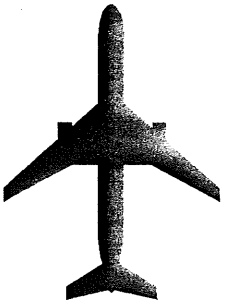
NAT SPG/SPECIAL



NORTH ATLANTIC SYSTEMS PLANNING GROUP

Summary of Discussions of the Special North Atlantic Systems Planning Group Meeting

Paris, 17 - 18 January 1994

TABLE OF CONTENTS

INTRODUCTION

i.1 The Special Meeting of the North Atlantic Systems Planning Group (NAT SPG) was held in Paris from 17 to 18 January 1994. The meeting was chaired by Mr. Karsten Theil, the Member for Denmark. A list of participants is at page i-4.

i.2 Mr. Christian Eigl, ICAO Representative, European and North Atlantic Office was Secretary of the Meeting and was assisted by Messrs Jacques Vanier, Daniel Oudin, RAC/SAR Technical Officers. Mr. Roderick Heitmeyer, Chief of the Joint Financing and Facility Management Branch, Mrs. Olga Recasens, Chief, Joint Financing Section and Mr. Normand Ostiguy, Senior Regional Affairs Officer also attended the meeting.

i.3 The principal objective of the Meeting was to agree on a height monitoring system to support the implementation of reduced vertical separation minimum in the NAT Region and to agree on a methodology for cost sharing and recovery of the agreed height monitoring system.

- - - - - - - - - - - - - - - - -

LIST OF PARTICIPANTS

CANADA
Don MacKEIGAN*

DENMARK
Karsten THEIL* *(Chairman)*
Knud ROSING

FRANCE
André BERMAN*

ICELAND
Einar EINARSSON*

IRELAND
Pat KEATING*
Myles MURPHY

NORWAY
Rolf GRIMSRUD*
Ommund MYDLAND

PORTUGAL
Jaime R. VALADARES*

RUSSIAN FEDERATION ♯
Gueorgui SAMARINE

SPAIN ♯
Luis MORALES-FERNANDEZ
Jose GARCIA-ARAUJO

UNITED KINGDOM
Paul WOOD*
Bernard PERRY
Ian PARKER

UNITED STATES OF AMERICA
Frank PRICE*
Bill JEFFERS

IATA ♯
Alan GILBERT
King GRAHAM
David STRAND

IFALPA ♯
Tom KREAMER

IFATCA ♯
Eddie WALLACE

ICAO
Christian EIGL *(Secretary)*
Jacques VANIER
Daniel OUDIN
Rod HEITMEYER
Olga RECASENS
Normand OSTIGUY

* Member
♯ *Observer*

LIST OF CONCLUSIONS

AGENDA ITEM 1: HEIGHT MONITORING SYSTEM(S) TO BE USED FOR THE IMPLEMENTATION OF REDUCED VERTICAL SEPARATION MINIMA (RVSM) IN THE NAT REGION

1.1 General

1.1.1 The Group recalled that, at its twenty-ninth meeting (Paris, 7 - 16 June 1993), it had agreed that it was necessary to ensure that the technical and financial critical paths for the implementation of RVSM in the NAT Region should be converged to one common date - January 1994 (NAT SPG/29 Report paragraphs 4.3.63 and 4.3.80 refers). A copy of the implementation schedule agreed to by the Limited NAT Regional Air Navigation (LIM/NAT/RAN) Meeting (1992) is in the **Appendix** to this part of the report (the financial implementation schedule is in paragraph 2.4.3 below). When agreeing to the foregoing, the Group had indicated that work on Height Monitoring Units (HMU), and especially their siting, should continue. Furthermore, the role of a Global Positioning System (GPS) monitoring system (GMU), or a hybrid HMU/GMU, was also to be reviewed taking into account the need for a re-evaluation of the optimum number of HMUs and their siting based on the assumption of the long-term constancy of Altimetry System Error (ASE).

1.2 Mathematical and statistical considerations

1.2.1 In order to recommend a monitoring system, it was necessary to define overall monitoring targets. Following a review of the information and data collected in the vertical studies programme, it was assumed, for planning purposes, that ASE for individual airframes would be stable for a period of two years. Important objectives of the verification period were therefore to characterize the ASE performance of the airframes which would be used in the NAT Region in RVSM operations and also to confirm the stability of ASE. In this connection, it was agreed that efforts should be made to start collecting data with monitoring units as soon as possible after they became available in order to verify the assumption that ASE was indeed stable.

CONCLUSION SP/1 - COLLECTION OF MONITORING DATA

That efforts be made to start collecting monitoring data as soon as monitoring units become available in order to verify the stability of Altimetry System Error.

1.2.2 With the above in mind, the Group discussed the objectives of the monitoring programme and considered how these objectives could be met. Firstly, it was agreed that the ultimate objective of carrying out a complete census of airframes was a valid one. The monitoring system should therefore be designed to be capable, in principle, of performing such a census over a period of one year. In agreeing to the foregoing, it was recognized that a complete census may prove to be an impractical target for the verification phase; therefore, the minimum targets, which are listed below, were agreed to as they should permit the Group to collect sufficient information on the height keeping performance of aircraft operating in the NAT Region:

a) sufficient airframes were measured to ensure that a minimum of 90% of flights in the NAT Region during a year would be made by aircraft which had been monitored at least once;

b) not less than 60% of all Minimum Aircraft System Performance Specification (MASPS) approved airframes have been monitored at least once during the verification phase;

c) at minimum, a census of aircraft types with MASPS approvals;

d) at minimum, a census of the MASPS approved aircraft types for every commercial operator; and

e) as many of the MASPS approved International General Aviation (IGA) aircraft as possible are measured and not less than 80% of the full population of MASPS approved IGA aircraft. Extraordinary efforts should be made to complete a census of MASPS approved IGA aircraft.

1.2.3 These targets were considered as minimum objectives which had been designed to ensure that a good representative sample of MASPS approved aircraft was obtained. It was also considered that the data obtained from a monitoring programme that met these targets would be sufficient to provide:

a) further evidence of the stability of ASE;

b) guidance on the efficacy of the MASPS and on the effectiveness of altimetry system modifications; and

c) confidence that the Target Level of Safety (TLS) would be met.

1.2.4 The targets had been agreed to on the assumption that aircraft height keeping performance would meet the global requirements. The collision risk due to this aspect of the system should then contribute only a very small part to the regional TLS. If the observed performance was significantly worse than the global height keeping requirements, the minimum sampling requirements would be increased to ensure that the regional TLS would not be threatened.

1.3 Progress report on HMU developments

1.3.1 The Group was informed that the HMU development was at an advanced stage following the installation and trials of the prototype at Strumble in the United Kingdom. Further work was under way to optimise both the intrinsic measurement performance and to consolidate the traffic handling capability. A significant number of aircraft had been monitored with the HMU and work had begun in connection with the development of an engineered Total Vertical Error (TVE) measurement unit (TMU) which was a sub-unit of the HMU. It was noted that development work on the HMU and its TMU sub-unit should be completed in the second quarter of 1994 at which time it could commence collecting data.

1.3.2 The trials had shown that the HMU performance was highly consistent and that the standard deviation (SD) of measured aircraft geometric height was 18 feet. Integration tests, with a prototype TMU, had successfully demonstrated the derivation of TVE and ASE. In this case, the SD of measured TVE for the trials aircraft was 21 feet.

1.3.3 The Group indicated that it would be highly desirable that more measurements be carried out at FL 290 and particularly at FL 410.

1.4 Progress report on GMU developments

1.4.1 A GMU system consisted of a portable computer, a GPS receiver and antennae which are attached to the inside of aircraft windows. In addition to the GMU itself, other facilities, such as GPS reference station, meteorological data, Secondary Surveillance Radar (SSR) data and post-flight processing facilities were required to support the data gathering and analysis of the GMU system.

1.4.2 Monitoring height keeping performance using the GMU system consisted of placing a GMU aboard a targeted aircraft and of retrieving the unit after the flight. The flight did not necessarily have to be conducted through Minimum Navigation Performance Specifications (MNPS) airspace. The collected GPS information was processed post-flight to produce corrected aircraft geometric height using reference measurements from any of eight GPS reference stations installed to serve the NAT Region.

1.4.3 In order to ensure estimates of sufficient quality to support RVSM monitoring, post-processed geometric height was discarded unless derived from a portion of the flight within 500 NM of one of the GPS reference stations. The geometric height of the flight level flown by the aircraft was obtained from outputs of the Bracknell worldwide forecast model. The difference between the corrected GPS-derived aircraft geometric height and the Bracknell-modelled flight level height provided TVE estimates throughout the flight, as long as GPS information was available. Mode C information was collected for any portion of the flight within SSR coverage to provide Assigned Altitude Deviation (AAD) estimates. The difference between TVE and AAD at any time gave an estimate of ASE. Under special circumstances, Mode C observations could be supplemented by on-board observations of Flight Technical Error (FTE).

1.4.4 A test programme to establish the accuracy of TVE and ASE measurements using GPS input yielded the following:

a) the geometric height of aircraft measured by a differentially corrected GMU system was compared with that measured by precision radar. The mean difference between radar and GPS measured geometric height was 24.0 feet with an SD of 10.2 feet; and

b) the test showed that estimation of ASE yielded an SD 59.4 feet with evidence that this could be reduced to an SD of approximately 49 feet using an estimation of flight level height from the Bracknell Worldwide Forecast Model. This expected error characteristic included the measurement uncertainty associated with determination of both aircraft and flight level geometric height and was considered adequate for RVSM monitoring purposes.

1.4.5 The Group was briefed on the difficulties encountered in receiving adequate GPS signals when the GMU antennae were placed on indium coated electrically heated cockpit windows. The Group was also briefed on the options being pursued to overcome this problem. First, it was postulated that an enhanced antenna model, which had proven acceptable in ground testing and which would be flight tested in early 1994, would overcome the heated windshield problem and that this design would allow placement of the GMU in the preferred location of the cockpit for all aircraft. Second, the Group was briefed on the option of placing the GMU in the cabin or galley where adequate GPS signals have consistently been acquired with existing antennae through clear/unheated windows. This option appeared feasible, but it was noted that certain airlines had expressed reservations about use of the cabin and/or galley areas. Third, the Group noted the option of

installing GPS antennae on the aircraft exterior or using data acquired through GPS already installed on some aircraft. At the time, these were not seen to be viable options.

1.4.6 The GMU had been shown to work effectively on business and commercial aircraft when antennae were attached to clear windows in the cockpit or cabin. Indeed it was noted that most IGA aircraft were not fitted with indium coated cockpit windows and hence the GMU could function well in its preferred cockpit location on these aircraft. Given the general low frequency of NAT operations of such aircraft, they could be expected to pass over HMU sites rarely and hence would be ideally suited to be monitored by use of GMUs.

1.4.7 The Group was presented information on a logistical plan for placing the GMU on different airframes to collect height keeping performance data. It was noted that this required an extensive effort and it expressed the concern that adequate staffing levels be planned to ensure that monitoring objectives would be met.

1.4.8 The Group was also briefed on GMU test flights which had been planned or conducted on airlines from various nations. The extensive time and effort to contact certain airlines and arrange for GMU carriage was noted. It was felt that, though this effort may be necessary to verify or monitor certain airlines, HMU's would enhance the capability to conduct verification in a timely manner by decreasing the number of airframes and operators that would need to be verified by the GMU.

1.5 Hybrid system

1.5.1 It was considered that it would be very difficult to achieve the monitoring objectives with only one of the proposed monitoring systems. The HMUs would allow a large sample of airframes to be collected over a short time. Repeat samples of individual aircraft could be obtained over long periods of time which would help to verify the assumption of ASE stability and to characterise the typical ASE range for a variety of aircraft types. Aircraft not monitored by the HMU system would be candidates for monitoring by the GMU system. The GMUs would also allow repeat measurements of suspect airframes and monitoring to be targeted on sub-populations which had been shown to be poor performers. Similarly GMUs could be used to obtain samples of aircraft operators/types whose normal operations would not take them over the site of an HMU.

1.5.2 The constraint of an HMU's (relatively) fixed location would be offset by the GMU's aircraft-specific capability. A complete census, by operator, type, or airframe, would therefore be more easily achieved by a combined system. The relatively expensive unit cost of the HMU was also counterbalanced by the reduced cost of a complimentary GMU system.

1.5.3 The relatively low volume of data gathered on a daily basis by the GMUs would be more than offset by the high daily data acquisition rate of the HMU. Similarly, the lack of real time alert capability of the former system would be counterbalanced by the capability of the latter system. Whereas the performance of a GMU target aircraft may not have been typical "on the day", HMU target aircraft, passively monitored, were more likely to be representative of their normal performance. The anticipated administrative/logistics problems of operating a stand-alone GMU monitoring system would be substantially relieved by the complimentary contribution that the HMU system would provide.

1.5.4 The Group agreed that the disadvantages of the HMU system were mitigated by the characteristics of the GMU system and that the disadvantages of the GMU system were offset by the characteristics of the HMU system. In addition, there were further independent advantages associated with each system. Therefore, it was agreed that a combination of HMUs and GMUs would provide,

during a transition period, the most suitable means of achieving the verification and monitoring objectives. In reaching this agreement, it was stressed that, because of the complementarity of the systems, both elements (HMU/GMU) were equally critical to the composition of the hybrid system.

1.6 Number and sites for HMUs

1.6.1 The Group considered the results of analyses of samples of NAT traffic obtained from 12 days during the first six months of 1993. From this analysis, it was shown that three sites had been considered in the United Kingdom: Lands End, Strumble and Deans Cross. The best site, in terms of the volume and mix of traffic likely to be observed, had been Strumble. Both alternate sites examined provided considerably less traffic and did not add significantly to the mix of aircraft types and operators likely to be observed. Because the prototype HMU was already located at Strumble, it was felt that this should be the site for the first HMU.

1.6.2 All three sites in Canada: Gander, St. John's and Goose Bay, provided similar samples of operators and types. However, Gander was considered to be the better site.

1.6.3 Approximately 10% of the total flights observed by the two HMUs were seen at both Gander and Strumble. The two sites could be expected to observe an average of 12% of all the operations in the system on a daily basis.

1.6.4 Analysis of traffic samples for a site in Iceland at 64N20W showed that only a very small sample could be expected. No aircraft types were seen that were not recorded at the Gander and Strumble sites. Few additional operators or operator/aircraft-type pairs were observed at the site in Iceland. It was therefore concluded that the siting of an HMU at this location was not justified as it would not add significantly to the traffic sample obtained.

1.6.5 Analysis of traffic samples for a site in Portugal between DIRMA and BARDI reporting points also showed that only a very small sample could be expected. No aircraft types were seen that were not recorded at the Gander and Strumble sites. A few additional operators were recorded and, provided that a GMU system was available to collect data on the traffic which operated in the southern NAT, an HMU located at this site would not be required.

1.6.6 In the discussions, it was pointed out that the reduction in the required number of HMUs was based on the assumption of ASE stability and a review of radar track data carried out by the mathematicians working group.

1.7 Benefit-to-cost ratio considerations

1.7.1 The Group reviewed a revised benefit-to-cost ratio which took into account a hybrid monitoring system. The results of the study showed that the benefit-to-cost ratio remained greater than one and, indeed, it even showed increases over previous studies despite the fact that aircraft certification costs had been taken into account.

1.8 Recommendations for the Height Monitoring System

1.8.1 The Group agreed that two HMUs be deployed to perform height monitoring for RVSM and that these be located at Strumble in the United Kingdom and Gander in Canada. It was estimated that these two sites would provide samples for at least 45% of the airframes in use in the system. In addition, assuming an overall NAT MASPS approved population of 3500, this would leave approximately 1900 airframes to be measured by the GMU. The GMU system should be designed to be capable of measuring this number of airframes during the verification period.

1.8.2 In concluding its discussions on this matter, the Group noted that it would not be possible to proceed to full implementation without a successful verification phase which should bring to light any deficiencies that may have been overlooked or parts of the system which have not been implemented.

CONCLUSION SP/2 - CHOICE OF HEIGHT MONITORING SYSTEM FOR THE IMPLEMENTATION OF REDUCED VERTICAL SEPARATION MINIMUM (RVSM) IN THE NAT REGION

That:

a) **a hybrid height monitoring system comprising Height Monitoring Units (HMU) and Global Positioning System (GPS) Monitoring Units (GMU) be deployed in support of the implementation of RVSM in the NAT Region;**

b) **the HMU element would consist of two HMUs, one in Gander (Canada) and one in Strumble (United Kingdom);**

c) **Canada and the United Kingdom closely co-ordinate the HMU implementation programme; and**

d) **the GMU system would consist of portable GMUs, GPS reference stations, access to Mode C information, post-flight processing facilities and adequate logistic support.**

1.9 NAT RVSM Guidance Material

1.9.1 The Group agreed that the NAT RVSM Guidance Material must make it clear to commercial and general aviation operators that they must participate in the verification and monitoring processes. States should also make provisions to work with military operators to collect aircraft performance data. Taking into account the amendment proposal to paragraph 2.1.3 of the NAT Regional Supplementary Procedures developed by the LIM NAT (COM/MET/RAC) RAN Meeting (1992) and subsequently approved by the ICAO Council, it was agreed that the following material be added to the NAT RVSM Guidance Material:

a) During the verification phase, each aircraft group of each NAT operator must undergo verification of height keeping performance. This should be accomplished by carriage of a GMU or by overflying an HMU.

Note: Although GMU carriage or HMU overflight does not necessarily have to be carried out on a NAT flight, it must be carried out in level flight between FL 290 and FL 410.

b) During operational trials and after RVSM implementation, each operator must cooperate with the Central Monitoring Agency (CMA) in the collection of altitude keeping performance data.

c) Aircraft of operators which do not co-operate in the height monitoring process will be cleared to operate above or below MNPS airspace.

1.9.2 Finally, it was noted that the NAT SPG, in accordance with its terms of reference, would continue to evaluate the level of height-keeping performance monitoring which would be required after sufficient confidence was gained that the RVSM airworthiness, maintenance, and operations programs were being applied effectively.

1.10 Information campaign to notify aviation authorities and operators

1.10.1 The Group agreed that, to enable all concerned to be aware of their roles and responsibilities in the height-monitoring programme, information, in the form of an Aeronautical Information Circular (AIC) should be distributed on this subject after the publication of the Advisory Circular and after the workshop on airworthiness requirements (NAT SPG Conclusion 29/30 refers) had been held. This information should be sent again shortly before the beginning of the verification phase. The information should present the objectives of the monitoring program, emphasize the importance of the successful execution of monitoring in the implementation plan and explain the role of the Central Monitoring Agency (CMA), of aviation authorities and of operators.

1.10.2 In addition to the above, it was also agreed that every effort should be made to take advantage of seminars and workshops on the implementation of the ICAO CNS/ATM systems to inform civil aviation authorities of the effects that the implementation of RVSM in the NAT Region could have on their certification programmes. Accordingly, the Group agreed that the Reduced Separation Standards Implementation Group (RSSIG) should develop a generic information package which could be used in these various fora to inform NAT user States of the RVSM requirements.

1.10.3 The Group also agreed that the forthcoming NAT user's conference, to be held in Iceland in October 1994, constituted an ideal forum to present an overview of the implications of the implementation of RVSM in the NAT Region.

CONCLUSION SP/3 - INFORMATION CAMPAIGN ON THE ROLE OF THE CENTRAL MONITORING AGENCY (CMA), AVIATION AUTHORITIES AND OPERATORS IN THE IMPLEMENTATION OF REDUCED VERTICAL SEPARATION MINIMUM (RVSM) IN THE NAT REGION

That:

a) **the Reduced Separation Standards Implementation Group (RSSIG) develop common wording for an Aeronautical Information Circular (AIC) which would explain the role of the CMA, of the aviation authorities and of the operators in the height monitoring programme related to the implementation of RVSM in the NAT Region;**

b) **the RSSIG develop a generic information package concerning the implementation of RVSM in the NAT Region which could be presented to civil aviation meetings throughout the world; and**

c) **all NAT provider and user States promulgate the AIC on a commonly agreed AIRAC date.**

1.11 States' commitment to the NAT RVSM programme

1.11.1 Finally, the Group felt that a significant amount of resources - financial, human etc - would be required to implement RVSM in the NAT Region in the agreed time frame. Accordingly, it was agreed to inform the High Level Managers meeting (January 1994) of the need for all States concerned to commit the resources necessary for the implementation of RVSM.

1.12 Other issues related to the implementation of RVSM in the NAT Region

1.12.1 The Group was informed of the delays which had been encountered in finalizing the Advisory Circular (AC) and Advisory Material Joint (AMJ) and of the possible effect that these delays could have on the implementation schedule. In this context, it was pointed out that if industry had to wait for the official publication of the AC/AMJ before commencing work on the data packages required for the certification of aircraft to meet the MASPS, delays to the implementation schedule could be likely. The Group noted that precedence existed whereby data packages had been produced on the basis of interim guidance material (AC/AMJ) and that this procedure should be used for RVSM.

1.12.2 The Group noted with appreciation the offers from the Members from the United States and from the United Kingdom to approach their airworthiness experts in the Federal Aviation Authorities and the Joint Airworthiness Authorities respectively in order to ensure that this issue would not lead to implementation delays. Finally, it was agreed that the RSSIG should make a progress report to NAT SPG/30.

- - - - - - - - - - - - - - - - -

APPENDIX - PLAN FOR THE IMPLEMENTATION OF REDUCED VERTICAL SEPARATION MIMIMUM IN THE NORTH ATLANTIC

(Paragraph 1.1.1 refers)

June 1994	a)	Decide on system performance monitoring technique to be used;
	b)	Acceptance of prototype HMU system; and
	c)	HMU contract to competitive tender.
January 1995	a)	Commence building operational HMUs; and
	b)	All ATC simulations completed.
April 1995	a)	Target of 50 per cent of operators approved for reduced VSM operations;
	b)	Operational HMUs come on-line;
	c)	ATC procedures and transition arrangements finalized;
	d)	Start system verification in 2 000 ft VSM environment;
		1) on the basis of data collected, ensure that aircraft meet the global system performance specification; and
		2) ensure that the system meets the NAT Region target level of safety (TLS) of 5.0×10^{-9}.
Second-half 1995	a)	Acceptance (progressive) of HMUs; and
	b)	All ATC facilities and arrangements in place.
January 1996	a)	Target of 90 per cent of operators approved for reduced VSM operations;
	b)	Applicability of Minimum Aircraft System Performance Specification (MASPS); and
	c)	Applicability of the NAT SUPPs relating to height-keeping performance.
January 1997	a)	Confirm that at least 90 per cent of operators approved for reduced VSM operations (the remaining 10 per cent could be accommodated outside MNPS airspace);
	b)	Applicability of the SUPPs relating to the implementation of 1 000 ft VSM;
	c)	Implementation of the transition areas;
	d)	Start of operational trial in 1 000 ft VSM environment; and
	e)	Aircraft and operators not approved for operation in MNPS airspace (including MASPS) will be excluded.
January 1998		Full implementation

AGENDA ITEM 2: COST SHARING RELATING TO HEIGHT MONITORING OF RVSM OPERATION

2.1 General

2.1.1 NAT SPG/27 (June 1991) had identified the need to examine questions relating to cost sharing/recovery of HMUs required for the implementation of RVSM in the NAT Region. It had also agreed that an equitable method of sharing the costs of height monitoring amongst all the NAT provider States was required and had therefore requested the Chief of the Joint Financing and Facility Management Branch at ICAO Headquarters to develop such a proposal based on ICAO's experience in joint financing. The Group had also recognized the need for such arrangements to take into account the DEN/ICE Joint Financing Agreements to permit certain of these costs to be recovered through these Agreements. Accordingly, a proposal for cost sharing/recovery was presented to NAT SPG/28 in June 1992 which had been accepted in principle by States that would have to install HMUs.

2.1.2 In response to NAT SPG Conclusion 29/33, a meeting of financial and operational experts had been held from 5-7 January 1994 in Ottawa for the purpose of developing cost sharing/recovery arrangements for a NAT height monitoring system.

2.1.3 The Group noted that the above meeting had been presented with a description of the height monitoring system as determined by the RSSIG. The NAT height monitoring system proposed was to be a hybrid one composed of two elements: the HMU developed by Eurocontrol and the GMU developed by the United States.

2.2 United States Participation

2.2.1 Due to the unique situation associated with the United States cost recovery system, it presented a proposal by which it could participate in the overall sharing of costs of the NAT HMU/GMU height monitoring process. The proposal, whereby the United States would fund the total capital costs associated with GMUs, which included the establishment of eight reference stations, the acquisition of 50 GMU units as well as post-processing equipment, was accepted by the Group. It was noted that the total capital cost was estimated to be $601,000.*

2.2.2 In addition, under the proposal, the United States would fund the total GMU operational and maintenance (O&M) costs for United States financial years (FY) 1995 and 1996, estimated as $270K and $1.3M respectively. The United States would also provide $200K for O & M costs in United States FY1997.

2.2.3 In summary, the total projected capital and O & M costs for the United States was estimated at $2.4M which would not be recovered from industry through NAT user charges. This sum represented the United States share for establishing and operating a NAT height monitoring system for RVSM.

---

* All ($) costs are in United States dollars

2.3 Joint Financing Arrangement for the NAT height monitoring system

2.3.1 The arrangement developed by the group of financial experts had adapted the previously recommended proposals for HMU cost sharing/recovery, as agreed to at NAT SPG/28, to the requirements and circumstances of the hybrid HMU/GMU system in the most cost effective manner and taking into account the proposal made by the United States. It included the establishment of a Joint Financing Arrangement under ICAO auspices for participation by the following NAT provider States with NAT Oceanic Area Control Centres (OAC) providing air navigation services in NAT MNPS airspace: Canada, Iceland, Ireland/United Kingdom and Portugal. The costs involved would be recovered by a NAT RVSM user charge to be billed and collected by the United Kingdom Civil Aviation Authority (CAA) on behalf of ICAO. Costs relating to Iceland would need to be recovered through the Icelandic Joint Financing Agreement administered by ICAO, subject to the approval of the ICAO Council. It was noted that Iceland had expressed its willingness to co-operate in the operation of the height monitoring system.

HMU/GMU HEIGHT MONITORING SYSTEM COSTS
1995-2002

HMU/GMU COSTS (excluding HMU interest) (US $ M)	
HMU Capital	6.40
O & M	5.84
Total HMU	12.24
CMA	1.47
Total HMU/CMA	13.71
GMU Capital	0.60
0 & M	6.23
Total GMU	6.83
TOTAL	**20.54**

HMU/GMU COSTS (including HMU interest) (US $ M)	
HMU Capital	6.40
Interest	2.56
O & M	5.84
Total HMU	14.80
CMA	1.47
Total HMU/CMA	16.27
GMU Capital	0.60
0 & M	6.23
Total GMU	6.83
TOTAL	**23.10**

2.3.2 The proposed Joint Financing Arrangement is presented in the **Appendix** to this part of the report. It includes Tables 1 to 7 which present relevant data relating to NAT traffic, shares by State, estimated HMU, GMU and CMA costs and costs per NAT flight relevant to the proposed agreement.

2.4 Administrative arrangements

2.4.1 The Group noted that the implementation of the joint financing arrangement for the NAT height monitoring system, as described in the **Appendix** to this part of the report, would require an agreement between all NAT provider States concerned which would need to be finalized in 1994. It was also noted that ICAO Council approval was required for the recovery of the cost share of Iceland under the Icelandic Joint Financing Agreement. Accordingly, the joint financing arrangement would be established under the auspices of ICAO which would be designated as Administrator and reimbursed for any costs involved in its establishment and administration. The joint financing arrangement would be administered through the Joint Support Committee of the ICAO Council on behalf of the NAT provider States concerned.

2.4.2 The Group agreed with the above proposal and noted that the arrangements should be as informal as possible in order to expedite their establishment and to facilitate their administration. It was also agreed that ICAO, through its Joint Financing Section, should be requested to develop the arrangements on the basis of the proposal which is in the **Appendix** to this part of the report. Because it was considered that the implementation of the arrangements was on the critical path, it was also agreed that a progress report be made to NAT SPG/30, scheduled for June 1994, and that any State which encountered difficulties should inform the Secretary of the NAT SPG as soon as possible.

2.4.3 With the above in mind, the Group reviewed the implementation dates for the financial elements that must be met to support the project and assigned follow up action as appropriate:

1. **January 1994** - Approval of Joint Financing Arrangements for NAT height monitoring system (completed).

2. **May 1994** - Confirmation by participating States of availability of funds required (all States to be confirmed by State letter sent by the ICAO European and North Atlantic Office).

3. **June 1994** - Drawing up of Joint Financing Arrangement (ICAO through its Joint Financing Section).

4. **August 1994** - HMU contract to competitive tender by the United Kingdom on behalf of States concerned to facilitate and expedite contractual arrangements.

5. **August 1994** - Implementation of Joint Financing Arrangement (all States concerned).

6. **October 1994 onwards** - Commencement of GMU procurement and operations.

7. **January 1995** - HMU contract award with progress payments beginning April 1995 to follow.

8. **January 1995** - Introduction of NAT RVSM user charge collection.

2.4.4 When reviewing the above dates, the Group agreed that the most critical one was the confirmation by participating States of availability of funds by May 1994. It was therefore agreed that this matter should be brought to the attention of the High Level Managers meeting scheduled in January 1994.

CONCLUSION SP/4 - COST SHARING/RECOVERY ARRANGEMENTS FOR THE NORTH ATLANTIC HEIGHT MONITORING SYSTEM

That:

a) **the cost sharing/recovery arrangements found in the Appendix to the Report on Agenda Item 2 be used as the basis for the development of cost sharing/recovery arrangements for the NAT height monitoring system;**

b) **the ICAO Joint Financing Section of ICAO be requested to finalize the arrangements in order to be able to implement them in August 1994;**

c) **the ICAO European and North Atlantic Office be requested to inform States of the need for them to confirm the availability of funds required; and**

d) **NAT SPG/30 be provided with a progress report on the above.**

2.4.5 In concluding its discussions on this matter, the Group expressed its sincere appreciation for the work that was carried out by the group of financial experts, particularly as the task was a difficult one. The Group also expressed its appreciation to Mr. Rod Heitmeyer, the Chief of ICAO's Joint Financing and Facility Management Branch, for his work within the group of financial experts. The Group also took the opportunity to wish him a happy retirement.

- - - - - - - - - - - - - - - -

APPENDIX - JOINT FINANCING ARRANGEMENT FOR THE NAT HEIGHT MONITORING SYSTEM

(Paragraph 2.3.2 refers)

The proposed Arrangement for the NAT Provider States to share and recover the costs of financing and operating the NAT HMU/GMU Height Monitoring System, as well as a Central Monitoring Agency (CMA), required to assist in the implementation of reduced vertical separation above FL 290 on the North Atlantic is outlined below.

A) HMU Capital expenditures

1. The proposed and preferred approach is for the capital expenditures for 2 HMUs (estimated at U.S.$ 6.4 million) to be financed by the following NAT Provider States with NAT OAC's providing Air Navigation Services in MNPS Airspace:

   Canada
   Iceland
   Ireland/United Kingdom
   Portugal

   The capital expenditures would be shared at time of purchase in accordance with their respective shares of total NAT traffic controlled by their OAC's (see Table 1). The capital costs involved (depreciation and interest over a 7-year period) would be recovered under a NAT RVSM user charge (see D) below). It is understood that Iceland's share would be financed through the Icelandic Joint Financing Agreement, requiring ICAO Council approval.

2. Should any of the Height Monitoring System equipment or other equipment become obsolete or need to be replaced before it is fully depreciated, the residual value would be charged to depreciation during the year of disposition. The capital expenditures for the new replacement of the Height Monitoring System or equipment would be shared by the NAT Provider States concerned, as indicated in paragraph A)1 above.

3. The capital expenditures for the new replacement HMUs or equipment would be shared by the NAT Provider States concerned as indicated in paragraph A)1 above.

4. Confirmation of availability of funds by the States concerned is required by end of May 1994.

5. **January 1995**: contract award with funds required for progress payments beginning April 1995.

6. United Kingdom Civil Aviation Authority (CAA) would deal directly with the HMU manufacturer on behalf of the provider States concerned and arrange for progress payments to the manufacturer.

TABLE 1

SHARE BY STATE OF HMU CAPITAL INVESTMENT
FOR TWO HEIGHT MONITORING UNITS (HMUs)

Participating ACCs	Percentage of NAT Flights	Share by State (US$)
Canada - Gander Oceanic	38.9 %	2 489 600
Iceland - Reykjavik Oceanic	11.9 %	761 600
Portugal - Santa Maria Oceanic	9.0 %	576 000
UK/Ireland - Shanwick Oceanic	40.2 %	2 572 800
TOTAL	**100.0 %**	**6 400 000**

Based on estimated exchange rate of £1 = US$2.

7. It was recognized that there could be funding problems and consideration was given to the possibility for external loans and leasing arrangements but these were not considered to be viable options in this case.

8. The option for each provider State, excluding the United States, recovering their share of HMU costs through their own user charges, with ICAO responsible only for recovery of GMU Operations and Maintenance costs (O & M) for 1997 and beyond was also discussed. However, most States did not favour this approach in this case, and IATA also considered that it would be less equitable than the proposed option.

B) GMU Capital, Operations and Maintenance Costs

1. GMU capital and O & M costs for United States financial years (FY) 1995, 1996 and US$ 200K for O & M costs for United States FY97 would be provided by the United States as its share of the Height Monitoring System costs, representing an estimated amount of US$ 2.4 million.

2. This would consist of:

   a) Total capital costs for GMU acquisition (estimated at 50 units), eight reference stations and post-processing equipment.

   b) Total O & M costs for United States FY95, United States FY96 and US$ 200K for United States FY97.

3. From 1 October 1996 onwards an Agency will be contracted by ICAO under the Arrangement in E) below to continue the GMU Height Monitoring Operations. The balance of O & M for United States FY97 and the costs for subsequent years would be financed under C) below and recovered through the NAT RVSM user charge under D) below.

C) HMU Operating and Maintenance Costs, CMA Costs, and post 1996 GMU Operations and Maintenance Costs

1. These costs consist of the following:

   a) HMU O & M costs (Canada and United Kingdom)

   b) CMA costs (United Kingdom)

   c) Agency contract costs for GMU O & M from United States FY97 ending 30 September 1997 (less US$ 200K United States share) onwards.

2. These costs would be recovered through the NAT RVSM user charge with annual adjustments in the charge for over- and under-recovery, administered by ICAO.

D) NAT RVSM User Charge

3. The user charge would be administered by ICAO through the Joint Support Committee of the ICAO Council on behalf of the NAT provider States concerned.

4. The user charge would be billed and collected by the United Kingdom CAA on behalf of ICAO as a separately listed charge using the DEN/ICE data base in a similar manner to the DEN/ICE charges. The charge would be promulgated under the United Kingdom's joint financing regulations. This approach would capture virtually all the flights involved (approximately 98%) and represents the most cost-effective charging system.

5. On a monthly basis the United Kingdom CAA would remit the revenues directly to ICAO for the HMU, CMA and post 1996 GMU O & M costs for distribution to the parties concerned.

6. Establishment of the NAT RVSM user charge and arrangements for adjustment of the level of this charge for over-/under-recovery is to be administered by ICAO. This will require the provision of estimated and actual costs by participating States and the GMU Agency, prior to 15 September each year, and the use of procedures similar to DEN/ICE.

7. The NAT RVSM user charge is to be a flat fee per full NAT crossing and 1/3 and 2/3 crossing, as per the DEN/ICE Agreements.

8. United Kingdom CAA is to charge an administrative fee for the NAT RVSM user charge collection, to recover the costs involved as per the DEN/ICE Agreements.

9. An ICAO administrative fee is to be added to the NAT RVSM user charge to recover ICAO's costs of administering this Arrangement, as per the DEN/ICE Agreements.

E) Joint Financing Arrangement for the NAT Height Monitoring System

1. An Arrangement would be established under the auspices of ICAO.

2. The Arrangement would cover A), C) and D) above and designate ICAO as Administrator (pursuant to Chapter XV of the Chicago Convention).

3. The Arrangement would also specifically cover the establishment and administration of a contract with a GMU Operating Agency on behalf of the provider States.

4. ICAO would be reimbursed for any costs involved in the establishment of the Joint Financing Arrangement, and also for its administration as indicated in D)7 above.

TABLE 2

NAT TRAFFIC SHARES FOR ALL NAT ACC'S
OPERATED BY CANADA, ICELAND, PORTUGAL,
UK/IRELAND AND UNITED STATES

Participating ACCs	NAT Flights 1993 (est.)	Percentage Share (est.)
Canada - Gander Oceanic	212 683	34,4 %
Iceland - Reykjavik Oceanic	65 163	10.5 %
Portugal - Santa Maria Oceanic	49 000	7.9 %
UK/Ireland - Shanwick Oceanic	220 061	35.6 %
United States - New York Oceanic	71 000	11.6 %
TOTAL	**617 907**	**100.0 %**

TABLE 3

NAT TRAFFIC SHARES FOR NAT ACC'S
OPERATED BY CANADA, ICELAND, PORTUGAL AND UK/IRELAND

Participating ACCs	NAT Flights 1993 (est.)	Percentage Share (est.)
Canada - Gander Oceanic	212 683	38.9 %
Iceland - Reykjavik Oceanic	65 163	11.9 %
Portugal - Santa Maria Oceanic	49 000	9.0 %
UK/Ireland - Shanwick Oceanic	220 061	40.2 %
TOTAL	**546 907**	**100.0 %**

TABLE 4

ANNUAL CAPITAL COSTS FOR TWO
HEIGHT MONITORING UNITS (HMUs)
(US DOLLARS)

Year	Depreciation	Interest	Total Depreciation and Interest	Residual Value
1996	914 286	640 000	1 554 286	5 485 714
1997	914 286	548 571	1 462 857	4 571 428
1998	914 286	457 143	1 371 429	3 657 142
1999	914 286	365 714	1 280 000	2 742 856
2000	914 286	274 286	1 188 572	1 828 570
2001	914 286	182 857	1 097 143	914 284
2002	914 284	91 429	1 005 713	0
Total	**6 400 000**	**2 560 000**	**8 960 000**	

Data is expressed in 1993 dollars.
Based on estimated exchange rate of £1 = US$ 2.
Depreciated over 7 years (straight line depreciation) assuming purchase in 1995.
Interest assumed at 10 % per year.

TABLE 5

HMU - ESTIMATED ANNUAL CAPITAL, MAINTENANCE AND OPERATIONS COSTS
AND CMA COSTS
(US DOLLARS)

	1995	1996	1997	1998	1999	2000	2001	2002
Capital costs (depreciation and interest)*	-	1 554 286	1 462 857	1 371 429	1 280 000	1 188 572	1 097 143	1 005 713
Maintenance and Operations	730 000	730 000	730 000	730 000	730 000	730 000	730 000	730 000
CMA costs (including data base and hardware)	190 000	190 000	190 000	180 000	180 000	1 80 000	180 000	180 000
Total	**920 000**	**2 474 286**	**2 382 857**	**2 281 429**	**2 190 000**	**2 098 572**	**2 007 143**	**1 915 713**

Data is expressed in 1993 dollars.
Based on estimated exchange rate of £1 = US$2.
* Assuming investment takes place in the previous year in 1995 with depreciation and interest at 10 % charged from 1995 onwards.

TABLE 6

GMU - ESTIMATED ANNUAL CAPITAL, MAINTENANCE AND OPERATIONS COSTS (US DOLLARS)

	1995	1996	1997	1998	1999	2000	2001	2002
Capital costs	401 000	100 000	100 000	-	-	-	-	-
Maintenance and Operations	269 000	1 277 000	781 000	781 000	781 000	781 000	781 000	781 000
Total	**670 000**	**1 377 000**	**881 000**	**781 000**	**781 000**	**781 000**	**781 000**	**781 000**

Data is expressed in 1993 dollars.

TABLE 7

HMU, CMA AND GMU COSTS PER STATE AND COST PER NAT FLIGHT (US DOLLARS)

	1995	1996	1997	1998	1999	2000	2001	2002
Canada	365 000	969 617	1 160 060	1 202 295	1 166 729	1 131 164	1 095 598	1 060 031
Iceland	0	184 960	243 219	256 139	245 259	234 379	223 499	212 619
Portugal	0	139 886	183 947	193 719	185 490	177 261	169 033	160 804
UK/Ireland	555 000	1 179 823	1 376 631	1 410 276	1 373 522	1 336 768	1 300 013	1 263 259
United States[1]	(670000)	(1377000)	(300000)	0	0	0	0	0
Total[2]	**920 000**	**2 474 286**	**2 963 857**	**3 062 429**	**2 971 000**	**2 879 572**	**2 788 143**	**2 696 7**
Number of Flights	248 276	262 030	272 171	282 704	293 645	305 009	314 403	324 087
Cost per Flight	3.71	9.44	10.89	10.83	10.12	9.44	8.87	8.32

1 Amounts to be paid by US including capital costs of $601K ($401K FY95; $100K FY96 and $100K FY97).

2 Total excluding US contribution not to be recovered through the NAT RVSM user charge.

- - - - - - - - - -

AGENDA ITEM 3: ANY OTHER BUSINESS

3.1 Introduction

3.1.1 Under any other business, the Group considered the following subjects:

a) future work related to communications;

b) a request by the International Air Carrier Association (IACA) to participate in the work of the NAT SPG;

c) participation in the work of the implementation sub-groups;

d) volcanic activity in Iceland; and

e) updates to the International General Aviation Manual.

3.2 Future work related to communications

3.2.1 The Group recalled that the question of organizing the work related to communications in the NAT Region had been discussed at the ad hoc meeting of the NAT SPG held in Cascais in November 1992 and that the 29th Meeting of the NAT SPG had decided that the Communications and ATM Automation Group (COMAG) should study the possibilities of carrying out the work which had been performed by the communications sub-group during the regular NAT SPG Meetings.

3.2.2 The Group was informed that this issue had been discussed at COMAG/1 held in Oslo from 18 to 22 November 1993. The COMAG had found that, in accordance with the directives given to it, the tasks being performed by the communications sub-group could not be carried out by the COMAG and that the desired efficiencies could only be achieved through a reappraisal of the modus operandi of the communications sub-group. The principal reason for COMAG's decision was that the participants in the group had ATM automation and communications engineering experience but lacked knowledge in the field of communications operations.

3.2.3 Although the COMAG had not been expected to report on its work until NAT SPG/30, it was agreed that the considerations on the future work related to communications in the NAT Region should be reviewed at this meeting due to the importance of the issue. In this context, the Group was presented with a proposal to create a task force to review this matter and to report their findings to NAT SPG/30.

3.2.4 Following an in-depth discussion on this issue, the Group noted the proposal and agreed that a task force was not necessary at that time. However, the Group agreed that this matter should be reviewed at NAT SPG/30, taking into account the role of the AFTN/AFS informal group, the communication sub-group, the terms of reference of the COMAG, as well as other issues in order to ensure that the communications requirements were handled in a homogenous fashion so as to guarantee that work in this field did not overlap between various groups. Finally, the Group noted with appreciation that the Member from the United States would present a working paper to NAT SPG/30 on this matter.

3.3 Request by IACA to participate in the work of the NAT SPG

3.3.1 The Group was presented with a request from IACA to participate in the work of the NAT SPG. It was noted that IACA members account for approximately 6 % of all NAT traffic. It was felt that IACA could contribute to the work of the NAT SPG and that it should therefore be invited to meetings. In agreeing to the foregoing, the Group emphasized the need for all observers, particularly those representing user organizations, to keep their delegations as small as possible. The Secretary was requested to inform observers of the above.

3.3.2 It was pointed out that IACA was not on the Council's list of approved organizations which can be invited to ICAO meetings and that it would be necessary to formally approach the Council to obtain their approval before inviting IACA to NAT SPG meetings. The Secretary was requested to carry out the necessary coordination on this matter.

3.4 Participation in the work of the implementation working groups

3.4.1 The Group was informed that States from outside the NAT or adjacent Regions had requested to attend, as observers, meetings of certain implementation working groups. The Group noted the foregoing and agreed that participation in the work of any of the implementation working groups was at the discretion of the rapporteur. The Secretary was requested to inform all the rapporteurs accordingly.

3.5 Volcanic activity in Iceland

3.5.1 The Group was presented with information on the possible operational impact of the eruption of volcanoes in Iceland and in particular Mount Katla. In the same context, the Group was also informed that Iceland did have contingency plans to cover such occurrences. Nevertheless, it was agreed that the NAT ATMG should be apprised of the foregoing by the Secretary and that this matter should be added to their work programme.

3.6 Updates to the International General Aviation (IGA) manual

3.6.1 The Group recalled that all States concerned should have sent their comments regarding the updating of the IGA manual to the Member from the United States by 31 December 1993. In this context, the Group was informed that it might be opportune to review the section on Search and Rescue (SAR) with the objective of tightening requirements for IGA operations in the NAT Region in order to minimize SAR costs. It was proposed that a meeting of SAR experts should be convened to address this specific issue. Following an in depth discussion, it was agreed that the deadline for comments on the IGA manual should be extended to 15 February 1994 and that all participants should review the issue concerning SAR with a view to addressing them at NAT SPG/30. Finally, it was noted that the United Kingdom, in co-operation with other provider States, would prepare a working paper on SAR and related issues in the NAT Region to be presented to NAT SPG/30.

- END -