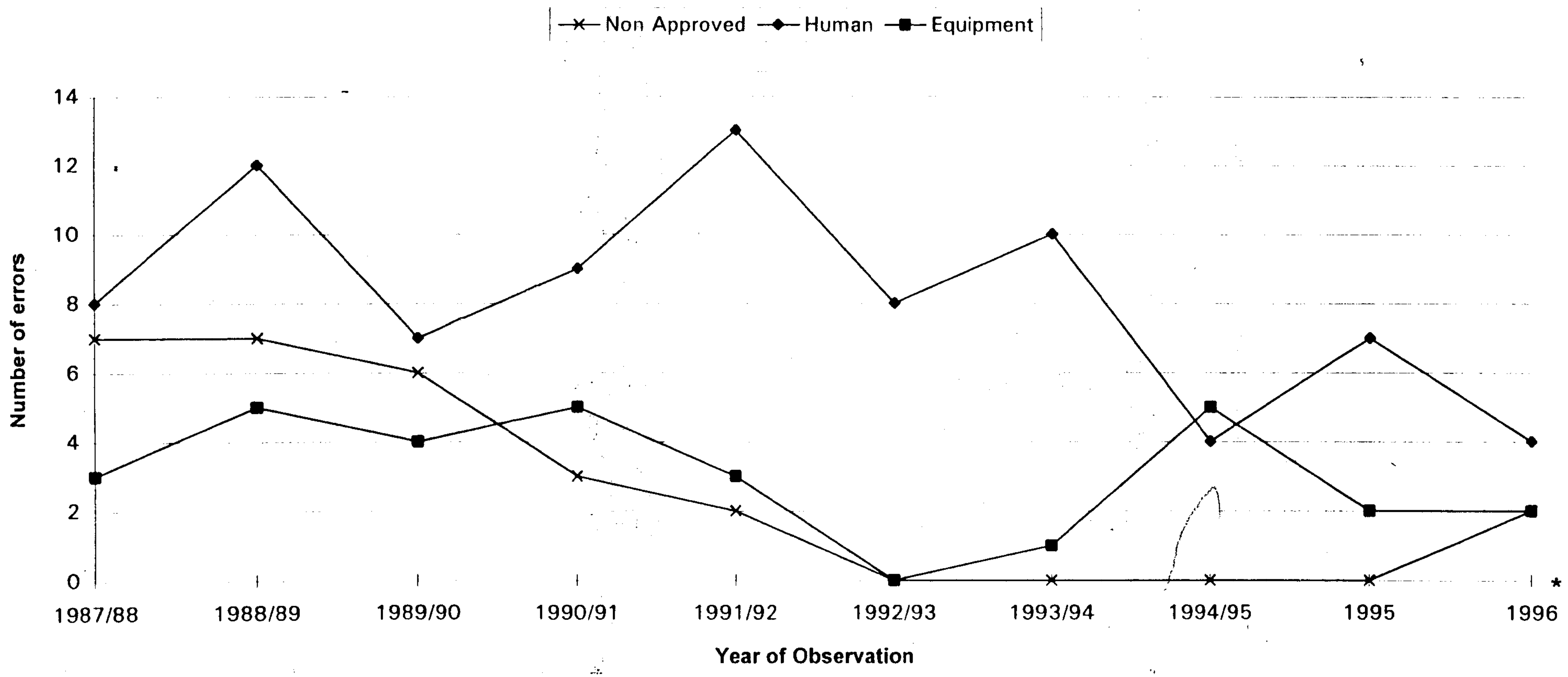
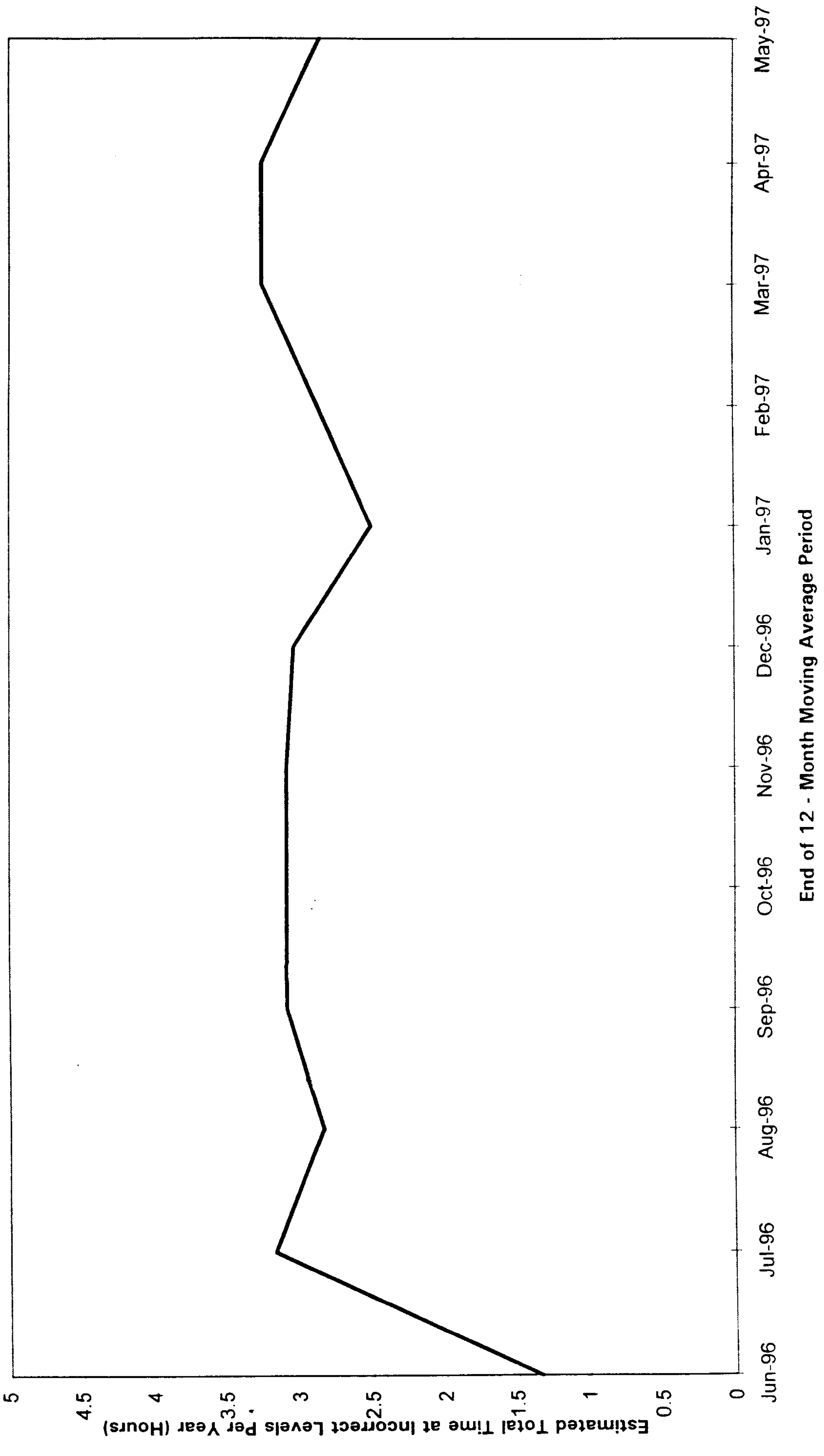


**Figure 3: Unweighted number of risk bearing GNEs > 50 Nm**




* For risk assessment purposes the two errors by unapproved users were also classified in the "human" or "equipment" categories (one in each)

**Figure 4: Estimated time spent on track at incorrect levels in NAT MNPS airspace**



## NAT Large Height Deviations (Phase 1 RVSM) Test Charts and Tables: 06/05/97

| | | |
|---|---|---|
| Lateral Nav. S.D. | 0.87 | (nmi.) |
| Py(0) | 0.0263 | |
| Pz(0) | 0.5000 | |
| **Aircraft Size:** | | |
| Length | 0.0306 | (nmi.) |
| Width | 0.0272 | (nmi.) |
| Height | 0.0086 | (nmi.) |
| **Aircraft Pair Velocity:** | | |
| Same Direction | 13 | (kts.) |
| Lateral | 20 | (kts.) |
| Vertical | 1.5 | (kts.) |
| Aircraft Velocity | 480 | (kts.) |
| Nx(equivalent) | 0.1646 | |

| | TLS | Required Pz(1000) | Required Error Probability | Required Error Frequency | Expected Number of Samples |
|---|---|---|---|---|---|
| NULL | 5.00E-09 | 1.122E-06 | 1.122E-06 | 1.235E-05 | 133002 |
| ALTERNATE | 2.00E-08 | 4.490E-06 | 4.490E-06 | 4.939E-05 | 84326 |

| | |
|---|---|
| Start Date | 06/01/96 |
| Number of Flights/Day | 544 |
| Number of Hours/ Flight | 3.5 |

Errors between 950 and 1050

FTE OE

| Error Count | Minimum number of fixed intervals in order to: Accept | Reject |
|---|---|---|
| 0 | 79491 | --- |
| 1 | 116917 | — |
| 2 | 154343 | — |
| 3 | 191769 | 32786 |
| 4 | 229194 | 70212 |
| 5 | 266620 | 107638 |

### Error Classification

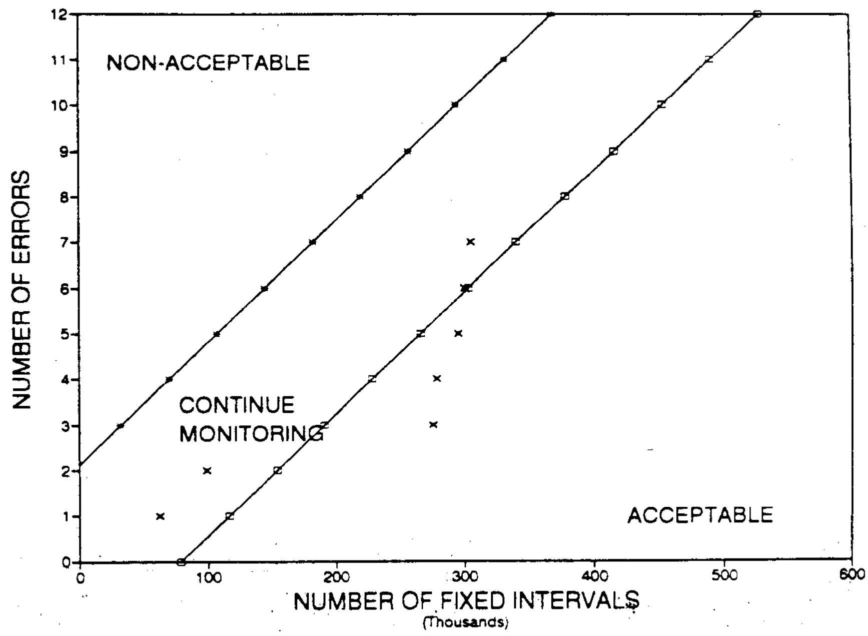
FTE

| Average Duration | Maximum Sample Duration |
|---|---|
| 0 to 10 mins. | 1.8 hrs. |

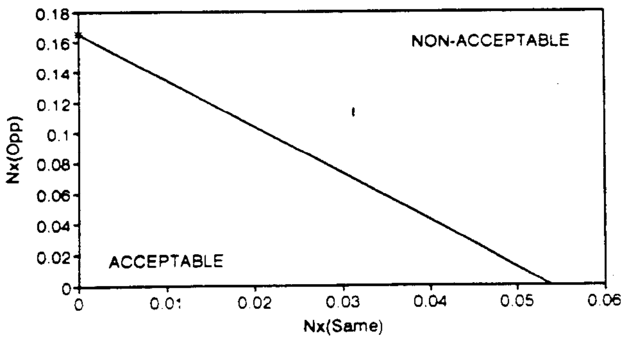
OE

| Average Duration | Maximum Sample Duration |
|---|---|
| 0 to 15 mins. | 1.4 hrs. |
| 0 to 20 mins. | 1.8 hrs. |

| | |
|---|---|
| Alpha | 0.05 |
| Beta | 0.05 |

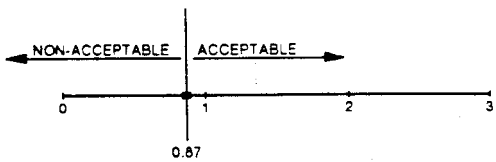



AIRCRAFT PASSING FREQUENCY TEST CHART




* Measured

LATERAL NAVIGATION PERFORMANCE TEST CHART




■ Measured

FIGURE 5

## APPENDIX B - MATHEMATICIANS' WORKING GROUP (MWG)

*(paragraph 3.2.69 refers)*

**Terms of Reference** The Mathematicians' Working Group (MWG) reports to the NAT SPG and is responsible for providing mathematical and statistical advice relating to the on-going monitoring of safety through the assessment of collision risk and any other tasks as agreed with the NAT SPG. The main tasks of the MWG are:

a) to estimate monthly and annually the lateral and vertical occupancies (traffic densities) in the NAT;

b) to estimate the current lateral, longitudinal and vertical collision risk, as appropriate, to show whether the respective TLSs are being met;

c) to periodically perform other data collections (e.g. core navigation studies) in order to ensure that the parameter values within the mathematical collision risk models remain current.

**Composition** The MWG is currently composed of experts from Canada, the United Kingdom and the United States. In order to ensure that NAT users' views are represented and to provide valuable operational experience, the MWG meetings are also attended by representatives from IATA and IFALPA. Representatives from Eurocontrol may also be invited as observers in order to ensure consistency between related European and North Atlantic work programmes.

**Rapporteur** The United Kingdom

**Working Methods** The MWG meets immediately prior to the NAT SPG Meeting and produces a report which is incorporated along with the report from the Scrutiny Group into "The Review of System Safety Performance". The report contains current estimates of collision risk in the NAT which are compared against previous values and also against agreed Target Levels of Safety. In this way, the safety of current separation minima can be demonstrated, any trends can be identified and remedial action can be recommended if required. The MWG report also reviews any mathematical related working papers submitted to the NAT SPG and details the MWG work programme for the period until the next NAT SPG meeting.

## APPENDIX C - OPERATIONS MANAGERS (OPS MNG) MEETINGS

*(paragraph 3.3.4 refers)*

**Terms of Reference** The annual NAT OPS MNG Meeting was established by NAT SPG/30 and was tasked to address operational issues that fall within a 12-month time frame on the basis of the following Terms of Reference:

a) Identify and propose remedial action for shortcomings and deficiencies;

b) co-ordinate the implementation of changes affecting air traffic management;

c) examine the effects of short to medium term operational developments on air traffic management;

d) co-ordinate airspace changes;

e) consult with users concerning their requirements;

f) co-ordinate airspace reservation activities and Civil/Military issues;

g) examine day to day operational issues and inter-centre co-ordination;

h) co-ordinate the development of contingency plans; and

i) examine other issues that might arise that may have an effect on day to day operations.

**Composition** The NAT OPS MNG Meeting is composed of representatives from OAC Bodø, OAC Gander, OAC New York, OAC Reykjavik, OAC Santa Maria, OAC Shanwick and FIC Sondrestrom together with representatives of civil and military users and the NAT IMG or NAT SPG Member from the host State.

The Meeting may invite participation by representatives from other air traffic control and flow management units as required.

**Working Methods** Meetings of the NAT OPS MNG Meeting shall be limited to a maximum of five days. A day shall be given to military and civil users. Any additional user participation would be decided depending on agenda items, as determined by the host State. Sufficient time shall also be set aside to facilitate a visit to the operations room at the host location.

The NAT OPS MNG Meetings shall be held concurrently with NAT user conferences or at NAT ATC facilities in Bodø, Gander, New York, Reykjavik, Santa Maria or Prestwick if no user conference is scheduled.

The host State shall be responsible for providing the Chairman as well as secretariat services. The Chairman will ensure that appropriate follow up action is taken after the meeting.

Proposed agenda and call for papers should be sent out 90 days prior to the Meeting.

Working Papers and Information Papers, including user inputs, should be distributed to the participants 30 days prior to the meeting.

The NAT SPG Member or the NAT IMG Member of the host State will participate in the meeting to the extent necessary to ensure compatibility with the overall NAT SPG objectives.

The Chairman of the meeting will ensure that a Working Paper containing details of the meeting process, conclusions and recommendations will be sent to the Secretary of the NAT SPG within 30 days of the end of the meeting and which will be disseminated to NAT SPG participants via the Secretary of the NAT SPG. The working paper should be limited to issues that are relevant to the NAT SPG and should not contain issues that are germane to the OPS MNGs themselves.

## AGENDA ITEM 4: DOCUMENTATION UPDATE

### 4.1 Introduction

4.1.1 Under this Agenda Item, the Group considered the following specific subjects:

a) Search and Rescue Incidents in the NAT Region

b) MNPS OPS Manual

c) IGA Manual

d) the NAT SPG handbook

e) consolidated Guidance Material (NAT DOC 001)

f) NAT Facilities and Services Implementation Document

### 4.2 Search and Rescue Incidents in the NAT Region

4.2.1 As in the past, the Group received, with appreciation from the United Kingdom, an update on the number of SAR incidents that had occurred in the NAT Region since 1987. From the information, it appeared that the IGA Manual was bearing fruit in that SAR incidents had decreased since 1987. Although no further measures were thought to be required at the time, the Group did feel that the United Kingdom should continue to monitor the situation and to report to the NAT SPG if anything untoward was identified. The results of this exercise are at **Appendix A** to the Report on Agenda Item 4.

### 4.3 MNPS OPS Manual

4.3.1 The Group noted that the seventh edition of the NAT MNPS OPS Manual, which would take into account RVSM, was being prepared by the United Kingdom and IATA and that publication was expected in September 1997.

### 4.4 International General Aviation Manual

4.4.1 The Group was informed that the United States was in the final stages of preparing the third edition of the IGA Manual. Accordingly, all concerned were requested to review the draft document and to provide the United States with their comments not later than 15 August 1997.

### 4.5 NAT SPG Handbook

4.5.1 The Group noted with appreciation that the third edition of the NAT SPG handbook, which had been produced by the Chairman, remained a valuable reference document for all those involved with the NAT Region. With this in mind, all participants had been invited to provide their inputs to the Chairman so that the document could be updated.

## 4.6 Consolidated Guidance Material (NAT Doc 001)

4.6.1 The Group noted that, in follow up to NAT SPG Conclusion 32/20, a draft of the seventh edition of the NAT Guidance material had been prepared. The Group agreed that because of time constraints, it would not be possible to finalise the document during the meeting. Accordingly, it was agreed that all concerned should provide their comments to the NAT SPG Secretary by 15 September 1997. The revised document would then be sent to NAT SPG participants for their endorsement so that it could be published not later than 1 November 1997.

**CONCLUSION 33/18 - SEVENTH EDITION OF THE NAT CONSOLIDATED GUIDANCE MATERIAL (NAT DOC 001)**

**That:**

**a) all concerned send their comments on the draft seventh edition of the NAT Guidance Material to the ICAO European and North Atlantic (EUR/NAT) Office by 15 September 1997; and**

**b) the seventh edition of the NAT Guidance Material be published by the ICAO EUR/NAT Office by 1 November 1997.**

## 4.7 NAT Facilities and Services Implementation (FASID) Document

4.7.1 The Group was informed that the Council had approved the outstanding parts of Recommendation 6/1 of the Limited NAT Regional Air Navigation (1992) Meeting which included the FASID and the new ANP. The only difference between the original proposal and the Council approved one was that the ATS route structure was to be included in the ANP rather than in the FASID. It was also mentioned that the trial editions of the NAT ANP and FASID would probably be re-issued as a regular ANP publication. The Group would be kept informed of developments.

## 4.8 Electronic copies of NAT documentation

4.8.1 The Group felt that, in view of the creation of a web page and the widespread use of e-mail, the Secretariat should explore ways and means to make available NAT documentation in an electronic format. The Secretary undertook to look into this matter and report to the Group at the earliest opportunity.

## APPENDIX A - SAR INCIDENTS IN THE NAT REGION

*(paragraph 4.2.1 refers)*

| | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|---|---|---|
| Denmark | 1 | 4 | 10 | 5 | 3 | 1 | 1 | 0 | 3 | 1 |
| Ireland/UK | 5 | 4 | 7 | 4 | 3 | 4 | 3 | 1 | 0 | 1 |
| USA | 2 | 2 | 4 | 2 | 0 | 0 | 0 | 2 | 0 | 2 |
| Portugal | 2 | 0 | 2 | 2 | 0 | 4 | 3 | 3 | 1 | 1 |
| Iceland | N/A | 12 | 5 | 10 | 2 | 0 | 2 | 3 | 0 | 0 |
| Norway | N/A | N/A | N/A | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| Canada | N/A | N/A | N/A | N/A | 0 | 2 | 0 | 0 | 4 | 4 |
| **Totals *(for data received)*** | 10 | 22 | 28 | 24 | 8 | 11 | 9 | 9 | 9 | 9 |
| Average (for RCCs reporting) | 2.5 | 4.4 | 5.6 | 4.0 | 1.1 | 1.6 | 1.3 | 1.3 | 1.3 | 1.3 |

Note: Denmark includes Faroe Islands and Greenland

## AGENDA ITEM 5: ANY OTHER BUSINESS

### 5.1 Introduction

5.1.1 Under this Agenda Item, the Group discussed the following specific subjects:

a) request to participate in the NAT IMG by IBAC;

b) Royal Danish Air Force due regard flights;

c) The need to squawk code 2000;

d) Amendment no 33 to Annex 2; and

e) next meeting of the NAT SPG.

### 5.2 Request to participate in the NAT IMG by IBAC

5.2.1 The NAT SPG Members examined a request from IBAC to become a member of the NAT IMG. Considering that the NAT IMG had been established by the meeting of high level managers, they could not agree to such a request as it was considered to be outside their remit. Nevertheless, it was recognised that IBAC's participation in the decision to proceed to Phase 2 RVSM would be beneficial; therefore, it agreed that the Chairman should invite IBAC to participate in NAT IMG meetings that deal with the expansion of RVSM airspace.

### 5.3 Royal Danish Air Force (RDAF) due regard flights

5.3.1 The Group was informed that RDAF flights may be operating over Greenland and in adjacent international airspace on occasions using "due regard". This activity should be infrequent and it was brought to the attention of the Group for information purposes only.

### 5.4 The need to squawk code 2000

5.4.1 The Group noted the concerns expressed regarding aircraft arriving at european level fall points that were not squawking Code 2000. Recalling the requirements of the PANS OPS (Doc 8126) and of the NAT SUPPs, it was agreed that pilots and controllers should be reminded of these provisions.

### 5.5 Amendment no 33 to Annex 2

5.5.1 The Group was informed that the Council had adopted Amendment 33 to Annex 2 regarding communications failure. It was pointed out that the amendment could not be applied in the NAT Region because of the peculiarities of Oceanic procedures and the use of HF communications. It was also pointed out that a provision had been made for regional differences. It was agreed that this matter needed to be followed up with caution because of the potential consequences on safety.

### 5.6 Next Meeting

5.6.1 The Group agreed that its next meeting should be held in Paris from the 8 to 11 June 1998. When agreeing to these dates, the Group also considered its new working arrangements. The decision to reduce the length of the meeting to 4 days was predicated on the experience of NAT SPG/33. However, the Secretary indicated that it had only been possible for the Group to complete its work in four days because meeting documentation had been kept to a minimum and it had, in general, been provided in advance. Delegates were therefore encouraged to ensure that all paper work be submitted to the Secretary in advance so that it could be processed. In addition, the Secretary indicated that the co-operation and help from the rapporteur of the MWG greatly facilitated the preparation of the report.

**- END -**