European and North
Atlantic Office

NAT DOC 005

Future ATM Concept of Operations for the North Atlantic Region

Second Edition
November 2012

Published on behalf of the North Atlantic Systems Planning Group by the European and North Atlantic Office of ICAO

EXCLUSION OF LIABILITY

EUROPEAN AND NORTH ATLANTIC OFFICE OF ICAO

E-mail	:	icaoeurnat@paris.icao.int
Internet	:	www.paris.icao.int/
Fax	:	+33 1 46 41 85 00
Mail	:	ICAO/OACI European and North Atlantic Office 3 bis, Villa Emile Bergerat 92522, Neuilly-sur-Seine, CEDEX FRANCE

AMENDMENTS

This table provides records of amendments to the 2nd Edition and forward.

Edition	**Paragraph(s)**	**Explanation**

Notes on the Second Edition

The First Edition of NAT Doc 005 was published in 2005. In the intervening time, a number of developments took place which necessitated significant updates. Accordingly, the Section Edition takes account of trial applications of reduced longitudinal separation and advances in the planning for reduced lateral separations and transition from an air traffic management concept based on Minimum Navigation Performance Specifications (MNPS) approvals to one based on the Performance Based Navigation (PBN) concept as described in the *Performance-based Navigation (PBN) Manual* (Doc 9613). The Second Edition also takes account of the decision of the NAT SPG to transition to a performance based planning approach as elaborated in the *Global Air Traffic Management Operational Concept* (Doc 9854), *Air Traffic Management System Requirements* (Doc 9882), the *Manual on global Performance of the Air Navigation System* (Doc 9883) and the *Global Air Navigation Plan* (Doc 9750). Finally, the Second Edition includes a section to describe CNS enablers as they pertain to the NAT Region future ATM concept.

TABLE OF CONTENTS

GLOSSARY OF TERMS

ADS-C	Automatic Dependent Surveillance - Contract
ADS-B	Automatic Dependent Surveillance - Broadcast
ANSP	Air Navigation Services Provider
ASAS	Airborne Separation Assistance System
ATC	Air Traffic Control
ATM	Air Traffic Management
ATN	Aeronautical Telecommunication Network
CDM	Collaborative Decision Making
CPDLC	Controller Pilot Data Link Communications
FANS	Special Committee on Future Air Navigation Systems
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HF	High Frequency
MNPS	Minimum Navigation Performance Specifications
NAT	North Atlantic
NAT IMG	North Atlantic Implementation Management Group
NAT SPG	North Atlantic Systems Planning Group
NICE	NAT Implementation Cost Effectiveness
OCA	Oceanic Control Area
OTS	Organized Track System
RLatSM	Reduced Lateral Separation Minimum
RNP	Required Navigation Performance
RVSM	Reduced Vertical Separation Minima
SATVOICE	Voice communications via satellite
TDA	Traffic Density Analyser

LIST OF DEFINITIONS

The following definitions are intended to clarify specialised terms used in this Document.

Height-keeping capability.
Aircraft height-keeping performance, which can be expected under nominal environmental operating conditions, with proper aircraft operating practices and maintenance.

Height-keeping performance.
The observed performance of an aircraft with respect to adherence to cleared flight level.

RVSM Airspace.
That airspace from FL290 inclusive up to and including FL410, where a Vertical Separation Minimum (VSM) of 300 m (1000 ft) is applied.

Target level of safety (TLS).
A target maximum set for the collision risk estimate in each of the lateral, longitudinal and vertical dimensions.

i. INTRODUCTION

i.1 During the 1990s, an Air Traffic Management Implementation Plan was developed under the auspices of the North Atlantic Implementation Management Group (NAT IMG). This strategy envisaged progressive reductions of separations standards through Reduced Vertical Separation Minima (RVSM) and three phases of reduced horizontal separation minima. The ultimate objective of the strategy, although not planned in detail, was free flight. The first phase of the strategy, RVSM, was very successful, so much so that the NAT Implementation Cost Effectiveness (NICE) report showed that that the residual fuel burn benefits of future separation reductions were so small as to be greatly outweighed by the required investment, principally in aircraft avionics fit. The strategy suffered a further setback when it was determined, that the first two phases of reduced horizontal separation minima, which did not require special equipment, could not be achieved due to safety performance limitations. Reduced longitudinal separation via the use of FANS 1/A or equivalent equipped flights was introduced as a trial in the Shanwick and Gander Oceanic Control Areas (OCA) in March 2011.

i.2 The capacity gain brought about by RVSM produced immediate improvements in the ratio of flights receiving their requested oceanic clearance. This factor, coupled with the downturn in traffic in the post 11 September 2001 era, has meant that the ratio of flights getting desired clearances has remained high; however, operational experience and projections of traffic growth indicate that this ratio will decline in coming years with the growth of traffic. Furthermore, with the advent of the *Global ATM Operational Concept* (Doc 9854), it is felt that the time is ripe to identify future service improvements which will deliver benefits to NAT users in the remainder of this decade and into the future.

i.3 The previous oceanic service strategy was only partially successful for two reasons, namely:

a) the difficulty in predicting future development direction over long periods due to economic, business and technical changes, meant that the long-term and specific nature of the strategy was constantly at the mercy of events which it could not fully envisage, let alone control;

b) the strategy depended upon the use of mandated equipment, specifically ATN, for its longer-term elements. The rate of equipage with this technology meant that the anticipated benefits would be a very long time in coming.

i.4 It is considered, therefore, that there is a need for a flexible strategy which moves towards an identified, long-term target, but allows other benefits to be realised, on an opportunity basis, along the way. Furthermore, the strategy has to take into consideration:

a) customer aspirations and development plans;

b) emerging concepts of operation, specifically the outputs from the Eleventh Air Navigation Conference (ANC/11, 2003);

c) technical opportunities presented by the widespread availability of technologies, such as FANS, GPS, and the improved communication, surveillance, navigation and timekeeping that they offer; and

d) the endorsement of the Aviation System Block Upgrades (ASBU) approach by the Twelfth Air Navigation Conference (2012).

ii. SAFETY MANAGEMENT

ii.1 Safety will remain the highest priority in aviation and the safety of air traffic will continue to be the most important consideration in all phases of the life cycle of the Air Traffic Management (ATM) system, from concept, through to design, development, operation and maintenance.

ii.2 An acceptable level of safety, as described in the *Safety Management Manual* (SMM, Doc 9859), Second Edition, 2009, paragraphs 6.2.4, is the way of expressing the "minimum degree of safety that has been established by the State and must be assured by a State Safety Programme (SSP); furthermore, paragraph 6.4.6 indicates that an acceptable level of safety is the "minimum degree of safety that must be assured by a system in actual practice". As such, it will be determined from the perception of safety needs by society and the aviation community and will be related to the trust required from the ATM system. An acceptable level of safety is normally related to the safety performance of a State and is defined within the framework of an SSP. The acceptable level of safety should normally reflect a combination of safety measurement and safety performance measurement. The NAT SPG may, in future, define regional safety performance indicators and related safety performance targets.

ii.3 A target level of safety (TLS) is a design parameter, which is used, in the development phase, to facilitate decision making regarding a planned implementation. The target level of safety is based on risk assessment and acceptance criteria and has also been used as an indicator to provide a means to detect whether the system, in actual practice, is operating as expected. The North Atlantic Systems Planning Group (NAT SPG) has established TLSs to support planning for separation reductions in the ICAO NAT Region. Historically, TLSs have been defined by the NAT SPG as estimated collision risk.

ii.4 It has been the practice that, if the estimated risk arising from a planned separation reduction exceeds the applicable TLS, then the reduction should not proceed, even on a trial basis.

ii.5 The NAT SPG currently estimates the risk of collision in three dimensions: vertical, lateral and longitudinal. If the estimated collision risk of the system in operation exceeds the TLS established for any of these three dimensions, concerted action is required to analyse relevant data to determine the root causes of the risk and determine what form(s) of mitigation is(are) required to reduce the risk. The outcome of this analysis will be used by the NAT SPG to decide upon an appropriate course of action.

ii.6 The NAT SPG has, for a number of years, been actively monitoring safety performance in the ICAO NAT Region. This has been done by a continuous process of tactical monitoring of aircraft technical performance and by assessing reports of operational errors (including air traffic services errors, navigational errors or inaccurate height-keeping) in the Region. This led to the identification of a number of short-comings and trends within the NAT operational system and, through the mechanisms of the NAT SPG, promulgation of guidance material and best practices to assist operators and service providers to operate in a context which is consistent with continuous safety improvement.

ii.7 Recognising the contribution of the scrutiny process to system safety, it was concluded that formalised safety management processes should be put in place to enhance safety. These processes will make a positive contribution to NAT system safety in the years ahead, enabling airspace utilisation to be maximised in a disciplined and safe environment.

iii. DESCRIPTION OF THE NAT ATM CONCEPT OF OPERATIONS

iii.1 The ATM system will be based on the provision of integrated services. However, to better describe how these services will be delivered, the NAT ATM Concept of Operations is defined in terms of seven concept components, together with their expected key conceptual changes. The ATM system needs to be disaggregated to understand the sometimes complex interrelationships between its components.

1. AIRSPACE ORGANIZATION AND MANAGEMENT

1.1 Airspace organization will establish airspace structures in order to accommodate the different types of air activity, volume of traffic, and differing levels of service. Airspace management is the process by which the airspace options are selected and applied to meet the needs of the ATM community. Key conceptual changes:

a) all airspace will be the concern of ATM and will be a useable resource;

b) airspace management will be dynamic and flexible;

c) any restriction on the use of any particular volume of airspace will be considered transitory; and

d) all airspace will be managed flexibly. Airspace boundaries will be adjusted to particular traffic flows and should not be constrained by national or facility boundaries.

NAT AIRSPACE ORGANIZATION

1.1.1 The NAT airspace organization should evolve to meet the changing demands of the aviation community. Provider States should coordinate their airspace planning to balance the conflicting but legitimate requirements of all users in order to efficiently provide sufficient capacity to meet traffic demands, to ensure optimum utilization, to ensure compatibility with their respective neighbours and to guarantee the safety of flight.

MNPS AIRSPACE

1.1.2 Minimum Navigation Performance Specification (MNPS) is a specified set of minimum navigation performance standards which aircraft must meet in order to operate in MNPS designated airspace. In addition, aircraft must be certified by their State of Registry for MNPS operation. The objective of MNPS is to ensure the safe separation of aircraft and to derive maximum benefit, generally through reduced separation standards, from the high navigational accuracy afforded by modern navigation equipment. Aircraft, which are not MNPS-certified may not operate in the MNPS airspace.

PERFORMANCE BASED NAVIGATION

1.1.3 As described above, the NAT Region was the first ICAO Region to implement separation standards with minimum navigation performance requirements. Subsequently, the Performance Based Navigation (PBN) concept was developed to support further reductions in separation standards. The Concept should support the implementation of PBN based separation minima and the benefits that can be derived therefrom.

1.1.4 The Concept should allow for the implementation of separation in an incremental fashion. A service provider could implement reduced separation standards in their area of responsibility before the entire NAT Region is prepared to implement the same reduced separation minimum provided that the change was in support of the direction of the ATM Concept of Operations. This would of course be contingent on having robust transition procedures in place.

1.1.5 The NAT SPG has agreed to transition from an ATM concept for the ICAO NAT Region to one based on the Performance Based Navigation (PBN) concept as described in the *Performance-based Navigation (PBN) Manual* (Doc 9613).

Note.–The planned evolution from MNPS to PBN is detailed in the MNPS to PBN Transition Plan for the ICAO NAT Region.

RVSM AIRSPACE

1.1.6 Reduced Vertical Separation Minimum (RVSM) are rules that apply to flight between FL290 and FL410 (inclusive) in navigation areas that have been designated as RVSM airspace; all of the NAT Oceanic Control Areas (OCA), between these levels, is so designated. RVSM rules allow aircraft that are properly equipped and certified and flown by a properly trained flight crew to operate in RVSM designated airspace. Aircraft and crews that do not meet these requirements are prohibited from operating in RVSM airspace except in very limited special circumstances. RVSM allows 1000 feet vertical separation operations.

2. AERODROME OPERATIONS

2.1 As an integral part of the ATM system, the aerodrome must provide the needed ground infrastructure including, *inter alia*, lighting, taxiways, runway and runway exits, precise surface guidance to improve safety and to maximize aerodrome capacity in all weather conditions. The ATM system will enable the efficient use of the capacity of the aerodrome airside infrastructure. Key conceptual changes:

a) runway occupancy time will be reduced;

b) the ability to safely manoeuvre in all weather conditions whilst maintaining capacity;

c) precise surface guidance to and from a runway will be required in all conditions; and

d) the position (to an appropriate level of accuracy) and intent of all vehicles and aircraft operating on the manoeuvring and movement areas will be known and available to the appropriate ATM community members.

2.2 Although there are a number of aerodromes in the NAT Region, none suffer from any capacity constraints; therefore the concept does not address aerodrome planning.

3. DEMAND AND CAPACITY BALANCING

3.1 Demand and capacity balancing will strategically evaluate system-wide traffic flows and aerodrome capacities to allow the airspace users to determine when, where and how they operate, while mitigating conflicting needs for airspace and aerodrome capacity. This collaborative process will allow for the efficient management of the air traffic flow through the use of information on system-wide air traffic flow, weather and assets. Key conceptual changes:

a) through collaborative decision-making at the strategic stage, assets will be optimised to maximize throughput thus providing a basis for predictable allocation and scheduling;

b) through collaborative decision-making, when possible, at the pre-tactical stage, adjustments will be made to assets, resource allocations, projected trajectories, airspace organization, and allocation of entry/exit times for aerodromes and airspace volumes to mitigate any imbalance; and

c) at the tactical stage, actions will include dynamic adjustments to the organization of airspace to balance capacity; dynamic changes to the entry/exit times for aerodromes and airspace volumes; and adjustments to the schedule by the users.

3.2 The NAT has implemented a process to develop more efficient airspace planning and improve procedures by increased use of Collaborative Decision Making (CDM). The objective is to improve efficiency, reduce delays and provide greater flexibility and predictability for NAT operations.

3.3 It has been recognised that, through the CDM process, greater benefits may be achieved for both aircraft operators and Air Navigation Services Providers (ANSPs). Particular emphasis was made on improving the interface between the NAT and domestic portion of the flight.

3.4 CDM using the threaded discussion feature of the Traffic Density Analyser (TDA) is the main tool used to provide common situational awareness. The Concept should take account of other traffic balancing tools that are being developed.

4. TRAFFIC SYNCHRONIZATION

4.1 Traffic synchronization refers to the tactical establishment and maintenance of a safe, orderly and efficient flow of air traffic. Key conceptual changes:

a) there will be dynamic 4-D trajectory control and negotiated conflict-free trajectories;

b) chokepoints will be eliminated; and

c) optimisation of traffic sequencing will achieve maximization of runway throughput.

AIR TRAFFIC SERVICE

4.1.1 Fundamental to the current concept of operation in NAT Oceanic airspace is the principle of providing, in advance, a conflict-free route from oceanic entry to landfall for each aircraft flying in the region. This key concept is the essential difference between this and other concepts of operation (i.e. tactical based on radar monitoring) and was born out of the unreliability of HF radio. The concept provides an inherently fail-safe service, even if communication is lost. The concept also enables a controller to handle much higher levels of traffic, as all aircraft are separated, and frequency of monitoring is much reduced.

4.1.2 The aim of the Air Traffic Management Service within the NAT Region is to maintain a ‘safe, orderly and expeditious flow of air traffic’. To achieve these objectives, aircraft are issued with conflict-free clearances which will result in an aircraft being separated from all other known aircraft, and reserved areas by at least the relevant separation minima. These separation minima vary according to the aircraft type, its equipment and navigational capabilities and the airspace type.

4.1.3 In areas where communications are reliable, a more tactical approach has been adopted by some service providers. Since communication reliability is improving, the emphasis on strategic separation is expected to decrease. The Concept should take this into account.

ORGANIZED TRACK SYSTEM (OTS)

4.1.4 As a result of passenger demands, time zone differences and airport noise restrictions, most of the North Atlantic air traffic is concentrated at particular times of the day, namely: westbound in the late morning and afternoon; and eastbound during the night and early morning. Consequently, North Atlantic airspace is comparatively congested at these times due to the meteorological situation concentrating flight route requests around optimum time paths and the height band for economical jet operation. To provide the best service, a system of organized tracks is constructed every 12 hours to accommodate as many aircraft as possible on, or close to, their most economical flight profiles.

4.1.5 Although the OTS has proved very successful in providing a good trade-off between capacity and operating efficiency, it is considered that, in the long term, the need for the OTS should be reduced to a minimum.

OTS DEFINITION

4.1.6 The function of OTS definition is to define a set of laterally separated tracks, which are economically suitable for use by customers and acceptable to adjacent ATC agencies. The primary objective in determining the OTS is to ensure that sufficient track and flight level profiles are provided to satisfy anticipated traffic demands.

5. AIRSPACE USER OPERATIONS

5.1 Airspace user operations refer to the ATM-related aspect of flight operations. Key conceptual changes:

a) accommodation of mixed capabilities and worldwide implementation needs will be addressed to enhance safety and efficiency;

b) relevant ATM data will be fused for an airspace user's general, tactical and strategic situational awareness and conflict management;

c) relevant airspace user operational information will be made available to the ATM system;

d) individual aircraft performance, flight conditions, and available ATM resources will allow dynamically-optimised 4-D trajectory planning;

e) collaborative decision-making will ensure that aircraft and airspace user system design impacts on ATM are taken into account in a timely manner; and

f) aircraft should be designed with the ATM system as a key consideration.

MANAGING FUTURE CHANGE

5.1.1 All of the developments described in this document will follow the same basic form, namely:

a) initial feasibility assessment to determine whether the development can be safely and practically achieved and the likely costs and benefits. This will involve a review of the likely impact on safety performance and a determination of whether operational procedures and technical infrastructure will be able to support the development. The review will also look at opportunities for 'quick hits' in much the same way as the CPDLC trials identified which messages could be used in the early phases of the project, without any safety risk;

b) an operational trial, which will monitor the success of the development, to identify and deal with any safety concerns or practical difficulties which are being encountered;

c) full operations, based on a final safety assessment to show that safety targets will continue to be met; and

d) strategy review, which will consider the impact of the project on the wider development programme to determine whether adjustments are required or if there are lessons to be learned for other parts of the programme.

6. CONFLICT MANAGEMENT

6.1 Conflict management will consist of three layers: strategic conflict management through airspace organization and management, demand and capacity balancing and traffic synchronization; separation provision; and collision avoidance.

6.2 Conflict management limits, to an acceptable level, the risk of collision between aircraft and hazards. Hazards that an aircraft will be separated from are: another aircraft, terrain, weather, wake turbulence, incompatible airspace activity and when the aircraft is on the ground, surface vehicles and other obstructions on apron and manoeuvring area. Key conceptual changes:

a) strategic conflict management will reduce the need for separation provision to a designed level;

b) the ATM system will minimize restrictions to user operations; therefore, the pre-determined separator will be the airspace user, unless safety or ATM system design requires a separation provision service;

c) the role of separator may be delegated, but such delegations will be temporary;

d) in the development of separation modes, separation provision intervention capability must be considered;

e) the conflict horizon will be extended as far as procedures and information permit; and

f) collision avoidance systems are part of ATM safety management, but are not included in determining the calculated level of safety required for separation provision.

IN-TRAIL CLIMB AND DESCENT

6.2.1 The improvements proposed for reductions in lateral and longitudinal separation are based on current aircraft equipage. Further opportunities are presented by technologies such as ADS-B-In. With the advent of this technology, opportunities are created for flights to have an accurate picture of the relative positions of other flights. This degree of situational awareness creates the opportunity for aircraft to assume responsibility for separation in an in-trail climb or descent manoeuvre. This manoeuvre will be based upon suitable ATC instructions, and aircraft will maintain their separation from each other to ensure it does not fall below that instructed by ATC.

6.2.2 As well as offering a degree of flexibility to flights, this approach would reduce controller workload to some extent. It would also offer the opportunity to build up the necessary knowledge and experience that would be vital for any ultimate move to airborne separation assurance.

AIRBORNE SEPARATION ASSISTANCE SYSTEM

6.2.3 Airborne Separation Assistance System (ASAS) applications will enable suitably-equipped flights to be responsible for maintaining pre-defined separation from one another; the flights involved would otherwise be free to exercise discretion in adapting the flight profile in accordance with operational and other needs. It is envisaged that this degree of freedom would allow further fuel burn savings and allow customers to better control their business.

6.2.4 It might be possible to apply an ASAS concept beyond the NAT airspace into some defined areas, or level bands, of domestic airspace, blurring the distinction between the current operations. Experience gained on ASAS in the NAT is likely to be an important element in enabling improvements in the domestic environment. For example it may be an enabler for the establishment of longitudinally spaced streams of traffic, or achievement of 'gate' times determined from arrival metering at busy airfields. ASAS on the NAT should probably, therefore, be viewed as an enabler for more general ATC improvements, rather than something that offers major benefits in and of itself.

6.2.5 The provision of ASAS would require the mandating of appropriate ADS-B-In equipment in segregated airspace. As with reductions in lateral separation, options would exist for applying this in a specified portion of airspace at the outset, thus maintaining a satisfactory level of service for non-equipped aircraft.

REDUCED LONGITUDINAL SEPARATION

6.2.6 There has been a significant increase in the number of aircraft with an ADS-C/CPDLC capability. The improved surveillance and communications capability offered by ADS-C/CPDLC coupled with the use of GPS clocks in these aircraft and general improvements in navigational accuracy arising from Global Navigation Satellite Systems (GNSS) has offered the opportunity to allow a trial of reduced separation between appropriately-equipped aircraft. A reduced longitudinal separation of 5 minutes (measured in seconds) can be applied between two ADS-C/CPDLC-equipped aircraft following the same identical or continuously diverging tracks to provide data to support the development of a 5 minute separation minimum, while standard separations are retained between non-equipped flights and between ADS-C/CPDLC flights and non-equipped flights.

6.2.7 This separation is based on suitably equipped flights acknowledging an ADS-C periodic contract with a reporting interval of no more than 18 minutes.

6.2.8 This concept is intended to support development of an ICAO separation minimum that will provide improved vertical flexibility to flights, improving their chances of receiving their preferred route or level with a consequent improvement in fuel burn.

6.2.9 Future developments may include the reduction of the longitudinal separation minima between flights on intersecting tracks and expanding the application of ADS-C/CPDLC based longitudinal minima to the planning phase of operations.

REDUCED LATERAL SEPARATION

6.2.10 While reduced longitudinal separation can be differentially applied, depending upon aircraft equipage, this will not be practical for reductions in lateral separations. However, it is expected that, over time, the proportion of data link equipped aircraft will steadily increase to the point where such equipage will become a de facto standard.

6.2.11 A Reduced Lateral Separation Minimum (RLatSM) of 25 nautical miles will allow for ½ degree lateral spacing between tracks in NAT MNPS airspace between RNP-4 authorized aircraft. This would have the effect of allowing more aircraft to have access to optimal fight profiles, providing opportunities for fuel burn savings. It would also create the opportunity to reduce the area covered by the OTS, with consequent benefits for random flights.

6.2.12 RLatSM will be implemented using the following phased approach:

a) Each implementation phase shall be harmonized to an appropriate step or benchmark (as determined by the NAT IMG) contained in the *MNPS to PBN Transition Plan for the ICAO NAT Region*.

b) Phase 1 shall introduce 25 NM lateral separation by implementing ½ degree spacing between the two core tracks within the vertical limits applicable to the airspace associated with the NAT Region

Data Link Mandate (NAT SPG Conclusion 46/2 refers); only aircraft with the appropriate Required Navigation Performance (RNP) approval, Automatic Dependent Surveillance-Contract (ADS-C) and Controller Pilot Data Link Communications (CPDLC) would be permitted to operate on the ½ degree spaced tracks.

Note 1 – Each Phase will be applicable in whatever vertical band is currently associated with NAT Region data link mandatory airspace.

Note 2 - The dates will also be harmonized with the dates applicable to the NAT Performance Based Communication and Surveillance Implementation Plan.

c) *Phase 2* shall expand the introduction of 25 NM lateral separation by implementing ½ degree spacing through the entire NAT Organised Track System (OTS), within the vertical limits applicable to the airspace associated with the NAT Region Data Link Mandate; only aircraft with the appropriate RNP approval, ADS-C and CPDLC would be permitted to operate on the ½ degree spaced tracks.

d) *Phase 3* shall introduce 25 NM lateral separation throughout the entire ICAO NAT Region, including for converging and intersecting track situations, within the vertical limits applicable to the airspace associated with the NAT Region Data Link Mandate. The application of the reduced separation standard between targets of opportunity should be permissible in any part of the ICAO NAT Region outside the OTS (mixed mode operations).

7. ATM SERVICE DELIVERY MANAGEMENT

7.1 ATM service delivery management will operate seamlessly from gate-to-gate for all phases of flight and across all service providers. The ATM service delivery management component will address the balance and consolidation of the decisions of the various other processes/services, as well as the time horizon at which, and the conditions under which these decisions are made. Flight trajectories, intent and agreements will be important components to delivering a balance of decisions. Key conceptual changes:

a) services to be delivered by the ATM service delivery management component will be established on an as-required basis subject to ATM system design. Where services are established they will be provided on an on-request basis;

b) ATM system design will be determined by collaborative decision-making and system-wide safety and business cases;

c) services will be delivered by the ATM service delivery management component through collaborative decision-making, balance and optimise user-requested trajectories to achieve the ATM community’s expectation; and

d) management by trajectory will involve the development of an agreement that extends through all the physical phases of the flight.

OTHER POTENTIAL DEVELOPMENTS

7.1.1 The developments identified in this document are, in effect, a response to opportunities presented by emerging technologies. In that sense, these developments are reactive rather than proactive; however, it is likely that joint investigation of potential improvements by air navigation service providers and customers may identify practical ways of achieving improvements in such areas as Gate-to-Gate operations and collaborative decision making as well as in future enhancements in ATM tools. Joint investigations of these options will therefore take place with a view to developing workable concepts of operation, which will form the basis for further, technical investigations to assess feasibility. Those options, which are agreed, will be incorporated into the development plan.

CNS ENABLERS

COMMUNICATIONS

For many years air-ground communication the NAT Region has been based essentially on the use of the non-DCPC HF radio, with the exception of the airspace surrounding Bodo, Iceland and the Azores Islands, where VHF/UHF communications are available (see figure below). The unreliability of HF radio was the main contributor factor for the implementation of conflict free strategic oceanic clearances across the ocean, allowing a safe service even if communication is lost.

Considering the fundamental role of communications in aviation as an enabler, the common objective is to ensure the provision of the desired services meeting appropriate performance and interoperability requirements in a cost effective manner.

The improvement in communication reliability in the NAT Region in the coming years is expected to allow a better ATC intervention capability, thus enabling not only separation reductions, but also migrating from the conflict free strategic oceanic clearance to a more tactical approach by ATS service providers, while at the same time ensuring the same or increased level of safety. The NAT Communication system evolution shall be planned in such a way so as to enable implementation of the Future Concept of Operations as described in this document.

The communication system provided to enable the application of the future separation reductions must ensure the controller's ability to intervene and resolve potential conflicts by contacting aircraft using normal means of communication in due time or using alternative means should normal means of communication fail.

AIR/GROUND COMMUNICATIONS SYSTEM

It is envisaged that the use of FANS 1/A (or equivalent) data-link communications (i.e. CPDLC) as well as voice SATVOICE as DCPC means of communication will facilitate the above objectives, allowing automation to support routine communication of for example en route significant weather information, conformance warnings and other pertinent and useful information for oceanic flight operations. The decisions of the NAT SPG to mandate the use of FANS 1/A (or equivalent) data link in specified portions of the ICAO NAT Region and to remove restrictions on the use of SATVOICE for ATS communications is expected to increase the use of these technologies.

It is expected that the SATVOICE infrastructure will continue to improve in terms of performance and geographic coverage. When appropriate, consideration should be given to amending airspace requirements such that appropriate SATVOICE equipage would permit relaxation of dual HF radio carriage requirements.

When appropriate, the data link services (ADS-C and CPDLC) will be required to meet certain performance characteristics defined in terms of an RCP (Required Communications Performance) specification type in accordance with the applicable separation minima within the NAT areas concerned. Where reduced separation minima are used, an RCP type may be prescribed, for example RCP 240 as per *the Global Operational Data Link Document* (GOLD). For that purpose the NAT airspace may be segregated by designating areas where aircraft, Air Traffic Service Providers and the communications infrastructure shall meet the RCP specification.

Note.—The planned evolution toward the application of the RCP and Required Surveillance Performance (RSP) concepts in the ICAO NAT Region is detailed in the NAT Performance Based Communication and Surveillance Implementation Plan.

As of 2012, data link services (ADS-C, CPDLC and data link Oceanic Clearance Delivery) were available throughout he ICAO NAT Region (except in the Bodø Oceanic FIR) south of approximately 82N using a network of Inmarsat satellites and VHF ground stations. It is expected that those services will become available in the entire NAT region using the Iridium satellite system.

VHF communications, supported by extended range facilities where required, shall be used to the maximum extent possible. Although the use of HF radio is expected to gradually decrease it will continue to be used in the foreseeable future as an alternative or backup communication system.

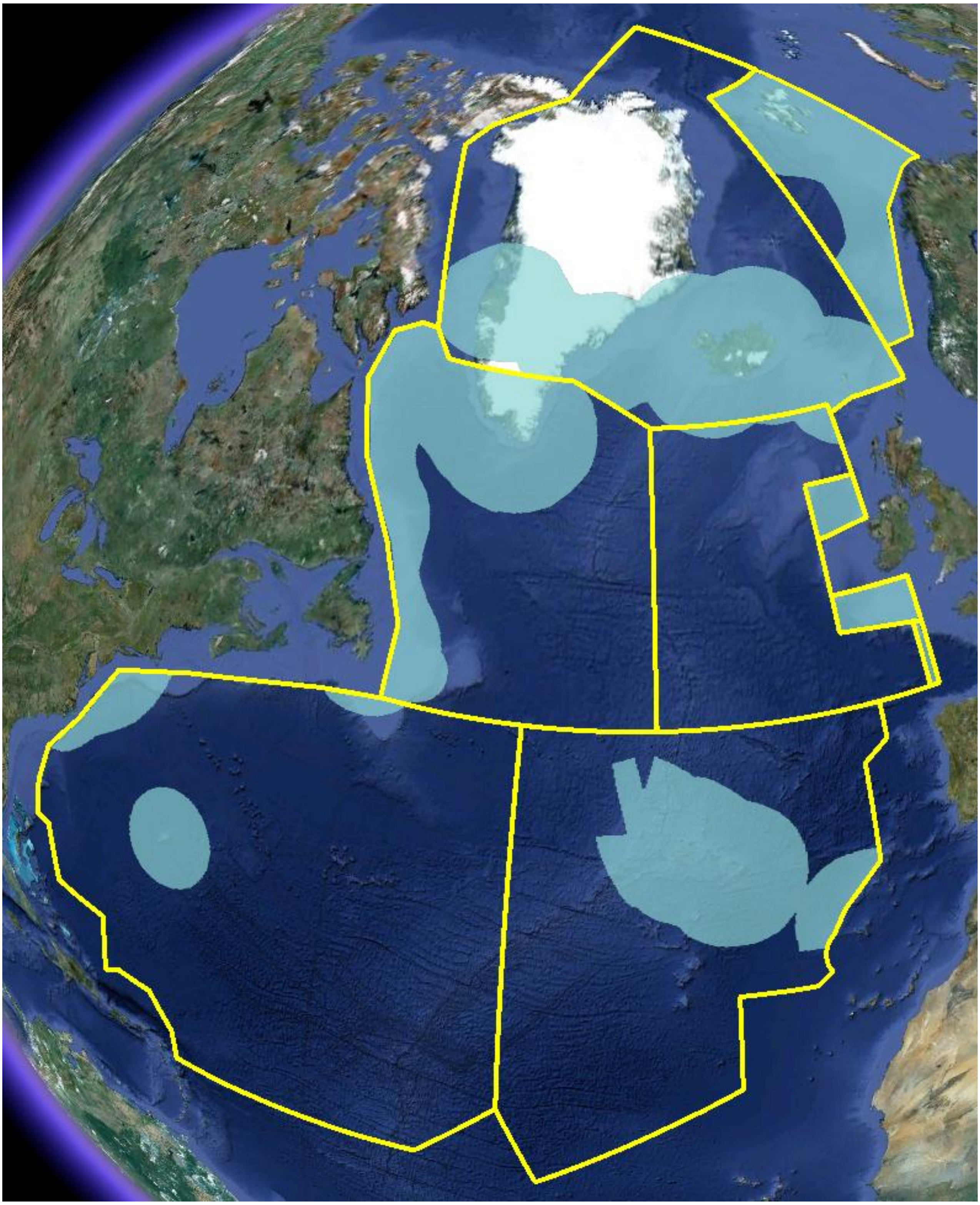

Figure 1: VHF coverage (circa 2013)

GROUND/GROUND COMMUNICATIONS SYSTEM

With regards to the NAT ground/ground communications system evolution, the short term main focus is the full implementation of Air Traffic Services (ATS) Inter-Facility Data Communication (AIDC) as described in *The North Atlantic Common Coordination Interface Control Document* (NAT Doc 002). Among other benefits, this is expected to improve safety performance by reducing inter-facility coordination errors.

Note.–Regional planning in regard to communications system evolution in support of the NAT current and future concepts of operations is also described in the NAT Basic ANP Doc 9634. Part IV – CNS.

PERFORMANCE BASED NAVIGATION (PBN)

Performance-based navigation (PBN) is a framework for defining a navigation performance specification along a route, during a procedure, or in airspace within which an aircraft must comply with specified operational performance requirements. It provides a simple basis for the design and implementation of automated flight paths and for airspace design, aircraft separation, and obstacle clearance. It also offers a straightforward means to communicate the performance and operational capabilities necessary for the utilization of such paths and airspace. Within the framework of performance-based navigation, the aviation industry has defined area navigation (RNAV) and required navigation performance (RNP) specifications that can be satisfied by a range of navigation systems.

RNP is RNAV with on-board navigation monitoring and alerting, RNP is also a statement of navigation performance necessary for operation within a defined airspace. A critical component of RNP is the *ability of the aircraft navigation system to monitor its achieved navigation performance, and to identify for the pilot whether the operational requirement is, or is not being met during an operation*. This on-board performance monitoring and alerting capability therefore allows a lessened reliance on air traffic control intervention (via radar monitoring, automatic dependent surveillance (ADS), multilateration, communications), and/or route separation to achieve the overall safety of the operation. RNP capability of the aircraft is a major component in determining the separation criteria to ensure that the overall containment of the operation is met. The RNP capability of an aircraft will vary depending on the aircraft equipment and the navigation infrastructure. For example, an aircraft may be equipped and certified for RNP 1.0, but may not be capable of RNP 1.0 operations due to limited NAVAID coverage.

Figure 2 shows how RNAV and RNP have improved the navigational process. Using the current ground navaids, the aircraft has to fly from beacon to beacon, often taking an inefficient route in order to pick up the signals at the appropriate place in the air. The dotted boxes indicate the expanse of the area in the sky that the aircraft could be in as it picks up those ground-based signals. This requires air traffic control to create larger areas of separation between aircraft, in order to maintain safety. In the RNAV and RNP routing, however, the dotted areas are far smaller, indicating that the aircraft can fly a much more precise route in the air. Additionally, the graphic illustrates the RNP "radius of turn" ability, essentially indicating how RNP enables the aircraft to make much tighter, more precise turns in the air.

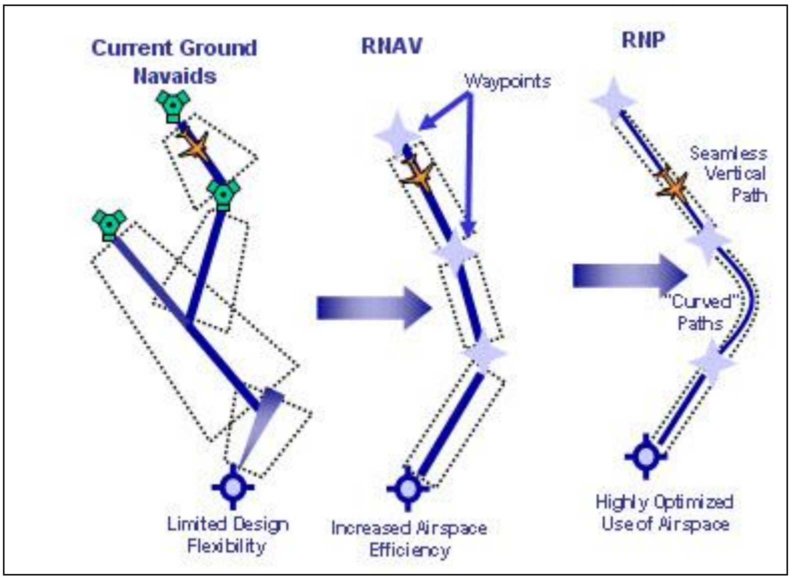

Figure 2: Performance-Based Navigation – RNAV/RNP

Certain RNP operations require advanced features of the onboard navigation function and approved training and crew procedures. These operations must receive approvals that are characterized as Special Aircraft and Aircrew Authorization Required (SAAAR), similar to approvals required for operations to conduct instrument landing system (ILS) Category II and III approaches.

RNAV and RNP specifications facilitate more efficient design of airspace and procedures, which collectively result in improved safety, access, capacity, predictability, operational efficiency, and environmental effects.

Detailed guidance material on PBN implementation is contained in the *Performance-based Navigation (PBN) Manual* (Doc 9613). It should be noted that any plans to transition to PBN operations should be in accordance with provisions contained in Doc 9613.

ATS SURVEILLANCE

Traditionally, position information for aircraft operating in the ICAO NAT Region has been provided by means of voice position reporting, supplemented by secondary surveillance radar (SSR) in certain parts of the region.

It is expected that ATS surveillance capabilities will be enhanced by improvements to the SSR service and the implementation of Automatic Dependent Surveillance – Broadcast (ADS-B). Position reporting via ADS-C is the preferred method of providing position reports in the ICAO NAT Region where ATS surveillance is not available.

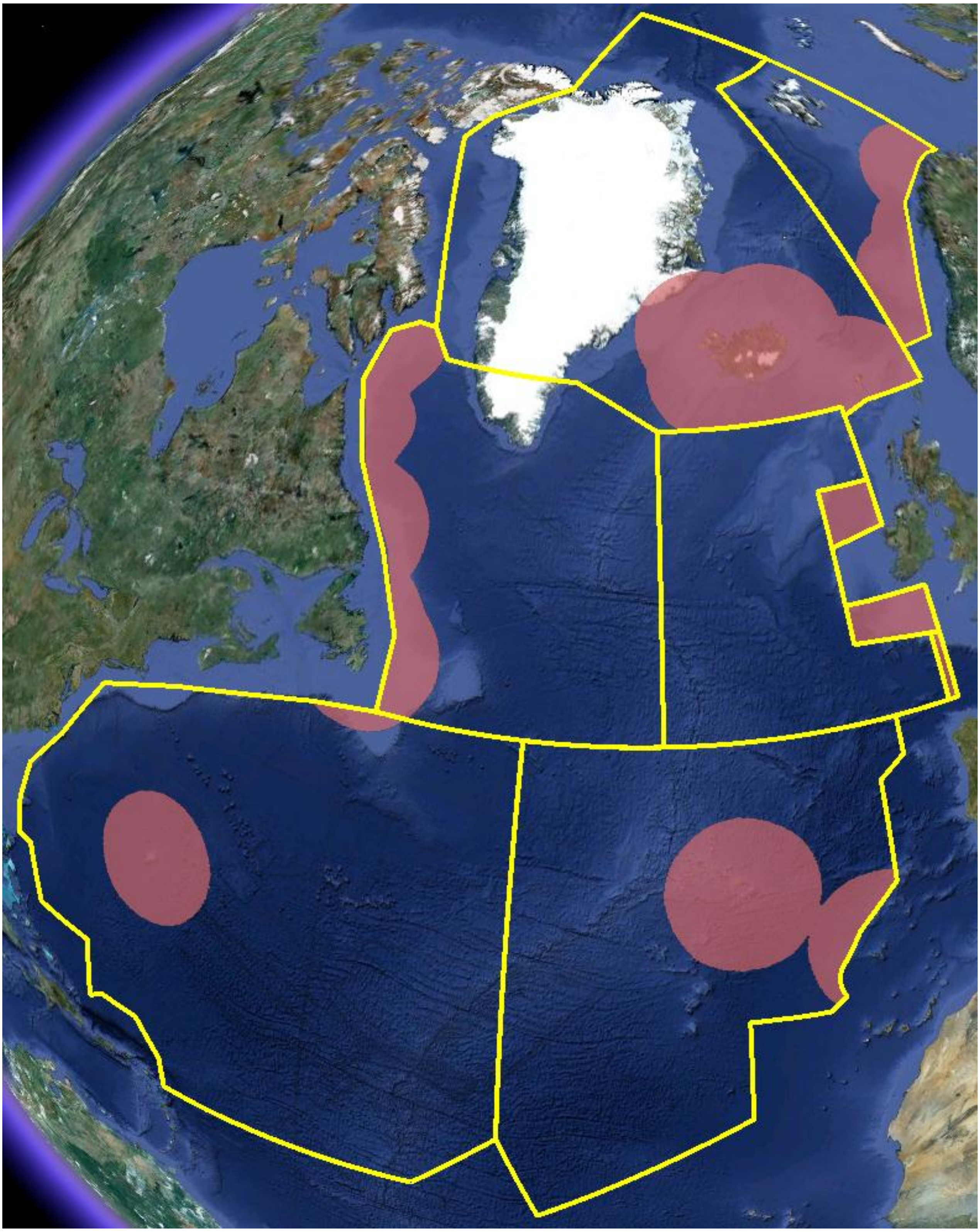

Figure 3: SSR coverage (circa 2013)

The use of FANS1/A (or equivalent) data link will be mandated in specified portions of the ICAO NAT Region from 2013 onwards. It is envisaged that ATS surveillance areas will be excluded from this mandate.

When appropriate, ADS-C services will be required to meet certain performance characteristics defined in terms of Required Surveillance Performance (RSP) type specification in accordance with the applicable separation minima within the NAT areas concerned. Where reduced separation minima are used, an RSP type specification may be prescribed, for example specification type 180 as per the GOLD.

Note.— The planned evolution toward the application of the RCP and RSP concepts in the ICAO NAT Region is detailed in the NAT Performance Based Communication and Surveillance Implementation Plan..

ADS-Broadcast (ADS-B) is based on the aircraft constantly broadcasting its position and intentions which allows other aircraft and ground systems to receive the information. As of 2012, ADS-B was limited to line of sight applications. It is expected that the use of satellite communications to transmit ADS-B data will expand the area where the provision of ATS surveillance services will be feasible. It is anticipated that ADS-B will eventually sustain the implementation of Airborne Separation Assistance System (ASAS) applications.

Along with expanding the area where ATS surveillance is available, the availability of direct controller/pilot communications (DCPC) throughout the area under consideration is equally important to support the application of ATS surveillance based separation minima. In conjunction with the commissioning of ADS-B stations, a network of VHF transceivers will therefore also be established. These transceivers will ensure reliable DCPC coverage of the airspace and thus permit tactical application of separation, whether procedural or ATS surveillance-based. This means that even those aircraft not carrying ADS-B transmitters will benefit from the provision of ATS surveillance services based on ADS-B.

In a future phase, the deployment of ADS-B further north may become possible depending on favourable cost/benefit analyses. In the medium-to-long term it is also envisaged that the ADS-B technology will replace current secondary surveillance radars in the NAT airspace.

Initially, no segregation between equipped and non-equipped ADS-B aircraft is contemplated. ATS Surveillance based separation minima will be applied only between eligible aircraft pairs and procedural separation minima will be applied otherwise. When equipage rates approach the critical point where segregation becomes a viable option and the non-equipage of aircraft becomes an operational and/or economical impediment segregation will be considered.

Note. – Regional planning in regard to surveillance system evolution in support of the NAT current and future concepts of operations is also described in the NAT Basic ANP Doc 9634. Part IV – CNS.

– END –