Appendix E – Implementation Plan for an Operational Trial of Application of GNSS based Lateral Separation below F285 over and in the vicinity of Greenland within the Reykjavik CTA

(paragraph 3.1.10 refers)

Implementation Plan

for an Operational Trial

of Application of GNSS Based Lateral Separation

Below F285 over and in the vicinity of Greenland

within the Reykjavik CTA

Version 1.1

Table of Contents

1 Introduction

1.1 The application of lateral separation in the area over and around Greenland between non-MNPS approved aircraft has always been very restrictive due to the fact that the only separation available for this purpose in the NAT document Application of Separation Minima (ASM) is 120 NM or 2 degrees gentle slope separation. This significantly affects the separation of non-MNPS approved aircraft operating in and out of Greenland and often results in aircraft choosing to remain in uncontrolled airspace below F195 rather than having to accept large reroutes or other restrictions to gain access to controlled airspace. The large separation may also prevent aircraft from avoiding severe weather.

1.2 The 120 NM separation stems from an era when navigation was via Dead Reckoning and communications were only possible via HF radios. This situation has now changed significantly with the majority of low level aircraft navigating via GNSS and General Purpose VHF being available in some areas.

1.3 The ICAO Separation and Airspace Safety Panel (SASP) has for some years been working on lateral separation standards for GNSS equipped aircraft. The development of those standards was completed at the SASP WG/WHL meeting in Montreal in May 2012 and was subsequently sent to the ICAO Air Navigation Bureau (ANB) and Air Navigation Commission (ANC) for further processing and publication. Due to the time it takes to progress document amendments through the ICAO system, it may be expected that the PANS-ATM amendment process will take several years.

1.4 The SASP PANS-ATM amendment proposal is presented in two documents; An amendment proposal and Impact statement which is presented in Attachment A to this Implementation Plan and an Implementation guidance Circular which is presented in Attachment B.

1.5 The amendment proposal and Impact statement lists the following:

- ✓ An amendment summary.
- ✓ Expected implementation impact.
- ✓ Expected benefits.
- ✓ Detailed rationale for the proposed PANS-ATM amendment.

1.6 The Implementation guidance Circular lists the following:

- ✓ An introduction section.
- ✓ The lateral separation minima that is covered by the Circular.
- ✓ Detailed description of the safety assessment, including collision risk modeling.
- ✓ A list of implementation considerations.
- ✓ Implementation hazard log.

1.7 Isavia is of the opinion that the work done by the SASP has reached such maturity that the separation could be implemented in the airspace over and around Greenland as an operational trial until the separation standards are published in the PANS-ATM. Utilizing those reduced separation standards would facilitate a huge improvement in Air Traffic Management in Greenland resulting in reduced fuel burn and greenhouse gas emissions and increased safety. The following provisions of Annex 11 section 3.4 should be considered in this context:

3.4 Separation minima

3.4.1 The selection of separation minima for application within a given portion of airspace shall be as follows:

a) the separation minima shall be selected from those prescribed by the provisions of the PANS-ATM and the *Regional Supplementary Procedures* as applicable under the prevailing circumstances except that, where types of aids are used or circumstances prevail which are not covered by current ICAO provisions, other separation minima shall be established as necessary by:

1) the appropriate ATS authority, following consultation with operators, for routes or portions of routes contained within the sovereign airspace of a State;

2) regional air navigation agreements for routes or portions of routes contained within airspace over the high seas or over areas of undetermined sovereignty.

Note.— Details of current separation minima prescribed by ICAO are contained in the PANS-ATM (Doc 4444) and Part 1 of the Regional Supplementary Procedures *(Doc 7030).*

b) the selection of separation minima shall be made in consultation between the appropriate ATS authorities responsible for the provision of air traffic services in neighbouring airspace when:

1) traffic will pass from one into the other of the neighbouring airspaces;

2) routes are closer to the common boundary of the neighbouring airspaces than the separation minima applicable in the circumstances.

Note.— The purpose of this provision is to ensure, in the first case, compatibility on both sides of the line of transfer of traffic, and, in the other case, adequate separation between aircraft operating on both sides of the common boundary.

3.4.2 Details of the selected separation minima and of their areas of application shall be notified:

a) to the ATS units concerned; and

b) to pilots and operators through aeronautical information publications, where separation is based on the use by aircraft of specified navigation aids or specified navigation techniques.

1.8 Since the GNSS navigation aid is not covered by the current ICAO lateral separation provisions Isavia believe that the above Annex 11 provisions are applicable in this situation.

1.9 In connection with the ADS-B implementation program in Greenland, Direct Controller Pilot Communications (DCPC) transceivers will be installed in several locations. This communication capability will enable the application of some of the new lateral separation minima.

1.10 Within ICAO there is skepticism concerning if it is appropriate to publish in the PANS-ATM new equipment based separation standards (GNSS) or if all new separation standards should be based on Performance Based Navigation (PBN). At the time of writing this Implementation Plan this issue is still unresolved within ICAO. It should however been made clear this this is solely a matter of policy and is not concerned with the safety of the proposed new separation standards.

1.11 This implementation plan follows the guidelines provided in ICAO Doc 9689 (Manual on Airspace Planning Methodology for the Determination of Separation Minima).

1.12 The implementation process is conducted in accordance with the guidelines provided in the draft Circular Chapter 4 as follows:

SASP Implementation Step	**Isavia implementation**
Step 1 Undertake widespread regional consultation with all possible stakeholders and other interested parties.	The following parties are consulted: a) Regulatory authorities. b) NAT ATMG, SARSIG, IMG and SPG. c) Aircraft operators conducting services in Greenland. d) Iceland Radio. e) Sondrestrom FIC.
Step 2: Develop an airspace design concept or ensure that the proposed separation minima being implemented will fit the current airspace system and regional or state airspace planning strategy.	Routes and waypoints are being reviewed and will be amended as required to suite the application of the new separation.
Step 3 Review this circular noting specific assumptions, constraints, enablers and system performance requirements.	This task has been completed.
Step 4 Compare assumptions, enablers, and system performance requirements in this circular with the regional or State's operational environment, infrastructure and capability.	This task has been completed.
Step 5 If a region or State or ANSP has determined that the change proposal for that region or State is equal to or better than the reference, requirements and system performance in this circular, then the region or State must undertake safety management activities including:	Isavia has determined that that the change proposal is equal to or better than the reference, requirements and system performance in the circular.
Step 5a) formal hazard and consequence(s) identification, and safety risk analysis activities including identification of controls and mitigators;	Isavia will conduct a Safety Assessment in accordance with Icelandic regulatory requirements before the new lateral separation standards are implemented. This activity needs to be completed before approval is granted by the Icelandic regulator.
Step 5b) implementation plan;	This document is the implementation plan.

SASP Implementation Step	Isavia implementation
Step 5c) techniques for hazard identification/safety risk assessment which may include: 1) the use of data or experience with similar services/changes; 2) quantitative modeling based on sufficient data, a validated model of the change, and analyzed assumptions; 3) the application and documentation of expert knowledge, experience and objective judgment by specialist staff; and 4) a formal analysis in accordance with appropriate safety risk management techniques as set out in the Doc 9859;	1) Identical services with different separation values are currently being provided within the Iceland domestic airspace and the procedures are therefore known with a long standing experience. 2) The quantitative modeling done by the SASP will be used. 3) This will be done in the FHA. 4) The quantitative modeling done by the SASP and the safety assessment specified in step 5a above is considered to satisfy this requirement.
Step 5d) identification and analysis of human factors issues identified with the implementation including those associated with Human Machine Interface matters;	Identical methods of separation are already in use in the Reykjavik centre using the same air traffic control systems which are: a) Flight Data Processing System (FDPS). b) Integrated Situation Display System (ISDS). c) Voice Communication System. This item will nevertheless be covered in the FHA.
Step 5e) simulation where appropriate;	Airspace design simulation is not considered necessary due to the simplicity of the operations. Simulation will be run during controller training.
Step 5f)operational training; and	Controllers will receive both classroom and simulator training.
Step 5g) regulatory approvals	Approval from the Icelandic regulator is required before implementation.
Step 6 If a region or State has determined that the change proposal for that region or State is not equal to the requirements and system performance in this circular, then the region or State must: i) consider alternative safety risk controls to achieve the technical and safety performance that matches the reference in this circular; or, ii) conduct appropriate quantitative risk analysis for the development of a local standard in accordance with Doc 9689.	This does not apply to this project.

SASP Implementation Step	Isavia implementation
Step 7: Develop suitable safety assessment documentation including a safety plan and associated safety cases.	This activity needs to be completed before approval is granted by the Icelandic regulator.
Step 8 Implementation activities should include:	
Step 8 i) trial under appropriate conditions;	This project is the trial.
Step 8 ii) expert panel to undertake scrutiny of proposals and development of identified improvements to the implementation plan;	An expert panel has already been formed and is managing the project.
Step 8 iii) develop an appropriate backup plan to enable reversion if necessary; and	The backup plan is reversion to the current separation standards.
Step 8 iv) continuous reporting and monitoring results of incidents, events, observations.	Continuous reporting and monitoring results of incidents, events and observations is a standard routine activity for all operations in the Reykjavik center. Any events that can be attributed to the new separation will be analyzed specially. A yearly report will be provided to the SARSIG.
Step 9: Develop a suitable post-implementation monitoring and review processes.	Continuous reporting and monitoring results of incidents, events and observations is a standard routine activity for all operations in the Reykjavik center. Any events that can be attributed to the new separation will be analyzed specially. A yearly report will be provided to the SARSIG.

2 Identification of the Need for Change

2.1 The following issues are the main drivers behind the proposal to apply GNSS based lateral separation between Domestic aircraft in Greenland and between aircraft departing from Greenland and Arriving to Greenland:

- Increased navigation capability in the form of GNSS.
- Increased communication capability in the form of General Purpose VHF and DCPC VHF.
- The current minimum lateral separation between non-MNPS approved aircraft is 120 NM or 2 degrees gentle slope separation. This seriously affects the separation of non-MNPS approved aircraft operating on domestic services in Greenland and also in and out of Greenland in the following manner:
    - Aircraft often have to accept large reroutes or other restrictions to gain access to controlled airspace.
    - Aircraft often choose to remain in uncontrolled airspace below F195 rather than having to accept large reroutes or other restrictions to gain access to controlled airspace.
    - The large separation limits aircraft in seeking optimum routing and flight levels to avoid severe weather conditions such as turbulence and icing.
    - The large separation results in increased fuel consumption and greenhouse gas emissions due to excessive track mileage and uneconomical flight levels.
- The GNSS lateral separation standards are considered as a safe and simple solution to bridge the gap until full PBN implementation.

3 Description of the Current Airspace and the CNS/ATM Systems

3.1 Airspace Structure

3.1.1 The responsibility for air traffic control services within the North Atlantic (NAT) Region is delegated by the International Civil Aviation Organization (ICAO) to seven states: the United Kingdom, Iceland, Canada, Norway, USA, Denmark and Portugal.

3.1.2 The Icelandic Air Navigation Service Provider, Isavia, is responsible for Air Traffic Management Services above flight level 195 in the BGGL FIR north of 63°30’N as well as the entire BIRD FIR (Figure 1).

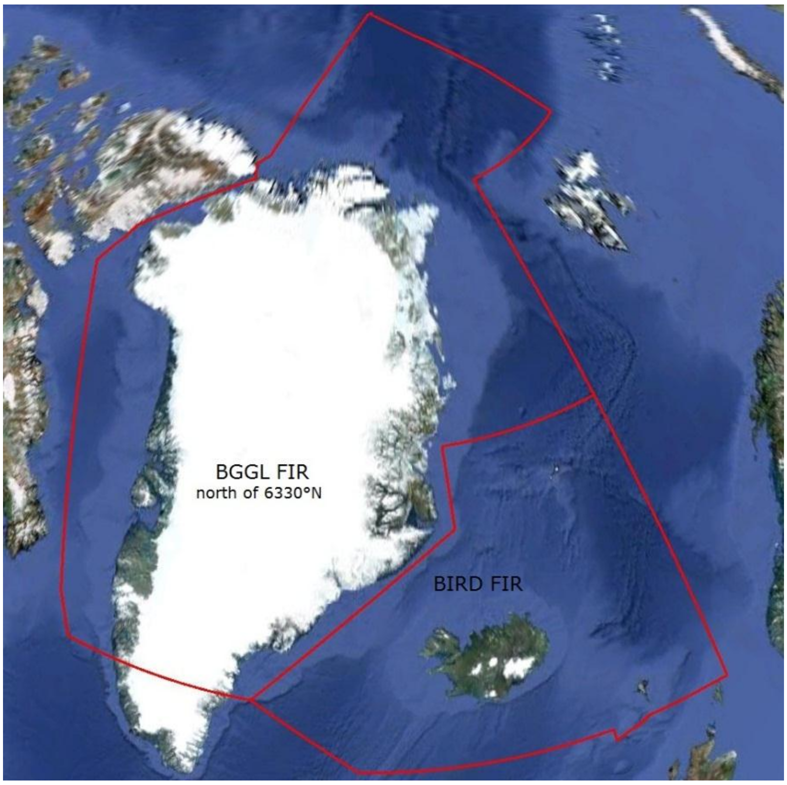


Figure 1: Reykjavik CTA within Reykjavik and Greenland FIRs

3.1.3 The airspace managed by Isavia is divided into four geographic sectors, namely the East; South; West and North Sectors (Figure 2). The first two are characterized by extensive radar coverage (Figure 3), the latter two are currently procedural. A project is under way to implement ADS-B surveillance and DCPC communication services within the West sector (Figure 4).

3.1.4 The four base sectors are split vertically according to the amount of traffic; the smallest definition of a sector being a single base sector with one flight level.

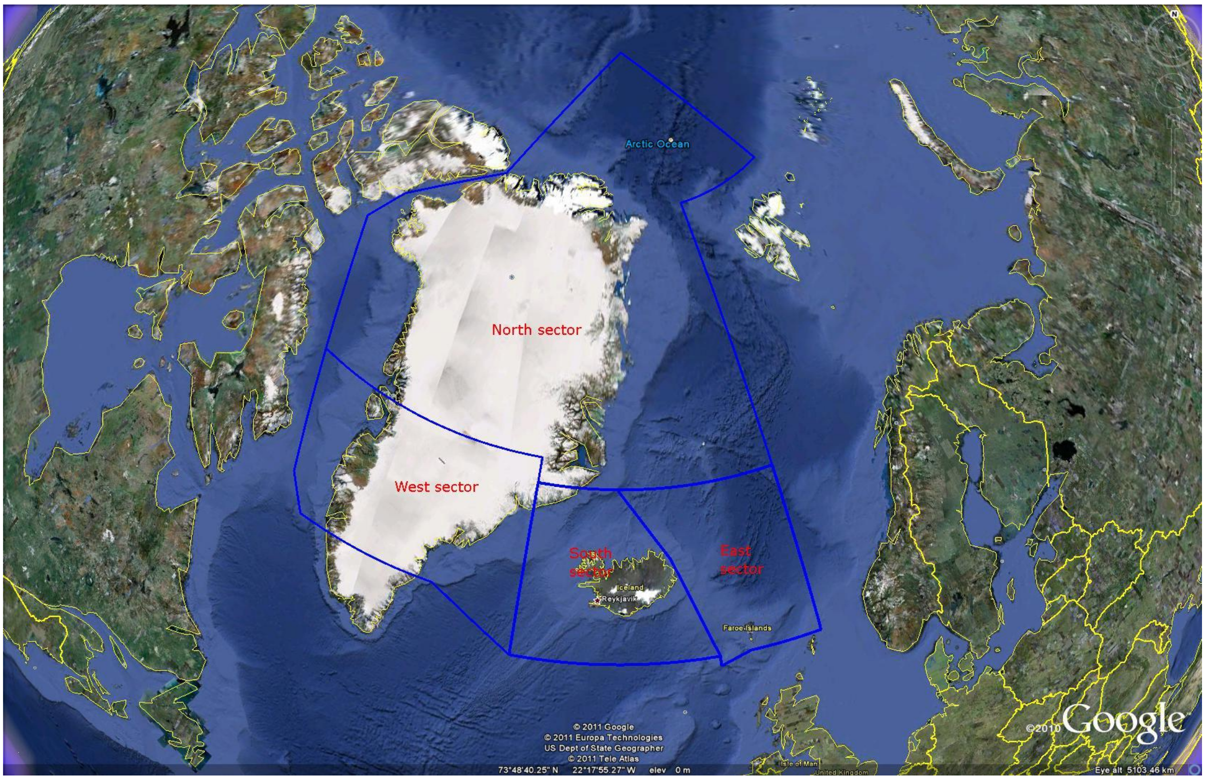


Figure 2: Reykjavik CTA

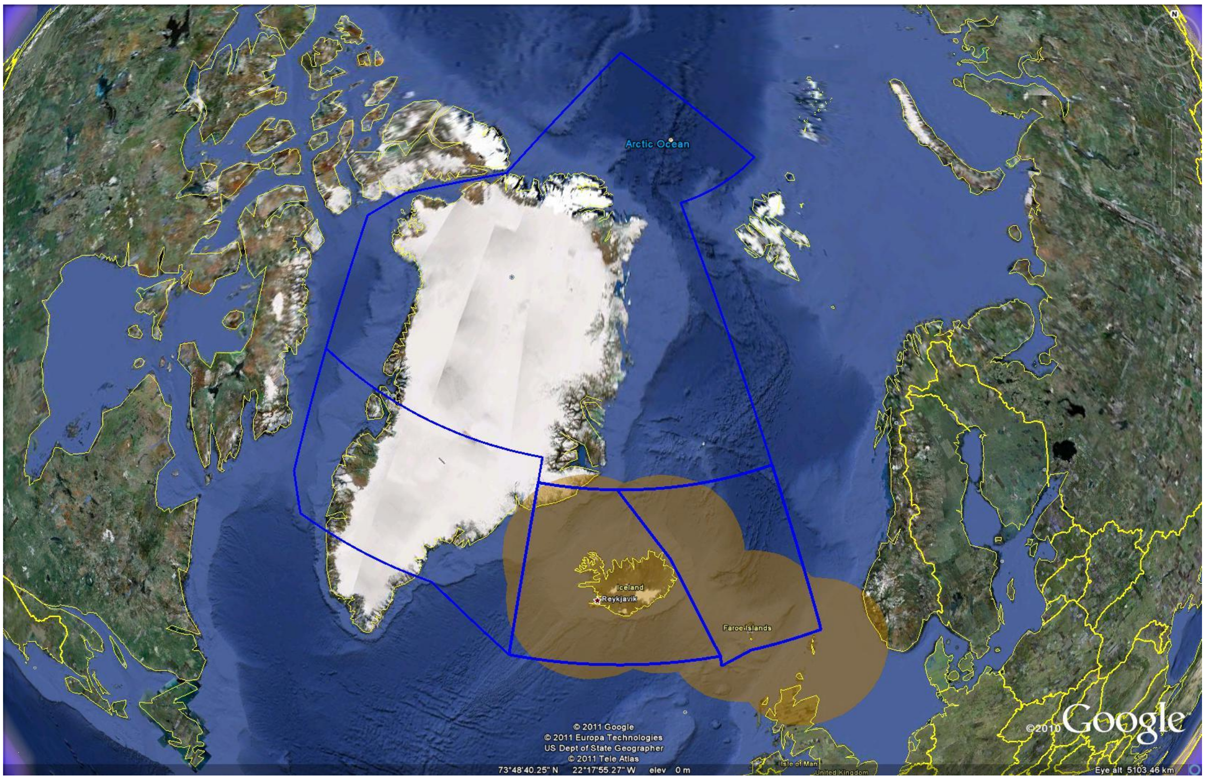


Figure 3: Current radar coverage

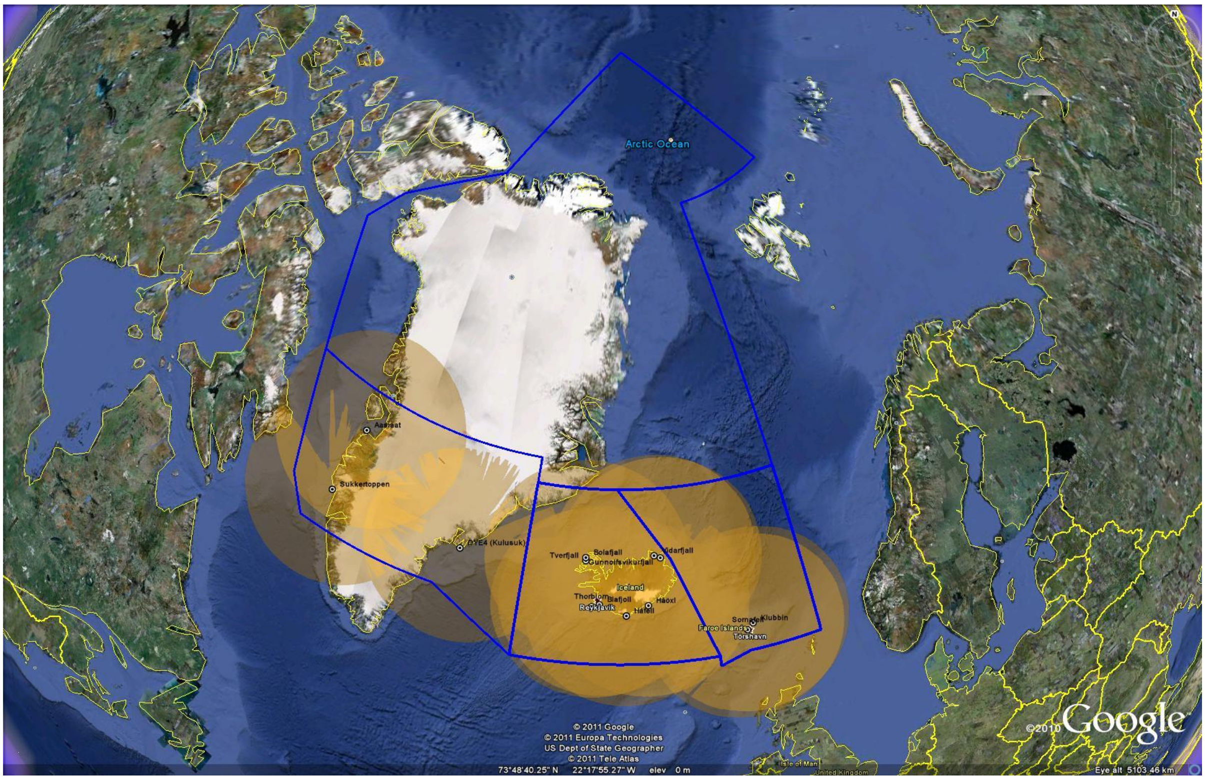


Figure 4: Estimated future ADS-B and DCPC VHF coverage at jet levels

3.1.5 The Reykjavik CTA abuts the following control areas: Scottish, Shanwick and Gander to the south, Edmonton to the west, Murmansk, Bodö and Stavanger to the East.

3.1.6 The airspace beneath the Reykjavík CTA West - and North Sectors consists for the most part of the BGGL FIR where Flight Information Service is provided by Söndreström FIC below F195, Söndrestrom TMA when Air Traffic Control service is provided by Söndrestrom Approach and Thule TMA where Air Traffic Control service is provided by Thule Terminal Radar Approach Control Cab (TRACAB). A small part of the West - and North sectors does however extend to sea level in the Reykjavik FIR, the lower boundary of controlled airspace in that portion is Flight Level 055.

3.1.7 The Reykjavik CTA is Class A airspace at and above F055 in which instrument flight rules (IFR) apply at all times. An exception to this is the domestic airspace over Iceland where the airspace below F200 is Class E for the most part. The oceanic airspace below F055 is Class G airspace.

3.1.8 The major airports in the area served by MNPS approved aircraft are Keflavík, Reykjavík, Akureyri and Egilsstaðir airports in Iceland, Vaagar in the Faroe Islands, Kangerlussuaq and Thule airports in Greenland. In addition there are a number of regional airports in Iceland and Greenland which are mainly served by regional aircraft. The main regional airports in Greenland that are effected by the change proposed in this implementation plan are Nuuk (BGGH), Kulusuk (BGKK), Kangerlussuaq (BGSF), Aasiaat (BGAA), Ilulissat (BGJN) and Nerlerit Inaat (BGCO).

3.1.9 The NAT traffic is predominantly commercial. International General Aviation (IGA) Business aircraft comprise a high proportion of the higher altitude airspace operations while regional commercial aircraft and private aircraft operate below the MNPS airspace.

3.2 Strategic Lateral Offset Procedure (SLOP)

3.2.1 Strategic lateral offsets of one or two miles right of a route or track centerline have been introduced as a means of reducing collision risk and is now standard operating procedure in the entire NAT Region.

3.3 Airborne Collision Avoidance Systems (ACAS)

3.3.1 In addition to the requirements of Annex 6, (Part I, paragraph 6.16 and Part II, paragraph 6.14) ACAS II shall be carried and operated in the NAT Region by all turbine-engine aircraft having a maximum certificated take-off mass exceeding 5 700 kg or authorized to carry more than 19 passengers.

4 Traffic Patterns

4.1 General

4.1.1 The traffic is dominated by five major traffic flows:

- First is the traffic linking Iceland with Europe and North America.
- Second is the traffic linking Europe to North America. The volume of this traffic flow varies from day-to-day depending on the high altitude winds and the corresponding location of the NAT tracks
- Third is the traffic linking the Middle East, India and Pakistan to North America.
- Fourth is the traffic linking North America with the Far East.
- Fifth is the low level traffic below the MNPS airspace which is mostly comprised of:
  - Icelandic domestic traffic.
  - Greenland domestic traffic.
  - Traffic between Iceland and Greenland and the Faroes.
  - International general aviation traffic transiting the NAT.

4.1.2 The major traffic flow between Europe and North America takes place in two distinct traffic flows during each 24-hour period due to passenger preference, time zone differences and the imposition of night-time noise curfews at the major airports. The majority of the Westbound flow leaves European airports in the late morning to early afternoon and arrives at Eastern North American coastal airports typically some 2 hours later - local time - given the time difference. The majority of the Eastbound flow leaves North American airports in mid/late evening and arriving in Europe early to mid-morning local time. Consequently, the diurnal distribution of this traffic has a distinctive tidal pattern characterized by two peaks passing 30° W, the Eastbound centered on 0400 Universal Co-ordinated Time (UTC) and the Westbound centered on 1500 UTC.

4.1.3 Following are a few key figures concerning the international traffic within the Reykjavik CTA in the year 2012 (excluding the Icelandic domestic traffic):

- Total number of flights 107.998.
  - Over flights 77.529 (71.8%), flights to and from Iceland 30.469 (28.2%).
  - Westbound flights 64.643 (59.8%), eastbound flights 43.355 (40.2%).
  - Commercial flights 99.466,(92.1%) general aviation flights 6.487 (6.0%), military flights 2.045 (1.9%).
  - The predominant aircraft types are B757, B777, B747, B767, A330, A340, and A320.

4.2 North Atlantic Organized Track System (NAT OTS)

4.2.1 As is the norm in most of the NAT Region the Reykjavik CTA is free of fixed routes, the only constrains on routing being the use of anchor points at whole degrees of latitude at every whole decades of longitude for tracks trending West/East and at 5° intervals of latitude for North/South oriented tracks.

4.2.2 A significant portion of the NAT traffic operates on tracks, which vary from day to day dependent on meteorological conditions. The variability of the wind patterns would make a fixed track system unnecessarily penalizing in terms of flight time and consequent fuel usage. Nevertheless, the volume of traffic along the core routes is such that a complete absence of any designated tracks (i.e. a free flow system) would currently be unworkable given the need to maintain procedural separation standards in airspace largely without radar surveillance.

4.2.3 As a result, an OTS is set up on a diurnal basis for each of the Westbound and Eastbound flows. Each core OTS is comprised of a set, typically 4 to 7, of parallel or nearly parallel tracks, positioned in the light of the prevailing winds to suit the traffic flying between Europe and North America.

4.2.4 The designation of an OTS facilitates a high throughput of traffic by ensuring that aircraft on adjacent tracks are separated for the entire oceanic crossing - at the expense of some restriction in the operator's choice of track. In effect, where the preferred track lies within the geographical limits of the OTS, the operator is obliged to choose an OTS track or fly above or below the system. Where the preferred track lies clear of the OTS, the operator is free to fly it by nominating a random track. Trans-Atlantic tracks, therefore, fall into three categories: OTS, Random or Fixed.

4.2.5 The location of the NAT tracks depends on the meteorological conditions and varies from day to day. In 2012 96% of the traffic in the Reykjavik CTA was on random tracks and 4% was on the NAT tracks. During 2012 the westbound NAT tracks entered the Reykjavik CTA 108 days while the eastbound NAT tracks entered the Reykjavik CTA only 8 days.

4.3 Greenland Traffic

4.3.1 Following are a few key figures concerning domestic traffic in Greenland as well as traffic departing from or arriving to airports in Greenland in the year 2012. It should be noted this only counts traffic that enters the Reykjavik CTA.

Total number of flights departing from or arriving to airports in Greenland: **5.960.**

Total number of flights equipped with GNSS ("G" in FPL Item 10a): **4.472** or **75%**.

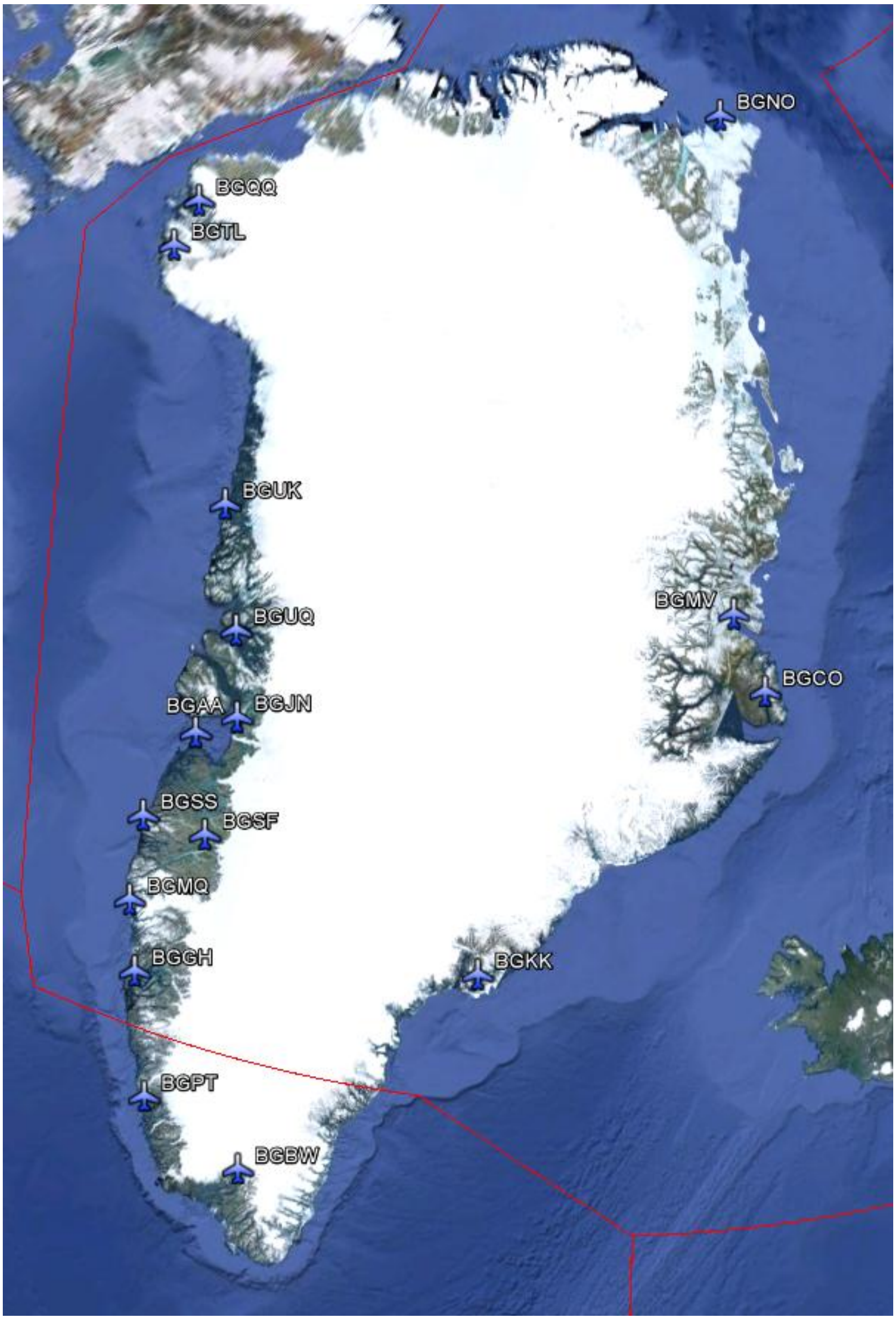


Figure 5: Greenland Airports

Airport	**Departures**	**Airport**	**Arrivals**
BGSF	947	BGSF	897
BGGH	621	BGGH	603
BGKK	470	BGBW	440
BGJN	393	BGKK	460
BGBW	388	BGJN	420
BGTL	277	BGTL	271
BGCO	185	BGCO	185
BGUK	152	BGUK	148
BGQQ	60	BGNO	49
BGMV	53	BGQQ	51
BGNO	48	BGMV	48
BGZZ	41	BGZZ	25
BGUQ	9	BGAA	16
BGSS	5	BGUQ	11
BGPT	2	BGSS	2
BGMQ	1	BGCP	1
		BGDB	1
		BGPT	1
TOTAL	**3652**		**3629**

Table 1: Number of Departures and Arrivals in Greenland

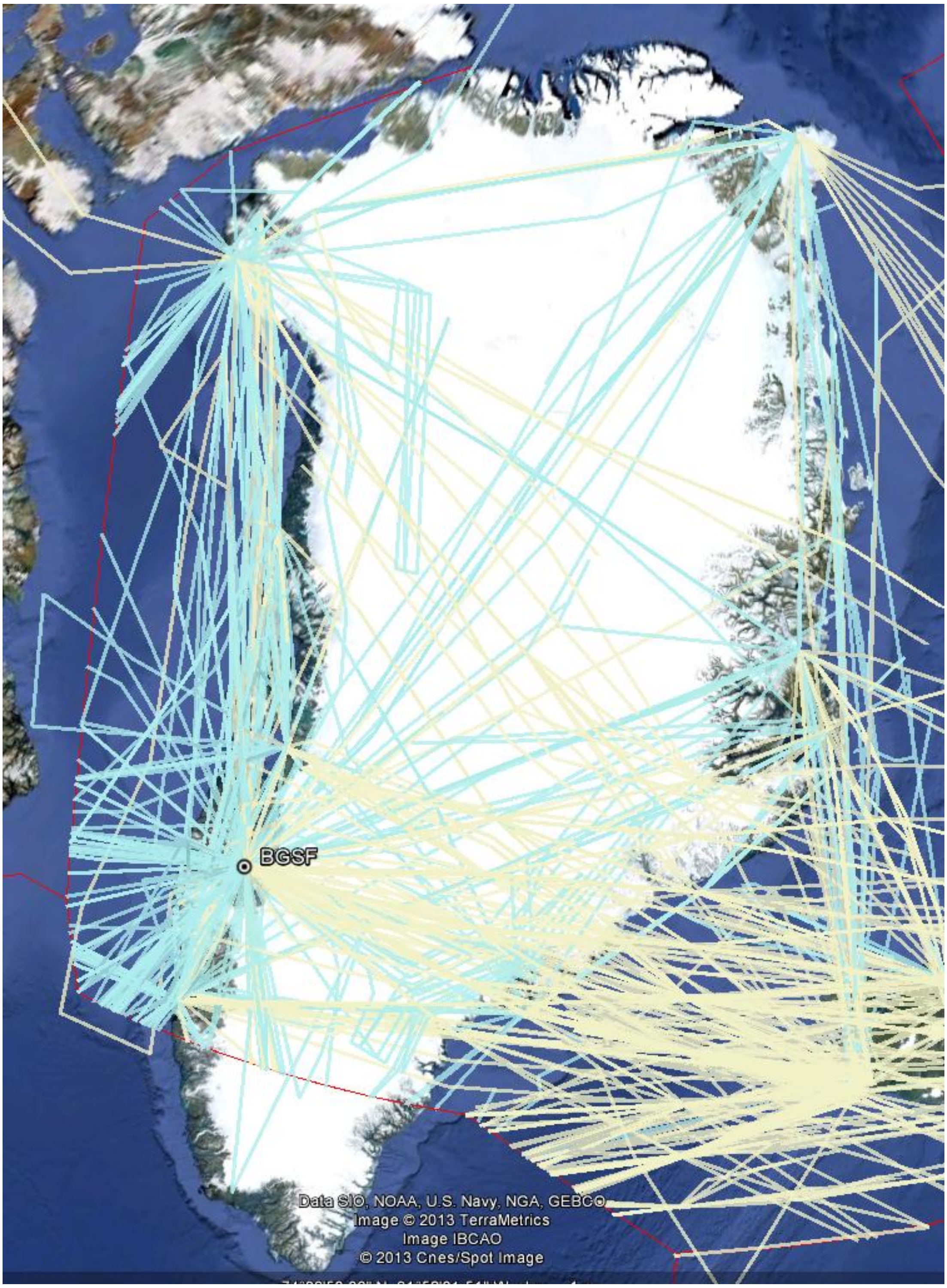


Figure 6: Departures from Greenland

(Blue = Westbound, Yellow = Eastbound)

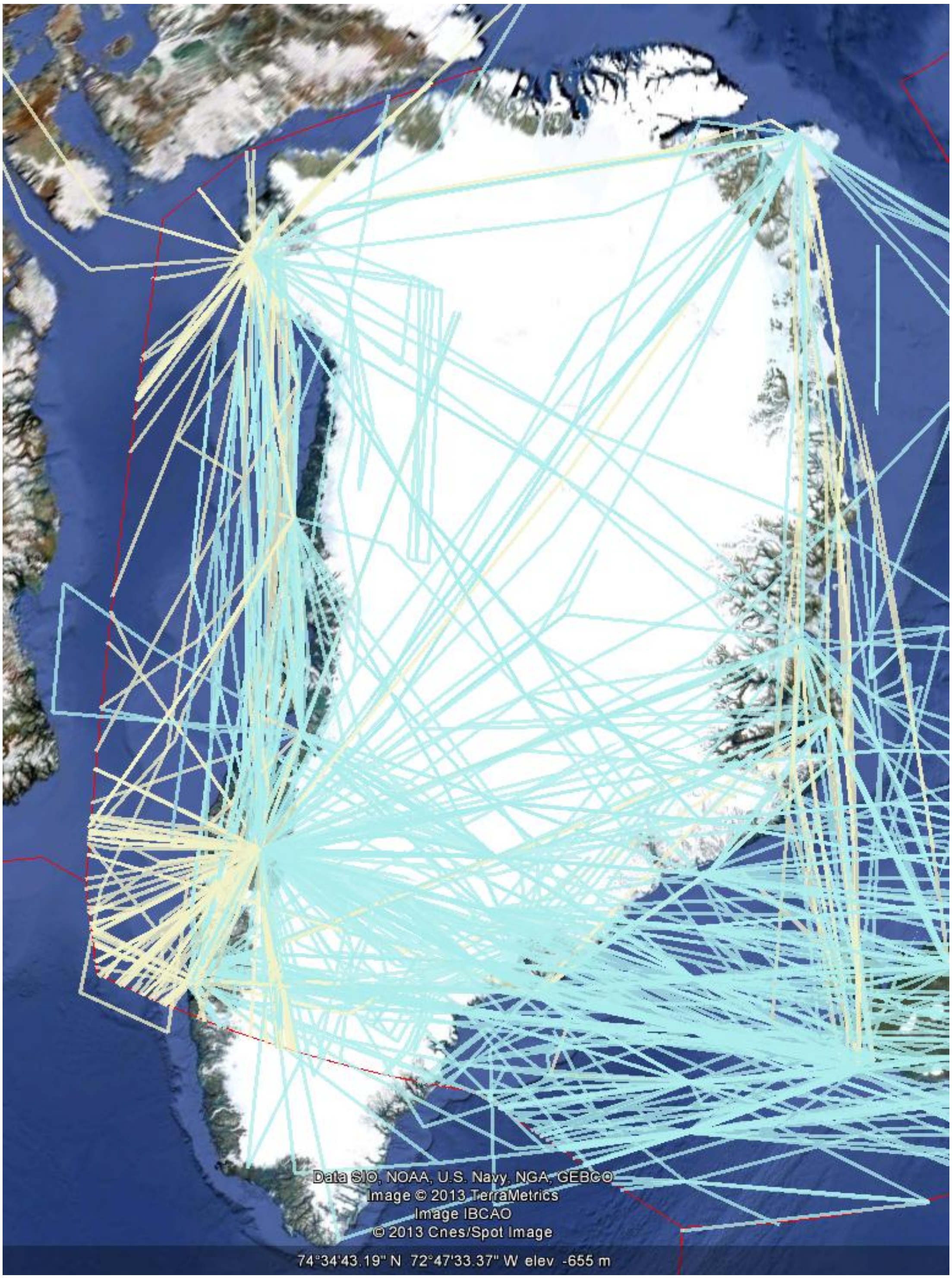


Figure 7: Arrivals to Greenland

(Blue = Westbound, Yellow = Eastbound)

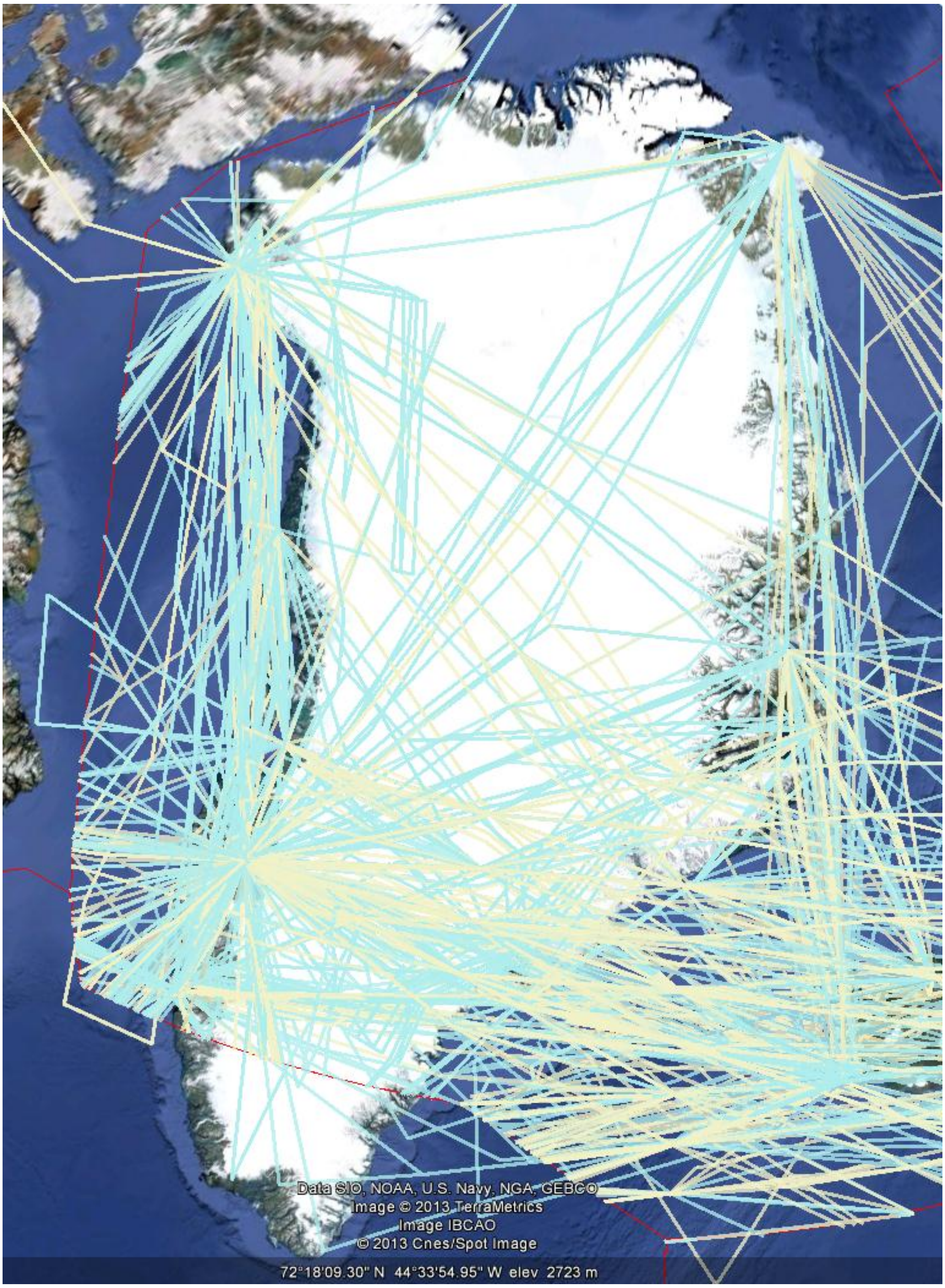


Figure 8: Departures and Arrivals from/to Greenland

(Blue = Westbound, Yellow = Eastbound)

City Pair	Number of flights
BGSF – EKCH	303
BIRK – BGKK	299
BGKK – BIRK	291
EKCH – BGSF	278
BIRK – BGBW	234
BGBW – BIRK	194
BGJN – BGGH	156
BGGH – BGJN	155
BGGH – BIRK	141
BIRK – BGJN	132
BGSF – BIRK	124
BIKF – BGSF	124
BGGH – BGKK	101
BGJN – BGUK	95
BIRK – BGSF	95
BGKK – BGGH	93
BGJN – BIRK	91
BGSF – BIKF	90
BGUK – BGJN	88
BGCO – BIRK	74
BIAR – BGCO	74
BGBW – BIKF	73
BGSF – BGBW	73
BGSF – CYFB	70
BIKF – BGGH	70
BIKF – BGBW	67
BGCO – BIAR	66
BGGH – BIKF	66
BGSF – CYYR	66
BIRK – BGCO	64
BGGH – CYFB	62
CYFB – BGGH	62
BGBW – BGSF	59
BGTL – KBWI	51
KBWI – BGTL	51

Table 2: City pairs with more than 50 flights

Aircraft type	Number of flights
DH8B	1651
F50	781
A332	524
BE20	469
C130	236
C30J	187
CL60	116
B737	112
DHC6	101
DH6	89
DH8A	85
PC12	63
DC87	61
C510	57
B350	55
SR22	48
C17	45
DC86	45
AN72	44
TBM8	37

Table 3: Top 20 aircraft types

4.4 Minimum Navigation Performance Specification

4.4.1 MNPS airspace has been established between FL285 and FL420. To ensure the safe application of separation between aircraft in the airspace, only MNPS approved aircraft are permitted to operate within the MNPS airspace. The current MNPS was established to ensure that the risk of collision as a consequence of a loss of horizontal separation would be contained within an agreed Target Level of Safety (TLS).

4.4.2 The lateral separation applied between MNPS approved aircraft is 50 NM. The longitudinal separation minima applied in the airspace vary greatly depending on aircraft class (jet, prop) among other criteria but for turbojet aircraft it is 15 minutes for crossing tracks and 10 minutes for aircraft that have reported a common point and follow the same track or continuously diverging tracks and 30 minutes for non-turbojet aircraft.

4.5 Reduced Vertical Separation Minimum (RVSM)

4.5.1 RVSM airspace has been established within the confines of MNPS airspace and associated transition areas. In RVSM airspace, 1000 feet vertical separation is applied between approved aircraft. Currently, RVSM is only applied between FL 290 and FL 410 inclusive. To ensure the safe application of the separation minimum, only RVSM approved aircraft are allowed to operate within RVSM airspace. Aircraft are monitored to ensure that the TLS is being met.

4.6 Special Use Airspace

4.6.1 There are no permanent special use airspace continuously in use in the Reykjavík CTA airspace. Temporary special use airspace is however on occasions established to cater for military exercises but those are confined to the airspace east of 30W.

5 Communication, Navigation, Surveillance

5.1 Communication

5.1.1 Air/Ground Communication

5.1.1.1 The following air/ground communication possibilities are available in the Reykjavik sectors:

- South and East sectors:
  - Direct controller pilot VHF voice communications.
  - General purpose VHF voice communications via Iceland radio.
  - HF voice communications via Iceland radio.
  - FANS1/A CPDLC.
  - SATCOM voice via Iceland radio and direct to the controller.
  - Oceanic clearance delivery via ARINC 623 data link.
- West sector:
  - General purpose VHF voice communications via Iceland radio.
  - HF voice communications via Iceland radio.
  - FANS1/A CPDLC.
  - SATCOM voice via Iceland radio and direct to the controller.
  - Oceanic clearance delivery via ARINC 623 data link.
- North sector:
  - HF voice communications via Iceland radio.
  - FANS1/A CPDLC south of 82N.
  - SATCOM voice via Iceland radio and direct to the controller.
  - Oceanic clearance delivery via ARINC 623 data link south of 82N.

5.1.1.2 All aircraft operating within the Reykjavík FIR/CTA shall maintain continuous watch on the appropriate frequency of Iceland Radio unless engaged in direct controller pilot communications with Reykjavik Control. HF RTF communication equipment with appropriate frequencies available is mandatory outside VHF coverage. When operating outside VHF coverage in MNPS airspace, aircraft are required to be equipped with dual long range voice communications system (HF or SATCOM). Over 40% of MNPS approved aircraft operating in the Reykjavik CTA is also FANS1/A equipped.

5.1.2 Ground/Ground Communication

5.1.2.1 Communication between sectors within the Reykjavik center is primarily effected through interactions with the Flight Data Processing system though voice intercom is of course available.

5.1.2.2 Aeronautical Interfacility Data Communication (AIDC) exists with Gander, Shanwick, Scottish, Stavanger and the Faxi TMA serving Reykjavik and Keflavik airports. This is used for initial coordination of flights crossing the common boundary. Any subsequent negotiation is effected via leased line voice connections. All coordination with Edmonton, Murmansk, Bodo, Sondrestrom FIC, Sondrestom APP, Thule APP and Vagar is effected via leased line voice connections.

5.1.2.3 Communication between Reykjavik OACC and Iceland radio is via AFTN and dedicated phone lines.

5.2 Navigation

5.2.1 The required navigation performance of MNPS approved aircraft is specified in the NAT section of DOC 7030 paragraph 4.1.1.5.1.2 as follows:

4.1.1.5.1.2 Except for those flights specified in 4.1.1.5.1.5, aircraft operating within the volume of airspace specified in 4.1.1.5.1.1 shall have lateral navigation performance capability such that:

a) the standard deviation of lateral track errors shall be less than 11.7 km (6.3 NM);

b) the proportion of the total flight time spent by aircraft 56 km (30 NM) or more off the cleared track shall be less than 5.3 × 10-4; and

c) the proportion of the total flight time spent by aircraft between 93 and 130 km (50 and 70 NM) off the cleared track shall be less than 1.3 × 10-5.

5.2.2 Except when operating on the special "Blue Spruce Routes" MNPS aircraft are required to carry two independent long range navigation systems.

5.2.3 No navigation requirements are specified for operations outside of the MNPS airspace within the Reykjavik CTA.

5.2.4 ISAVIA has analyzed the navigation capabilities of MNPS aircraft filed in received flight plans during three different periods, the most recent one being 16. September 2011 – 15. September 2012. The results were as follows:

	1. May 2009 – 30. April 2010		16. Sept 2010 – 15. Sept 2011		16. sept 2011 - 15. sept 2012	
MNPS only	33.118	24,3%	24.672	16,4%	24.010	16.6%
X, G	18.664	13,7%	32.334	21,4%	23.281	16.1%
X, RNP10	24.527	18,0%	20.319	13,5%	10.960	7.6%
X, RNP4	1.412	1,0%	1.186	0,8%	967	0.7%
X, G, RNP10	42.886	31,5%	54.157	35,9%	51.389	35.5%
X, G, RNP4	337	0,2%	1.208	0,8%	1.918	1.3%
X, RNP10, RNP4	1.426	1,0%	1.548	1,0%	3.290	2.3%
X, G, RNP10, RNP4	13.951	10,2%	15.370	10,2%	28.799	19.9%
Total MNPS FPLs	**136.321**		**150.794**		**144.614**	
GNSS equipage	75.838	55,6%	103.069	68,4%	105.387	72.9%
RNP10 equipage	82.790	60,7%	91.394	60,6%	94.438	65.3%
RNP4 equipage	17.126	12,6%	19.312	12,8%	34.974	24.2%
MNPS only	33.118	24,3%	24.672	16,4%	24.010	16.6%
GNSS and/or RNP10 and/or RNP4	103.203	75.7%	126.122	83.6%	120.604	83.4%

5.2.5 Comparison between the data for the three time periods indicates the following:

a) In the first time period 75.7% of aircraft filing MNPS capability were also equipped with GNSS or approved for RNP4 or RNP10. This increased to 83.6% in the second period and then remained stable at 83.4% in the third period.

b) The number of RNP 10 approved MNPS aircraft remained constant at 60.7% and 60.6% in the two first time periods but increased to 65.3% in the third time period.

c) The number of RNP 4 approved MNPS aircraft remained constant at 12.6% and 12.8% in the two first time periods but increased to 24.2% in the third time period.

d) The number of MNPS only aircraft decreased from 24.3% to 16.4% between the first and second time periods and then remained constant at 16.6% in the third time period.

e) The number of GNSS equipped MNPS aircraft increased from 55.6% in the first time period to 68.4% in the second time period to 72.9% in the third time period.

5.2.6 MNPS aircraft navigate mostly using GNSS and IRS/INS. Several ground based navigations aids such as VOR, NDB and DME are available in Iceland, Faroe Islands and Greenland but those aids are scarce and far between and do therefore not significantly contribute towards the navigation performance.

5.2.7 Isavia have also analyzed the GNSS equipage of non-MNPS flights during the period 16. September 2011 – 15. September 2012. Domestic flights within Iceland were excluded. The result is:

Total number of non-domestic non-MNPS flight plans:	18.291	
GNSS equipped non-domestic non-MNPS flights:	11.719	64.1%

5.2.8 Isavia have also analyzed the GNSS equipage of Domestic flights in Greenland as well as those flights that are departing from Greenland and arriving to Greenland during the calendar year of 2012. The result is that out of the total number of flights which is **5.960** the number of flights equipped with GNSS ("G" in FPL Item 10a) is **4.472** or **75%**.

5.3 Surveillance

5.3.1 ATS Surveillance service is currently provided with seven SSR radar stations; five stations in Iceland, one station in the Faroe Islands and one station in the Shetland Islands (see figure below).

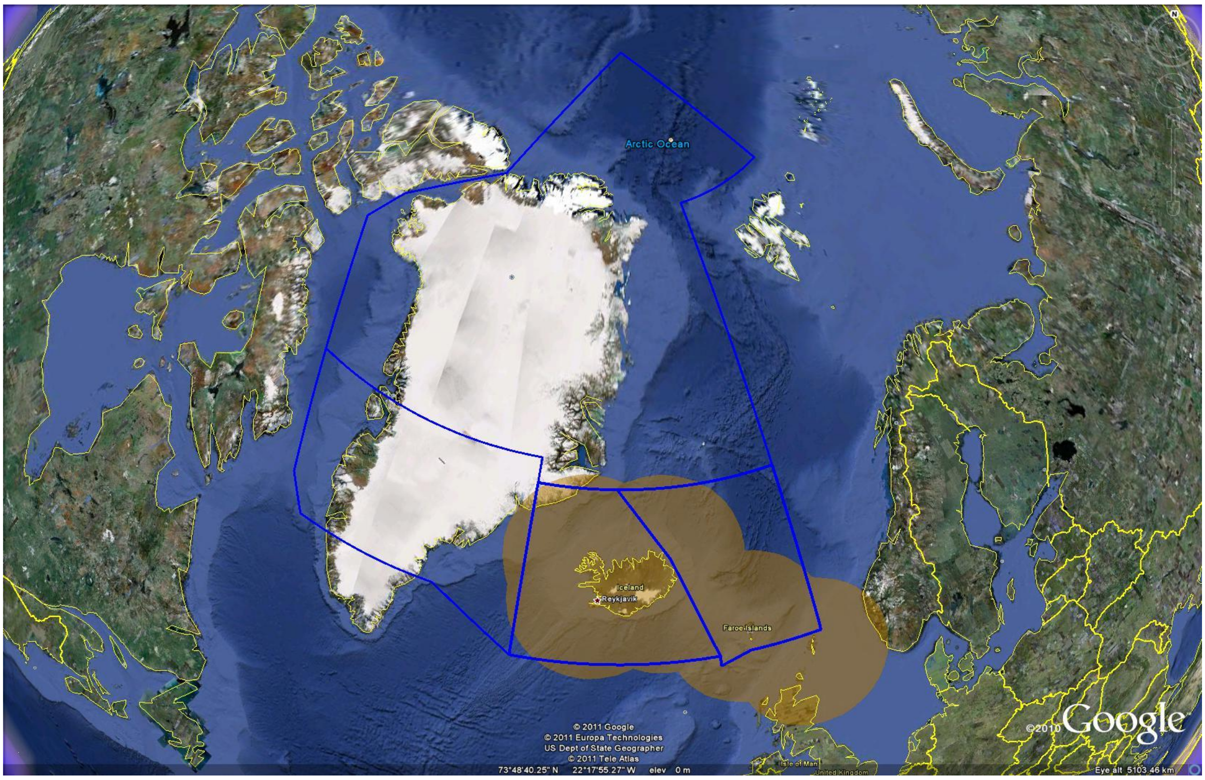


Figure 9: Current radar coverage at jet levels

5.3.2 The radar surveillance allows the system to provide more economical flight profiles to flights in the South- and East sectors than could be provided in a procedural system. The radar system also provides lateral- and vertical conformance monitoring against the cleared oceanic flight profile.

5.3.3 Surveillance data is otherwise provided to the Reykjavik ATC system by:

- Voice position reports via HF, general purpose VHF and SATCOM via Iceland radio and other radio stations.
- Position reports via FANS1/A ADS-C.
- Position reports via FMS position reporting.

5.3.4 Surveillance data is presented to the controller on an Integrated Situation Display System (ISDS) displaying radar tracks and FDPS generated CPL tracks where no radar data is available. Distinction between radar- and CPL tracks is done using symbology and color coding (see figure below).

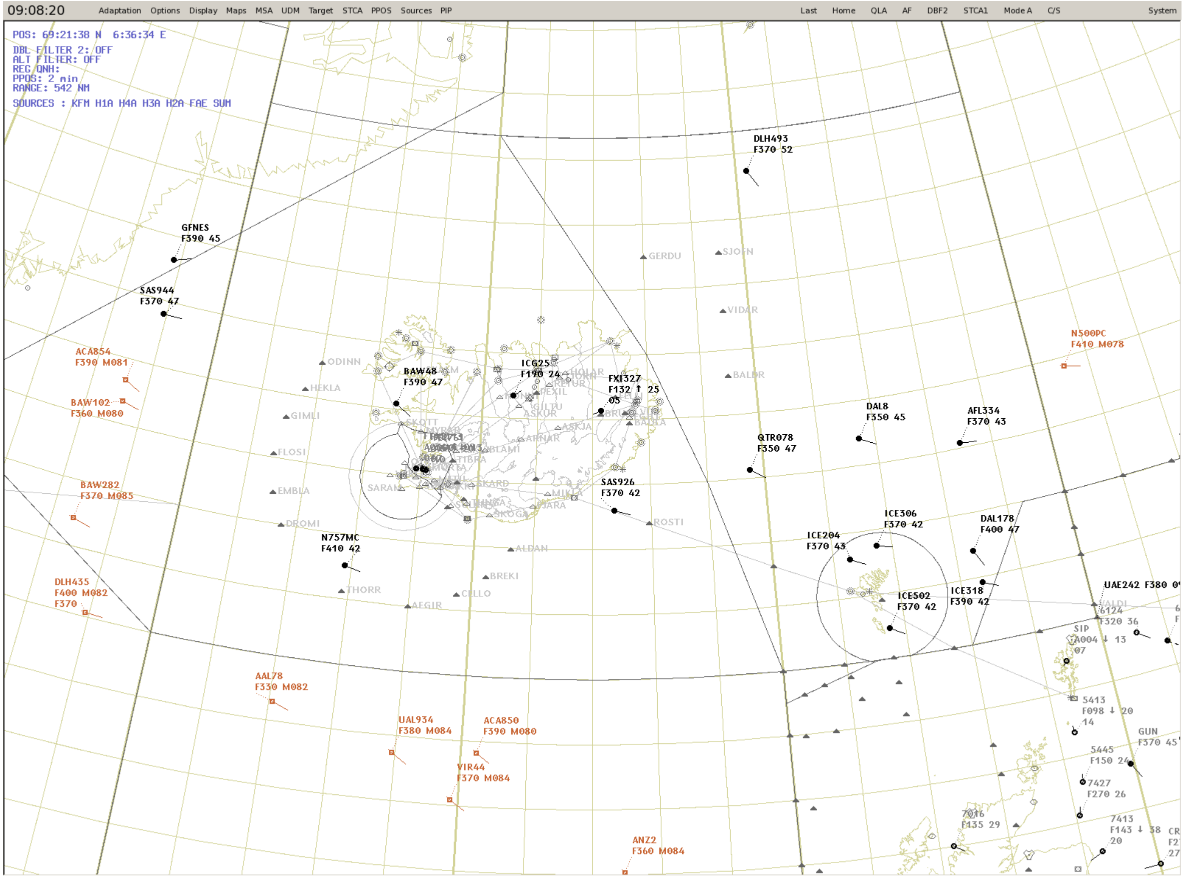


Figure 10: Integrated Situation Display System (ISDS)
(special print colors are shown)

5.4 ATC System

5.4.1 The air traffic control systems employed in the Reykjavik control center are:

- Flight Data Processing System (FDPS) providing:
  - General flight data processing.
  - Electronic flight progress strips.
  - Automatic internal and external coordination.
  - Conflict probing.
  - Flight progress calculation based on a weather model.
  - FANS1/A ADS-C and CPDLC.
  - ARINC 623 Oceanic clearance delivery.
- Integrated Situation Display System and radar data processing system providing:
  - Multi Radar data processing.
  - Air situation picture showing both radar and CPL tracks.
  - Short Term Conflict Alerting (STCA).
  - Lateral- and vertical conformance monitoring against the cleared oceanic flight profile.
  - Functionality to graphically display flight profiles, estimates, crossing times, special use airspace etc.
- Voice Communication System for both internal and external voice communication.

6 Determination of the Proposed System and Operational Application

6.1 The proposal is for a phased implementation of the following lateral separation standards:

a) Phase 1 Spring 2013:

i) 20 NM lateral separation between GNSS equipped aircraft on parallel or non-intersecting tracks or ATS routes, while one aircraft climbs/descends through the level of another aircraft, using communications other than DCPC VHF voice.

ii) 20 NM lateral separation between GNSS equipped aircraft on intersecting tracks or ATS routes, using communications other than DCPC VHF voice. This separation is larger than the 15 NM separation specified in the SASP proposal. Isavia however prefer for practical reasons to have the separation value for intersecting tracks and non-intersecting tracks identical.

b) Phase 2 End-of-year 2013:

i) 15 NM lateral separation between GNSS equipped aircraft on parallel or non-intersecting tracks or ATS routes, applicable at the same level or while one aircraft climbs/descends through the level of another aircraft, using DCPC VHF voice communications.

ii) 15 NM lateral separation between GNSS equipped aircraft on intersecting tracks or ATS routes, using DCPC VHF voice communications.

iii) 7 NM lateral separation between GNSS equipped aircraft on parallel or non-intersecting tracks or ATS routes, while one aircraft climbs/descends through the level of another aircraft, using DCPC VHF voice communications.

6.2 The separation detailed above will only apply below F285 and will therefore not be applicable within the MNPS airspace.

6.3 GNSS equipage is indicated by means of the letter "G" in Item 10a of the ICAO flight plan and is displayed to the controller on the electronic flight progress strip. According to the PANS-ATM the inclusion of the letter "G" in the ICAO flight plan signifies the following:

a) the presence of relevant serviceable GNSS equipment on board the aircraft; and

b) GNSS equipment and capabilities are commensurate with flight crew qualifications; and

c) where applicable, authorization from the appropriate authority has been obtained.

6.4 Initially, the separation will not be integrated into the conflict probe software in the Reykjavik FDPS. For non-MNPS aircraft the system probes for full 120 NM lateral separation. Unit directives will be updated to allow controllers to apply the separation specified 6.1 above when the required conditions are satisfied. Graphical representation of routes on the Integrated Situation Display System enables the controller to accurately measure the distance between aircraft cleared tracks and this system will therefore support the application of the separation.

6.5 Domestic separation is in general not programmed in the Reykjavik FDPS conflict probe (VOR separation, DME separation etc.). The feasibility of integrating the separation in 6.1 above into the conflict probe will be considered in the future based on the outcome of the trial.

6.6 New waypoints and routes will be added to the airspace as deemed required to make the application of the separation practical.

6.7 The method of applying the separation in 6.1 is identical to the methods of application of the NAT lateral separation standards. The controllers are therefore already fully trained and experienced in the application of this type of separation.

6.8 The separation in 6.1 is less than the separation currently applied in the adjacent Edmonton and Gander areas. The Reykjavik controllers are already trained in the application of the separation that is applicable in those areas and training will include the required awareness that aircraft must be transferred to the adjacent area with the required separation before the aircraft cross the common boundary. Other interfaces will not be affected by the new separation. SF FIC, SF APP and TL CTA will be briefed on the new separation.

6.9 The intention is to use the new separation for aircraft departing and arriving from/to BGGH which is located within the Gander area of common interest. Discussions will be effected with Gander to seek approval for the application of the new separation for those flights within the area of common interest.

6.10 The planned start of the operational trial for the separation in 6.1 a) is in the spring 2013 timeframe. The planned start of the operational trial for the separation in 6.1 b) is in the end-of-year 2013 timeframe. Details of the implementation will be published in an AIC and exact implementation dates will be promulgated via NOTAM.

7 Identification of the Method of Safety Assessment

7.1 Collision risk of the separation specified in section 6.1 has been evaluated by full collision risk modeling performed by the ICAO Separation and Airspace Safety Panel (SASP) as described in Attachment B.

7.2 Isavia compared the assumptions in the collision risk modeling to the Greenland environment to ensure that it falls within the scope of the SASP collision risk modeling.

7.3 Isavia will conduct an implementation safety assessment including Functional Hazard Assessment.

8 Evaluation of the Risk

8.1 General

8.1.1 The safety assessment done by the SASP for the separation standards specified in 6.1 is documented in the draft ICAO Circular *Guidelines for the Implementation of Lateral Separation Minima* (see Attachment B). The work was completed at the SASP WG/WHL/20 meeting in May 2012 and subsequently sent to the ICAO ANB for further processing and publication. The SASP safety assessment is contained in Chapter 3 of the document and the SASP implementation hazard log is contained in the draft Circular Attachment A.

8.1.2 The draft Circular states in paragraph 3.3.6:

> 3.3.6 The assessment of the collision risk due to navigation performance complies with the guidance from the *Manual on Airspace Planning Methodology for the Determination of Separation Minima* (Doc 9689) concerning the "Evaluation of system risk against a threshold" method.

8.1.3 The draft Circular states in paragraph 3.3.5:

> 3.3.5 The minimum spacing between parallel tracks and the minimum distance of a lateral separation point are considered to be "safe" when
>
> a) The level of aircraft collision risk (made up of the collision risks due to typical and atypical navigation performance) does not exceed a target level of safety (TLS) of 5×10^{-9} fatal aircraft accidents per flight hour; AND
>
> b) The risk due to all other hazards is "negligible".

8.1.4 For the 7 NM and 20 NM separation which is applicable for aircraft climbing or descending through the level of another such aircraft the following approach was however taken by the SASP and is described in the following sections of the draft Circular:

> 3.7.2 The estimate of the procedure's collision risk used some of the principles of the well-known "Reich model"; however, its result was not given as a rate of accidents, but rather as the probability of collision in a typical execution of the procedure.
>
> 3.7.4 In most of the SASP's work on separation minima, the TLS has been stated as a maximum tolerable rate of fatal accidents due to the loss of planned separation (in one or another of the three dimensions), and expressed in units of fatal accidents per flight-hour. Since a TLS is generally applied to all of the operations in any given airspace, the risk attributable to the climb or descent procedure would be added to the sum of all of that airspace's other estimates of the rate of fatal accidents due to the loss of planned lateral separation. These other estimates would normally vary from one airspace to another; and so the unused risk budget available for the climb or descent procedure would also vary from one airspace to another.
>
> 3.7.5 In order to avoid the possibility that different airspace management agencies might impose different separation minima for the procedure, the SASP decided to use another metric for the TLS. In its work on separations for terminal routes the panel had applied a TLS expressed as a maximum tolerable probability of collision for a typical pair of airplanes, one arriving at an airport while the other was departing from it. (See section 3.5.2 of reference 2.) The SASP adopted a similar TLS for its work on the climb or descent procedure, i.e., the maximum tolerable probability of a collision in a typical execution of the procedure. The numerical value of the TLS was taken to be 5×10^{-10}, the same value used for the SASP's work on terminal routes.

8.2 15 NM Lateral Separation on non-Intersecting Tracks

8.2.1 The SASP safety assessment for the application of 15 NM lateral separation between GNSS equipped aircraft operating on non-intersecting tracks is documented in the draft Circular section 3.6.

8.2.2 The following assumptions were made during the safety assessment by SASP with regard to the operational scenario and the collision risk model and which affect the operational implementation:

Assumption	Isavia implementation
Aircraft are either GNSS-equipped with integration of the GNSS receiver into the FMS and the cockpit course deviation indicator display, or have GNSS-approved and certified equipment. The modelling was not intended to apply to aircraft with only an onboard, uncertified hand-held GNSS receiver. (Draft Circular paragraph 3.6.6 refers).	Isavia will use the GNSS equipage indication “G” in Item 10a of the ICAO flight plan which is displayed to the controller on the electronic flight progress strip. According to the PANS-ATM the inclusion of the letter “G” in the ICAO flight plan signifies the following: a) the presence of relevant serviceable GNSS equipment on board the aircraft; and b) GNSS equipment and capabilities are commensurate with flight crew qualifications; and c) where applicable, authorization from the appropriate authority has been obtained.
Aircraft fly between designated waypoints on a defined route with knowledge of the nominal track. A cockpit course deviation indicator (CDI) would show lateral departures from this nominal track. (Draft Circular paragraph 3.6.7 refers).	Aircraft will be cleared on direct tracks between published waypoints or along published routes. The use of ad-hoc Latitude/Longitude waypoints may be allowed subject to a positive outcome of a safety assessment (refer to draft Circular hazard log Subject 6).
Communications between pilot and controller are at least as good as VHF-voice. (Draft Circular paragraph 3.6.8 refers).	For the application of this separation DCPC VHF voice communications will be prescribed.
There is no surveillance requirement. Results are intended to apply to a procedural separation environment, however surveillance would reduce the mid-air collision risk calculated by the modeling. (Draft Circular paragraph 3.6.9 refers).	Surveillance will be by means of position reports provided by the pilot via DCPC VHF voice communications.
Aircraft navigate by GNSS as primary means. The density of ground-based navigation aids may be low. (Draft Circular paragraph 3.6.10 refers).	When aircraft file GNSS navigation capability in the filed flight plan it is assumed that the GNSS navigation system is the primary navigation system.

Assumption	**Isavia implementation**
A RAIM outage is assumed to be detected by the pilot, reported to ATC within two minutes, and an alternate navigation means established within five minutes of the start of the outage. (Draft Circular paragraph 3.6.11 refers).	The AIC specifies the following: If the letter "G" has been included in Item 10 of the FPL the pilot shall immediately inform ATC of any deterioration of navigation performance, including loss of GNSS integrity. RAIM warnings shall be reported immediately to ATC.
A cockpit course deviation indicator (CDI) was assumed to be set to show +/- 5 NM either side of the nominal track in enroute mode (Basic-GNSS). A pilot (or autopilot) can reasonably be expected to fly within half of the full-scale deflection. (Draft Circular paragraph 3.6.17 refers).	The AIC specifies the following: In application of the separation standards specified in section 3 above the following assumptions are made concerning the navigation accuracy: For Basic-GNSS navigation systems a course deviation indicator (CDI) is assumed to be set to show +/- 5 NM either side of the nominal track in enroute mode. A pilot (or autopilot) is expected to fly within half of the full-scale deflection 95% of the flying time. or ensure that the CDI scaling is 5 NM or less.
The traffic density used had a typical aircraft passing/being passed by 1 same direction aircraft and 3 opposite direction aircraft on an adjacent parallel route at the same flight level every flight hour, i.e. $N_x(same) = 1$ and $N_x(opp) = 3$ passings per flight hour were assumed. Aircraft dimensions were risk-conservatively set at Airbus A380 values. (Draft Circular paragraph 3.6.19 refers).	The assumed traffic density is much higher than the actual traffic density in the Greenland airspace below F285. The aircraft operating in the airspace are much smaller than the A380.

8.2.3 Both typical and atypical navigational errors were included in the modeling. Typical errors may be present in normal flight. The three sources of typical lateral navigational error included were: GNSS navigational error; navigational error in the event of a RAIM outage; and flight technical error (draft Circular paragraph 3.6.12 refers).

8.2.4 The results of the collision risk modeling for typical navigation error are documented in the draft Circular section 3.6.20 as follows:

> 3.6.20 Substitution of all the collision risk model parameter values into the model resulted in the collision risk due to the loss of planned lateral separation and typical lateral navigational error being estimated as $N_{ac} = 7.68 \times 10^{-10}$ fatal accidents per flight hour. This estimate is well beneath the target level of safety (TLS) of 5×10^{-9} fatal accidents per flight hour, leaving some room for collision risk due to the loss of planned lateral separation and atypical navigational error.

8.2.5 The conclusions concerning atypical navigation errors are documented in the draft Circular section 3.6.21 as follows:

3.6.21 Atypical navigational errors include gross operational errors and large uncorrected deviations. They were modeled by a Double Exponential distribution and carried through the calculations. One example was given in which the scale parameter of the Double Exponential distribution was set conservatively to $\lambda_E = 15$ NM and an atypical error weighting factor $\beta = 2.76 \times 10^{-7}$ led to a risk N_{ac} just under the TLS of 5×10^{-9} fatal accidents per flight hour. It is therefore possible to have the collision risk under the TLS in 15 NM lateral separation of RNP 2 aircraft on parallel routes with operational error dominating the risk budget.

8.3 7 NM and 20 NM Lateral Separation between GNSS aircraft climbing/descending through the level of another such aircraft on parallel or non-intersecting tracks or ATS routes

8.3.1 The SASP safety assessment for the application of 7 NM and 20 NM lateral separation between GNSS equipped aircraft climbing or descending through the level of another such aircraft is documented in the draft Circular section 3.7.

8.3.2 The following assumptions were made during the safety assessment by SASP with regard to the operational scenario and the collision risk model and which affect the operational implementation:

Assumption	Isavia implementation
The collision risk model in eq. (3.7.1) was applied for two different cases of communication, namely direct controller-pilot VHF voice communication, and communication through a third party. Paragraph 3.7.25 explains how these two cases influenced the SASP's choice of values for one of the critical parameters underlying the collision risk model. (Draft Circular paragraph 3.7.6 refers).	Isavia will implement the 7 NM separation in a DCPC VHF environment and the 20 NM separation for other types of communication.
The airplanes involved in the procedure are assumed to be flying on parallel paths. (Draft Circular paragraph 3.7.7 refers).	Isavia will implement the separation on track segments that are non-intersecting and "near parallel".
Both of the airplanes involved in the procedure – the one that is climbing or descending, and the one that is maintaining its flight level – are assumed to be using the global navigation satellite system (GNSS) to navigate. (Draft Circular paragraph 3.7.18 refers).	Isavia will use the GNSS equipage indication "G" in Item 10a of the ICAO flight plan which is displayed to the controller on the electronic flight progress strip. According to the PANS-ATM the inclusion of the letter "G" in the ICAO flight plan signifies the following: a) the presence of relevant serviceable GNSS equipment on board the aircraft; and b) GNSS equipment and capabilities are commensurate with flight crew qualifications; and c) where applicable, authorization from the appropriate authority has been obtained.

8.3.3 The parameter α ($0<\alpha<1$) is the fraction of flying time during which airplanes commit atypical errors. After reviewing summaries of North Atlantic performance in recent years, and recognizing that concerted North Atlantic efforts to improve navigation had yielded significant reductions in that region's empirically estimated values of α, the SASP chose values that it believed to be reasonably conservative: $\alpha = 6\times10^{-5}$ when direct controller-pilot communication (DCPC) is available, and $\alpha = 2\times10^{-4}$ when communication between controllers and pilots is accomplished through a third party (Ref. 3.7.8). (Draft Circular paragraphs 3.7.19 and 3.7.25 refer).

8.3.4 The results of the collision risk modeling are documented in the draft Circular section 3.7.26 as follows:

> Using these values in the table for which $\sigma_L = 5/6$ NM, the SASP found that the pair ($S = 7$ NM, $\alpha = 6\times10^{-5}$) yielded $\text{Prob}\{collision\} = 4.24\times10^{-10}$, and the pair ($S = 20$ NM, $\alpha = 2\times10^{-4}$) yielded $\text{Prob}\{collision\} = 4.91\times10^{-10}$. These were the smallest integer values of S for which the collision probabilities (at the chosen values of α) were less than the TLS of 5×10^{-10}. Therefore, the SASP recommended to the ICAO Air Navigation Commission that the climb-or-descent procedure use a lateral separation minimum of 7 NM when DCPC is available, and a lateral separation minimum of 20 NM when controller-pilot communication is accomplished through a third-party provider of communication services.

8.4 15 NM Lateral Separation between GNSS aircraft operating on intersecting tracks

8.4.1 The SASP safety assessment for the application of 15 NM lateral separation between GNSS equipped aircraft operating on intersecting tracks is documented in the draft Circular section 3.8 and specifically in 3.8.2.

8.4.2 The following assumptions were made during the safety assessment by SASP with regard to the operational scenario and the collision risk model and which affect the operational implementation:

Assumption	Isavia implementation
The 15 NM lateral separation minimum on intersecting tracks was developed to exploit the advanced navigational capabilities of enroute GNSS-equipped aircraft in a VHF-voice communications environment, but with no requirement for surveillance to be present. (Draft Circular paragraph 3.8.2.2 refers).	Refer to section 9 below.
Aircraft are either GNSS-equipped with integration of the GNSS receiver into the FMS and the cockpit course deviation indicator display, or have GNSS-approved and certified equipment. The modeling was not intended to apply to aircraft with only an onboard, uncertified hand-held GNSS receiver. (Draft Circular paragraph 3.8.2.4 refers).	Isavia will use the GNSS equipage indication “G” in Item 10a of the ICAO flight plan which is displayed to the controller on the electronic flight progress strip. According to the PANS-ATM the inclusion of the letter “G” in the ICAO flight plan signifies the following: a) the presence of relevant serviceable GNSS equipment on board the aircraft; and b) GNSS equipment and capabilities are

Assumption	**Isavia implementation**
	commensurate with flight crew qualifications; and c) where applicable, authorization from the appropriate authority has been obtained.
Aircraft fly between designated waypoints on a defined route with knowledge of the nominal track. A cockpit course deviation indicator (CDI) would show lateral departures from this nominal track. (Draft Circular paragraph 3.8.2.5 refers).	Aircraft will be cleared on direct tracks between published waypoints or along published routes. The use of ad-hoc Latitude/Longitude waypoints may be allowed subject to a positive outcome of a safety assessment (refer to draft Circular hazard log Subject 6).
Communications between pilot and controller are at least as good as VHF-voice. (Draft Circular paragraph 3.8.2.6 refers).	Refer to section 9 below.
There is no surveillance requirement. Results are intended to apply to a procedural separation environment, however surveillance would reduce the mid-air collision risk calculated by the modeling. (Draft Circular paragraph 3.8.2.7 refers).	Surveillance will be by means of position reports provided by the pilot via DCPC VHF voice communications.
Aircraft navigate by GNSS as primary means. The density of ground-based navigation aids may be low. (Draft Circular paragraph 3.8.2.8 refers).	When aircraft file GNSS navigation capability in the filed flight plan it is assumed that the GNSS navigation system is the primary navigation system.
A RAIM outage is assumed to be detected by the pilot, reported to ATC within two minutes, and an alternate navigation means established within five minutes of the start of the outage. (Draft Circular paragraph 3.8.2.9 refers). A description of the modeling of navigational error in the event of a RAIM outage is included for the sake of completeness, but the possibility of a RAIM outage was ignored in the calculations due to the short duration of the crossing procedure. (Draft Circular paragraph 3.8.2.10 refers).	Refer to section 9 below.
A cockpit course deviation indicator (CDI) was assumed to be set to show +/- 5 NM either side of the nominal track in enroute mode (Basic-GNSS). A pilot (or autopilot) can reasonably be expected to fly within half of the full-scale deflection. (Draft Circular paragraph 3.8.2.15 refers).	The AIC specifies the following: In application of the separation standards specified in section 3 above the following assumptions are made concerning the navigation accuracy: For Basic-GNSS navigation systems a course deviation indicator (CDI) is assumed to be set to show +/- 5 NM either side of the nominal track in enroute mode. A pilot (or autopilot) is expected to

Assumption	Isavia implementation
	fly within half of the full-scale deflection 95% of the flying time. or ensure that the CDI scaling is 5 NM or less.
The calculations were performed for five crossing pairs of GNSS aircraft per hour with intersection angles from 5 degrees to 175 degrees. (Draft Circular paragraph 3.8.2.18 refers).	The assumed traffic density is much higher than the actual traffic density in the Greenland airspace below F285.

8.4.3 Both typical and atypical navigational errors were included in the modeling. Typical errors may be present in normal flight. The three sources of typical lateral navigational error included were: GNSS navigational error; navigational error in the event of a RAIM outage; and flight technical error (draft Circular paragraph 3.8.2.10 refers).

8.4.4 The results of the collision risk modeling for typical navigation error are documented in the draft Circular section 3.8.2.19 as follows:

> The calculations were again performed for five crossing pairs of GNSS aircraft per hour with intersection angles from 5 degrees to 175 degrees. As before, for each intersection angle, the **maximum** collision risk was calculated. The largest (maximum) collision risk was of the order of 10^{-18} without speed errors and 10^{-17} when speed errors with a scale parameter value of 20 kts were included. These values are well below a target level of safety (TLS) of 5×10^{-9} fatal accidents per flight hour. The largest (maximum) values occurred again for the extreme angles of 5 degrees and 175 degrees.

8.4.5 The considerations concerning atypical navigation errors is documented in the draft Circular section 3.8.2.23 – 3.8.2.24 as follows:

> 3.8.2.23 The most likely high-consequence operational error was identified as aircraft 2 failing to reach a vertically separated level by the edge of the protected area and continuing through the track of aircraft 1 at the same flight level. For a single pair of GNSS aircraft and a protected area half-width of 15 NM and for a number of angles the maximum collision risk was approximately 0.02 (unpublished). Averaging over the initial positions of aircraft 1 would reduce this risk considerably and the occurrence rate for this operational error would also be small.
>
> 3.8.2.24 The operational errors are essentially the same for the protected area scenario as they are for PANS-ATM paragraph 5.4.1.2.1.2. For angles other than 90 degrees the protected area method of lateral separation provides greater protection against operational error than the PANS-ATM paragraph 5.4.1.2.12 method since the distance from the intersection at which aircraft 2 climbs or descends is greater (Ref. 3.7.7). It is also possible to require a buffer before (and after) the protected area to further reduce the collision risk

8.5 SASP Conclusions

8.5.1 The SASP conclusions concerning the safety assessment are documented in the draft Circular section 3.10 as follows:

> 3.10.1 The application of the SASP process demonstrated that the separation minima developed and detailed in this document have been determined as being safe. SASP also identified a number of hazards together with appropriate mitigations and controls.

3.10.2 Notwithstanding the above, there is a requirement for a Region or State to undertake an implementation safety assessment. In principle, this comprises two parts, namely a safety assessment for navigation performance and a hazard assessment. In practice, only a hazard assessment needs to be performed for any local implementation since the safety assessment for the navigation performance under the various navigation specifications is valid for any implementation. The hazard analysis is to identify hazards and related mitigation measures that are specific to the local situation.

9 Communications – Intersecting track separation

9.1 Section 3.8 of the draft Circular deals with the intersecting track separation and section 3.8.2 specifically deals with the 15NM lateral separation between GNSS/RNP2 aircraft on intersecting tracks. Paragraph 3.8.2.6 states "*Communications between pilot and controller are at least as good as VHF-voice*". It is believed that this is an error in the draft Circular and is being confirmed with members of the SASP. While the SASP decided to require DCPC VHF voice for the 15NM separation on non-intersecting tracks this was not intended for the intersecting track separation and this is reflected in the proposed PANS-ATM amendment.

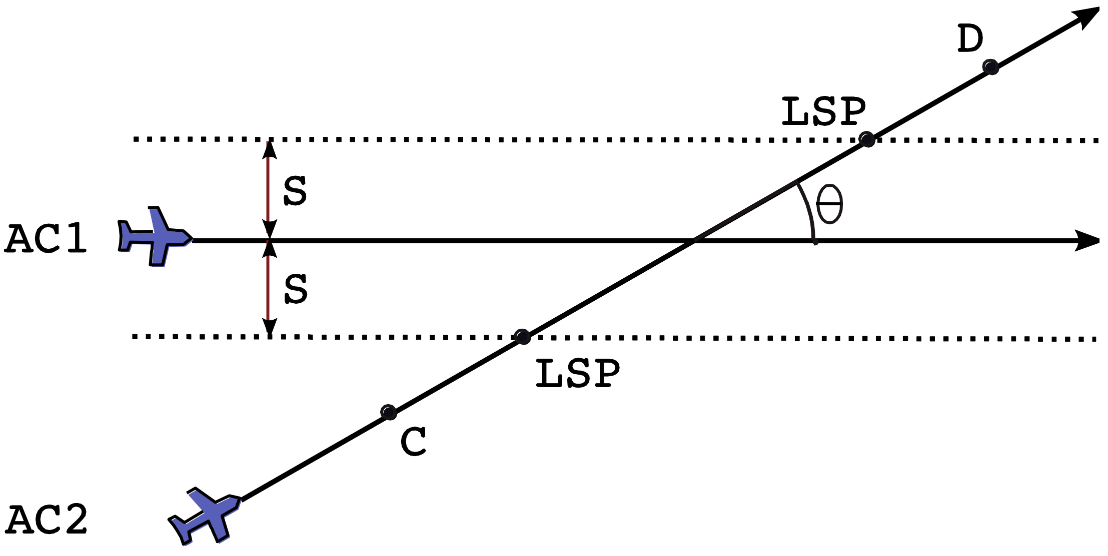
9.2 The SASP safety work for the intersecting track separation was presented in WP49 of the SASP WG/WHL/13 meeting. The work does not at all mention specific communication performance or specific types of communication medium.

9.3 The only mention of communications that can be found is in draft Circular paragraph 3.8.2.9 which states that "*A RAIM outage is assumed to be detected by the pilot, reported to ATC within two minutes and an alternate navigation means established within five minutes of the start of the outage*". But subsequently in the next paragraph (3.8.2.10) it is stated that "*A description of the modeling of navigational error in the event of a RAIM outage is included for the sake of completeness, but the possibility of a RAIM outage was ignored in the calculations due to the short duration of the crossing procedure*". This issue was therefore ignored in the calculations and the SASP mathematicians have now confirmed that Communications between pilot and controller were assumed to be such that the aircraft will comply with any climb/descent clearance before/after the specified location.

9.4 The draft PANS-ATM amendment (which can be found in Chapter 2 of the Circular) specifies DCPC VHF voice for the 15 NM separation on parallel and non-intersecting tracks. This is however not specified for the 15 NM lateral separation on intersecting tracks. This issue was discussed extensively in SASP and it was decided that due to the many possible permutations in the application of lateral separation on intersecting tracks, it was not feasible for the SASP to proscribe the communication performance. This is reflected in Subject 2 of the Hazard log in the Circular where the following is stated: "*The possible permutations in the application of lateral separation are many and the SASP does not consider it feasible to prescribe for all the lateral separation minima on globally applicable basis the communication to be used in each case. This task is left to the appropriate ATS authority to determine when the communication requirements are not specified with the separation minima*".

9.5 It can be seen that the statement in the Circular paragraph 3.8.2.6 creates a contradiction with the PANS-ATM amendment proposal.

9.6 The following revision to the Circular paragraph 3.8.2.6 is being coordinated within the SASP:



(This is figure 3.8.1.1 in the draft Circular)

3.8.2.6 Communications between pilot and controller are assumed to be such that the aircraft will comply with any climb/descent clearance before/after the specified location . It is assumed that the implementing authority will assess the communication capability requirements (controller intervention capability) for a given application of the separation.

Example: (refer to figure 3.8.1.1)

Scenario 1:

AC1 is at F230 and AC2 is at F250. AC2 is cleared to descend to F210 after passing the second Lateral Separation Point (LSP) in the figure.

Scenario 2:

Both aircraft are at F230. AC2 is cleared to climb to F250 before passing the first LSP in the figure.

From a communication performance point of view these are two very different situations that are handled differently by ATC procedures. In Scenario 2 the controller should not let AC2 run close to the LSP before issuing the climb clearance unless he has reliable communications whereas in Scenario 1 the reliability of the communications is not as important from a controller intervention capability point of view because the aircraft are vertically separated to start with.

9.7 Isavia has therefore decided the following concerning the application of the new lateral separation minima on intersecting tracks:

a) The 15 NM separation will only be used if DCPC VHF voice communication exists with both aircraft and will be applied to aircraft at the same level as well as to climb/descend through situations.

b) 20 NM lateral separation will be applied to aircraft using communications other than DCPC VHF voice and will only be applied to situations where one aircraft is climbing/descending through the level of the other aircraft. The separation will not be applied to aircraft maintaining the same flight level.

10 Assessment of the SASP Hazard Log

10.1 Isavia has done a preliminary assessment of the SASP hazard log with regards to the implementation in the Greenland environment. The assessment is detailed below. The end results are subject to detailed functional hazard assessments which is in progress.

Subject 1 – Application of Separation
Hazard Loss of separation.
Unsafe Event (cause) A failure of the process by which controllers apply lateral separation based on the cleared route, position reports, pilot reported distances from waypoints/fixes and climb/descend clearances with restrictions. Those methods are designed to ensure that, when applying lateral separation, aircraft are never separated by less than the applicable minima.
Analysis The distances specified in PANS-ATM paragraphs 5.4.1.2.1.6 and 5.4.1.2.1.7 are minimum separation values. In reality aircraft are often (most of the time) spaced by larger values when applying this separation. The track geometry depends on local airspace design. Minima close to the intersecting track standard could effectively be used in association with altitude restrictions such as "*maintain an altitude until a certain position*" or "*reach an altitude by a certain position*". Controllers apply the lateral separation based on: a) the cleared route of the aircraft; and b) position reports; and c) reported distances from a waypoint or a fix; and when required d) a climb/descent clearance with a restriction. It is important to note that controllers are not required to determine the actual ground distance between any two aircraft when applying this type of lateral separation. In the case of non-intersecting tracks the controller determines the distance between the tracks as measured perpendicular between the track centerlines. In the case of intersecting tracks, the controller ensures that at least one of the aircraft does not get closer to the track of the other aircraft than the applicable minimum lateral separation unless longitudinal or vertical separation exists. In many (or most) cases, in normal operations, aircraft will be separated by more than the required minimum separation.
SASP global controls and/or mitigators SASP has done a collision risk assessment that demonstrates that the estimated collision risk based on the use of the lateral separation discussed in this document is sufficiently small (refer to chapter 3 for a description of the collision risk assessment).

Subject 1 – Application of Separation
Regional and local controls and/or mitigators required 1) All instances of loss of separation related to this separation minima must be reported and investigated. 2) The ATS authority intending to apply this separation must ensure that the airspace and route design is such that the application of this separation is practicable. 3) The ATS authority intending to apply this separation must ensure that the amount of traffic is not more than can be safely handled by this type of separation. 4) The ATS authority intending to apply this separation must ensure that appropriate training concerning the application of separation is provided to controllers.
Isavia implementation: 1) Isavia already has in place a safety management system where incidents are reported and investigated. All such events are also reported to the NAT Central Monitoring Agency (CMA). 2) Waypoints and routes will be setup in a way to facilitate the application of the separation with distances between the waypoints and routes taking account of the separation. 3) The low level Greenland airspace in the Reykjavik CTA can be split into two separate sectors, north and south of 7030N. The amount of low level traffic in Greenland is small enough to be easily handled by those two sectors. 4) Air traffic controllers will receive both theoretical and simulator training. This training process will be aided by the fact that all Reykjavik controllers are already trained in the application of this type of lateral separation.

Subject 2 – Communications
Hazard Loss of separation.
Unsafe Event (cause) Use of inappropriate communication media.
Analysis For some of the lateral separation standards the communication media is explicitly described in the PANS-ATM whereas for other standards the determination of the required communication is left to the appropriate authority. Using appropriate communication media is paramount in ensuring the timely communication of clearances to aircraft for intervention purposes. The application of lateral separation requires the necessary clearances be communicated to the pilot in a timely manner to ensure that alternative separation is established before lateral separation is eroded. The communication media and the reliability of the media is also important in ensuring that the controller has the required intervention capability when an actual or potential loss of separation is detected. Additionally the amount of traffic being handled in the airspace must not be more than what can be safely handled by communication infrastructure. The possible permutations in the application of lateral separation are many and the SASP does not consider it feasible to prescribe for all the lateral separation minima on globally applicable basis the communication to be used in each case. This task is left to the appropriate ATS authority to determine when the communication requirements are not specified with the separation minima.

Subject 2 – Communications
SASP global controls and/or mitigators The following paragraphs 5.2.1.4 and 5.2.1.5 have been added to the PANS-ATM: 5.2.1.4 Where communication requirements are not specified for the application of separation minima it is the responsibility of the appropriate ATS authority to determine these requirements by means of an appropriate safety assessment for each area of application. 5.2.1.5 Prior to and during the application of any separation minimum, the controller must consider the adequacy of the available communications, considering the time element required to receive replies from two or more aircraft, and the overall workload/traffic volume associated with the application of such minima.
Regional and local controls and/or mitigators required 1) Perform an implementation safety assessment in accordance with the PANS-ATM provisions quoted above. 2) Provide appropriate training to controllers regarding communication procedures and communication performance.
Isavia implementation: 1a) DCPC VHF voice communication will be used for the application of the 15 NM and 7 NM lateral separation on non-intersecting tracks in accordance with the draft PANS-ATM amendment. 1b) DCPC VHF voice communication will be used for the application of the 15 NM lateral separation on intersecting tracks in order to cater for the intervention capability required for converging aircraft at the same flight level. 1c) Third party VHF and HF communications will be used for the application of the 20 NM lateral separation on non-intersecting tracks in accordance with the draft PANS-ATM amendment. 1d) Third party VHF and HF communications will be used for the application of the 20 NM lateral separation on intersecting tracks in accordance with arguments provided in section 9 of this implementation plan. 2) All Isavia controllers are already fully trained regarding communication procedures and communication performance.

Subject 3 – Area Navigation

Subject 3 – Area Navigation
Hazard Loss of separation.
Unsafe Event (cause) A lack of awareness of the specifics of the difference between "TO-TO" and "TO-FROM" navigation may result in a controller applying intersecting track lateral separation incorrectly.
Analysis The GNSS receiver functions differently compared to conventional avionics receivers (i.e. DME). a) The GNSS receiver presents data to the pilot in reference to the waypoint the aircraft is approaching. Once an aircraft passes this waypoint, the GNSS receiver again sequences the next waypoint as the 'active' waypoint, and all information displayed is in reference to this new waypoint. This is referred to as "TO-TO" navigation. b) Some aircraft navigating using GNSS are not capable of flying an outbound track from a waypoint. Those aircraft always have to track towards a waypoint. c) In some cases, after passing fly-over waypoints, the aircraft will not join a track from the fly-over waypoint but rather join a track direct towards the next waypoint. While the concept of "TO-TO" navigation may pose a potential hazard, the safety analysis shows that technical risks are limited. The change from "TO-FROM" navigation to the "TO-TO" navigation introduces changes to the pilot's perspective in regard to their tools, tasks, and associated procedures and how the controller applies the separation. Those issues need to be addressed by means of training and awareness initiatives.
SASP global controls and/or mitigators 1) A paragraph 5.4.1.1.2.2 has been added to the PANS-ATM stating that *"Area navigation based track separation shall not be applied on tracks originating from fly-over waypoints".* 2) A note has been added to paragraph 5.4.1.2.1.2.5 of the PANS-ATM stating that "*It should be noted that some aircraft may not have the capability of flying an outbound track, radial or bearing which does not have a termination waypoint".*
Regional and local controls and/or mitigators required 1) Any risk associated with the different behavior of area navigation system as opposed to conventional VOR/NDB/DME systems should be mitigated by means of training and awareness initiatives. This is the responsibility of the appropriate ATS authority. 2) ATC should whenever practicable request distance to the next waypoint. Nevertheless, pilots should be advised by means of AICs or State AIPs, that position reports from other than 'TO' waypoints may be requested by ATC for the purpose of track and distance based separation. To this end, pilots should be reminded to be familiar with their avionics equipment so that this information can be provided as soon as practicable. It is the responsibility of the appropriate ATS authority to issue the appropriate guidance material to pilots. Following is an example of a suitable text for this purpose: *GNSS avionics typically display the distance to the next waypoint. To ensure proper separation between aircraft a controller may request the distance from a waypoint that is not the currently-active waypoint in the avionics; it may even be behind the aircraft. Pilots should be able to obtain this information from the avionics. Techniques vary by manufacturer, so pilots should ensure familiarity with this function.* 3) When establishing lateral separation points, it is important that coordination is effected among air traffic control, airspace planners and procedure designers when ATC require a lateral separation point to be published as a named waypoint.

Subject 3 – Area Navigation
Isavia implementation: 1) Isavia controllers have already received training concerning the use of GNSS for separation and the difference between GNSS and conventional navigation aids. The training done for the new separation minima will nevertheless refresh this knowledge. 2) The AIC contains the following text: *Compared to conventional avionics receivers such as the DME, GNSS receivers or FMSs incorporating GNSS input function differently, in that they always present distance information in reference to the next waypoint. Once an aircraft passes this waypoint, the GNSS receiver again sequences the next waypoint as the "active" waypoint, and all information displayed is in reference to it. This is referred to as "TO-TO" navigation as opposed to the old "TO-FROM" navigation of VOR/NDB/DME.* *In the application of the GNSS longitudinal separation the controller may request the distance from a waypoint that is not the currently-active waypoint in the avionics; it may even be behind the aircraft. Pilots should be able to obtain this information from the avionics. To this end, pilots are reminded to be familiar with their avionics equipment so that this information can be provided as soon as practicable.* 3) For this project coordination is done between air traffic control and airspace planners. Coordination is not required with procedure designers since this is enroute airspace.

Subject 4 – Database integrity
Hazard Loss of separation.
Unsafe Event (cause) Loss of integrity in a database may result in incorrect waypoint information in the aircraft and ATM system navigation database.
Analysis Database integrity issues are common to all aspects of area navigation and to the application of all separation minima that employ area navigation. This issue is therefore not specific to the application of lateral separation. With the implementation of area navigation procedures, the handling of navigation data is a significant aspect of safe operations. Its importance increases as operations move away from traditional procedures and routes based on flying "to and from" ground-based NAVAIDs. Data base integrity relies on minimizing errors throughout the entire data chain, commencing with surveying, through procedure design, data processing and publication, data selection, coding, packing processes and up to the replacement of onboard data. The latter occurs as often as every 28 day AIRAC cycle, and in the future may become a near real-time activity. Modern ATM systems also employ navigation databases. Data base errors may result in incorrect results from conflict probes and could therefore lead to loss of separation. International efforts are currently in progress to ensure database integrity by the introduction of new database quality control procedures. Refer to the following documents for information about this issue: List of documents: Annex 15, RTCA document DO-200A.
SASP global controls and/or mitigators None.

Subject 4 – Database integrity
Regional and local controls and/or mitigators required The appropriate ATS authority must ensure that appropriate quality control procedures are followed at all levels of the data chain to ensure database integrity in aircraft and ATM systems.
Isavia implementation: Isavia does not have control over the quality control procedures that are enforced with regard to aircraft navigation data bases. This is the responsibility of the aircraft operator and the appropriate authority responsible for the aircraft operator. The AIC will nevertheless address this issue with the following text: *The accuracy of aircraft navigation databases is paramount in the application of separation based on area navigation. The navigation database suppliers should comply with RTCA DO-200A/EUROCAE document ED 76, Standards for Processing Aeronautical Data to ensure the integrity of the data. Discrepancies in the navigation data should be reported to the navigation database supplier and affected data should be prohibited by an operator's notice to its pilots. Aircraft operators should ensure that the aircraft navigation database is current and should consider the need to conduct periodic checks of the operational navigation databases in order to meet quality system requirements.* The navigation data in the Isavia FDPS is taken from official sources of information which is national AIPs. The FDPS update and testing process is designed to conserve the integrity of the data.

Subject 5 – Incorrect waypoint
Hazard Loss of separation.
Unsafe Event (cause) Pilots providing distance and track information with reference to the 'wrong' waypoint.
Analysis With the multitude of waypoints stored in the navigation system database, there is a possibility that a pilot will provide distance in reference to an incorrectly selected waypoint or fly a track to an incorrectly selected waypoint. The resulting position information will be erroneous and could result in loss of separation. This risk exists with the application of any area navigation type procedure. There are numerous procedures that require pilots to navigate to waypoints, and report distances or progress in regard to waypoints imbedded in their databases. When lateral separation is used between area navigation aircraft, the separation can be erroneous when pilots report the distance or track in regard to the wrong waypoint. It is paramount that controllers and pilots use standard phraseology when obtaining and giving track and distance reports. This helps in minimizing the possibility of errors.
SASP global controls and/or mitigators Specific phraseology for obtaining and reporting distance from navaids and waypoints is published in PANS-ATM section 12.3.1.9.
Regional and local controls and/or mitigators required Pilots and controllers should be advised by means of respective directives, circulars, manuals and training the importance of including the **name** of the waypoint when reporting the distance to/from that waypoint.

Subject 5 – Incorrect waypoint

Isavia implementation:

1) Isavia controllers are already trained in appropriate phraseology in this regard. Nevertheless refresher training on the phraseology will be included in training for the new separation.

2) The following text is included in the AIC:

It is important that controllers and pilots use standard phraseology when obtaining and giving distance reports. This helps in minimizing the possibility of errors. For this purpose ICAO has created, and published in the PANS-ATM, standard phraseologies for the application of GNSS based longitudinal separation. The standard phraseologies are as follows:

Controller requesting a report at a specified place or distance	REPORT (*distance*) MILES (GNSS) FROM (*significant point*)
Pilot response	**(*distance*) MILES (GNSS) FROM (*significant point*)**
Controller requesting a report of present position	REPORT (GNSS) DISTANCE FROM (*significant point*)
Pilot response	**(*distance*) MILES (GNSS) FROM (*significant point*).**

where (GNSS) is optional.

It is important that pilots keep the following in mind:

a) Always include the name of the applicable significant point when reporting distance from that point.

b) When the controller specifically requests "GNSS distance" then:

i) Provide the distance information if your aircraft is equipped in accordance with the Equipment eligibility section above; or

ii) Advise the controller that you are unable to provide the distance information for reasons such as:

- the aircraft is not equipped in accordance with the Equipment eligibility section above; or
- there is no GNSS input into an integrated navigation system; or
- the distance cannot be provided due to a RAIM warning.

Subject 6 – Incorrect waypoint entry
Hazard Loss of separation.
Unsafe Event (cause) A manual waypoint entry error results in navigation to an incorrect waypoint.
Analysis Navigation systems allow pilots to create waypoints manually in the enroute mode. This presents the possibility that pilots may enter waypoint co-ordinates incorrectly. CPDLC enables ATC to uplink route information into the area navigation system. This presents the possibility that ATC may uplink an incorrect waypoint. Pilots and ATC sometimes have to create ad hoc latitude/longitude waypoints in the absence of predefined waypoints or air routes. The risk of entering such waypoints incorrectly into the ATC- or navigation system increases as the number of digits defining the waypoint increases. The risk of manually entering very complex waypoints such as 6521.9N01312.6W may be too high in the context of applying lateral separation. There may be a high risk of misunderstanding when communicating such waypoints between controller and pilot.
SASP global controls and/or mitigators None.
Regional and local controls and/or mitigators required The appropriate ATS authority should design the airspace and air routes in such a way that the requirement to use manually created latitude/longitude waypoints is avoided. This can be done by publishing waypoints and airways/routes in a manner that aids the application of lateral separation.
Isavia implementation: 1) Waypoints and routes will be setup wherever possible in a way to facilitate the application of the separation with distances between the waypoints and routes taking account of the separation. 2) The airspace has a long history of using ad hoc latitude and longitude waypoints for defining the aircraft track. Due to the vastness of the airspace it is impossible to set up waypoints to cater for every eventuality, for example for cases where aircraft are operating to/from the glacier. For the application of this lateral separation, where predefined waypoints are not provided, Isavia will, subject to a positive outcome from a safety assessment, allow the use of waypoints defined by whole and half degrees of latitude/longitude (example 66N040W, 7730N032W).

Subject 7 – Filing of incorrect FPL information

Hazard

Loss of separation.

Unsafe Event (cause)

A navigation specification, which the aircraft and aircrew is not approved for, and/or incorrect navigation equipment is filed in the FPL.

Analysis

The safety analysis used for determining the lateral separation standards was based on the assumption that the concerned aircraft and crew had the required approvals and had correctly filed the approvals and the on board navigation equipment. If an incorrect approval or incorrect navigation equipment is filed in the FPL then the controller could apply inappropriate separation.

Aircraft operators need to obtain an approval for the aircraft and aircrew to operate in accordance with a specified PBN navigation specification. After this approval has been granted the operator is allowed to file in the FPL the appropriate designator for the navigation specification.

Aircraft operators are required to correctly file the on board navigation equipment that is serviceable and usable by the crew.

ATC reads the navigation and equipment designators from the FPL and apply separation accordingly. ATC normally does not question the data in the FPL and trusts that the filed data is correct.

It is important that aircraft operators and aircrew understand the importance of obtaining the appropriate operational approvals and filing correct data in the FPL, and the adverse impact that incorrectly filing this information can have on airspace risk.

SASP global controls and/or mitigators

The following guidance material is published by ICAO:

1) Performance Based Navigation (PBN) Manual (ICAO doc 9613) providing guidance concerning area navigation, navigation specifications and operational approvals.

2) PANS-ATM providing guidance for completing the FPL form.

3) This Circular providing guidance on implementation of lateral separation.

Regional and local controls and/or mitigators required

The appropriate ATS authority should ensure that aircraft operators are granted operational approvals in accordance with the ICAO PBN Manual.

Subject 7 – Filing of incorrect FPL information

Isavia implementation:

Isavia does not have control over the approvals that are granted by the regulatory authorities. The AIC will nevertheless address the issue of the GNSS equipage with the following text:

> *The new separation standards may be applied between aircraft that have an IFR certified GNSS installation as indicated with the letter "G" in Item 10 of the ICAO FPL. Such systems are:*
>
> *a) A GNSS receiver that is approved in accordance with the requirements specified in TSO C-129a or higher; or*
>
> *b) An integrated navigation system incorporating GNSS input.*
>
> *Operators and pilots are reminded that the inclusion of the letter "G" in Item 10 of the FPL signifies the following:*
>
> *a) the presence of relevant serviceable GNSS equipment on board the aircraft; and*
>
> *b) GNSS equipment and capabilities are commensurate with flight crew qualifications; and*
>
> *c) where applicable, authorization from the appropriate authority has been obtained.*

Subject 8 a – Errors in interpreting FPL information

Hazard

Loss of separation.

Unsafe Event (cause)

The air traffic controller applies an incorrect separation as a consequence of misinterpreting the FPL information.

Analysis

The safety analysis used for determining the lateral separation standards was based on the assumption that the ATM system or air traffic controller reads the navigation specification and navigation equipment information from the FPL and applies the appropriate separation standard. A mistake in interpreting the FPL information may lead to the controller applying inappropriate separation.

Aircraft operators file the on board navigation equipment and operational approvals in the ICAO FPL. The air traffic controller or the ATM system reads this information from the FPL and applies separation accordingly.

Increasing complexities of navigation information in the FPL may lead to mistakes in reading and interpreting the FPL navigation data leading to application of incorrect separation standards and the adverse impact on airspace risk.

SASP global controls and/or mitigators

The following guidance material is published by ICAO:

1) Performance Based Navigation (PBN) Manual (ICAO doc 9613) providing guidance concerning area navigation, navigation specifications and operational approvals.

2) PANS-ATM providing guidance for completing the FPL form.

3) This Circular providing guidance on implementation of lateral separation.

Subject 8 a – Errors in interpreting FPL information
Regional and local controls and/or mitigators required 1) ATM systems should display aircraft navigation capabilities to the controller in a clear and unambiguous manner. 2) Conflict probe systems should automatically interpret the navigation information in the FPL.
Isavia implementation: 1) The Isavia FDPS displays GNSS equipage on the electronic flight progress strip if the indicator "G" has been entered in Item 10a of the FPL. 2) As described elsewhere in this implementation plan the new lateral separation standards will not be implemented in the conflict probe, at least to start with. It was not the intention of the SASP to require the use of conflict probe for the application of this separation. An amendment of this paragraph to read "When conflict probe systems are used, they should automatically interpret the navigation information in the FPL" is being coordinated with members of the SASP.

Subject 8 b – GNSS outage
Hazard Loss of separation.
Unsafe Event (cause) GNSS failure affecting multiple aircraft or a failure of individual GNSS receivers.
Analysis The effect of a failure of an individual GNSS receiver or a failure affecting multiple aircraft will have different impacts on the ATM system. GNSS outages are detected by RAIM equipment. If an individual GNSS receiver fails the pilot shall advise ATC if the failure results in the aircraft no longer being able to navigate using the GNSS signal or no longer being able to satisfy an applicable navigation specification. Controllers will then apply other forms of separation that are not reliant on GNSS. This is no different from a traditional avionics equipment failure. Local GNSS outages are possible, for example during periods of GNSS signal interference. Pilots cannot distinguish interference from loss of GNSS integrity, so again they would simply advise ATC that they are receiving a RAIM warning, and ATC would again apply a different form of separation. Following further RAIM warning reports from other pilots in the area, controllers should suspect that interference may be occurring, and shall not use GNSS for separation.
SASP global controls and/or mitigators 1) Navigation Specifications in the PBN Manual detail that the pilot shall inform ATC when the aircraft can no longer satisfy the navigation requirements applicable to the navigation specification being employed in the airspace. 2) The following paragraph is contained in PANS-ATM: *5.4.1.1.3 When information is received indicating navigation equipment failure or deterioration below the navigation performance requirements, ATC shall then, as required, apply alternative separation methods or minima.*
Regional and local controls and/or mitigators required The appropriate ATS authority must consider the effect of GNSS outages in their contingency plans.

Subject 8 b – GNSS outage
Isavia implementation: 1) Isavia will monitor RAIM prediction for the area where GNSS separation is applicable. 2) Isavia procedures specify that controllers shall not apply GNSS based separation in case of RAIM prediction warning or a pilot reported RAIM warning. 3) The AIC will contain the following text to remind pilots that they shall report RAIM warnings to ATC. *If the letter "G" has been included in Item 10 of the FPL the pilot shall immediately inform ATC of any deterioration of navigation performance, including loss of GNSS integrity. RAIM warnings shall be reported immediately to ATC.* *If the letter "G" is included in Item 10 of the FPL the pilot shall check RAIM forecasts for the route of flight before departure.*

Subject 9 – An aircraft fails to meet a restriction
Hazard Loss of separation.
Unsafe Event (cause) A pilot does not comply with an ATC clearance.
Analysis When applying lateral separation controllers may instruct pilots to climb/descend after passing a specific position or may instruct pilots to climb/descend to reach a flight level/altitude before passing a certain position or distance from a fix. It is the responsibility of the pilot to judge whether such a clearance can be met and to advise ATC if unable to comply. When applying lateral separation to aircraft on intersecting tracks controllers can use the following means to effect the separation: a) clear aircraft to reach a certain level before the lateral separation point; b) clear aircraft to descend/climb to a certain level after passing the lateral separation point. There may be several reasons that a pilot fails to meet such a clearance: a) pilot overestimates the rate-of-climb/descend capability of the aircraft; b) the aircraft is not able to reach a certain altitude because of temperature, turbulence etc. c) the pilot forgets to initiate a climb/descent at the correct time/position. d) the pilot misunderstands the clearance/instruction/restriction. Ultimately it is the responsibility of the pilot to judge if he can safely comply with a clearance/instruction/restriction. All those issues are common to the application of any separation minima. This issue is therefore not specific to the application of lateral separation
SASP global controls and/or mitigators None.
Regional and local controls and/or mitigators required The appropriate ATS authority should include the appropriate application methods of lateral separation in controller training programmes.

Subject 9 – An aircraft fails to meet a restriction
Isavia implementation: 1) Isavia controllers are already trained in this type of application of separation. 2) Application of the new separation standards will be covered in controller training before the separation is implemented.

Subject 10 – Misunderstanding in communicating the clearance to the aircraft
Hazard Loss of separation
Unsafe Event (cause) Pilot misunderstands the clearance.
Analysis There is a possibility that a pilot could misunderstand a clearance and therefore fly a different flight profile than was intended by the controller to effect proper separation. This can result in loss of separation. Air traffic controllers must communicate clearances to aircraft. Some clearances are simple while other clearances are complex. There are various means of communication: VHF, UHF, HF, CPDLC, SATCOM. The quality of communications varies and language barriers exist between pilots and controllers with different native tongues. All of these and more issues can influence the likelihood of a misunderstanding in communicating a clearance to the aircraft. There are many things that can lead to misunderstanding and mishearing in ATC communications. Examples are: a) bad quality of communications (static, noise etc.); b) lack of English language proficiency; c) bad radiotelephony procedures; d) non-standard phraseologies; and e) non-standard CPDLC procedures and misunderstanding of CPDLC message elements. All those issues are common to any ATC communications and application of any separation minima. No communication issue seems to be specific to the application of lateral separation.
SASP global controls and/or mitigators 1) Standard voice phraseology is published in PANS-ATM chapter 12. 2) Standard CPDLC procedures and message elements are published in the ICAO Global Operational Data Link Document (GOLD).
Regional and local controls and/or mitigators required The appropriate ATS authority should enforce the use of standard phraseologies and standard CPDLC procedures in pilot-controller communications.
Isavia implementation: 1) Isavia MANOPS already includes standard voice phraseologies and CPDLC procedures. 2) Standard voice phraseologies for the application of the new separation will be covered in controller training before the separation is implemented. CPDLC training is not required for this purpose since none of the aircraft that are targeted with the new separation are CPDLC equipped.

Subject 11 – Airspace design and fly-by turns
Hazard Loss of separation.
Unsafe Event (cause) The separation being applied does not accommodate the expected variability in the performance of area navigation systems executing fly-by turns.
Analysis Most waypoints in area navigation are fly-by waypoints. By design this involves the aircraft turning before reaching the waypoint and completing the turn without ever flying over the waypoint. The distance from the fly-by waypoint at which an aircraft commences and terminates the fly-by turn depends on many factors, i.e. the magnitude of the turn, aircraft speed, altitude, wind velocity etc. Because lateral separation of aircraft is measured between the centrelines of the nominal cleared track, turning aircraft may not be on the expected track and could result in loss of separation. Document Eurocae ED-75B/ RTCA DO-236B, "*MASPS Required Navigation Performance for Area Navigation*" issued in December 2003 deals with fly-by turns. This document contains guidance material for navigation systems operating in an RNAV environment and provides guidance for the development of airspace and operational procedures. In section 3.2.5.4 the document deals with the issue of fly-by transitions (turns) and provides formulas for deriving fly-by transition areas based on assumptions of ground speed and roll angle. Fly-by Theoretical Transition (turn) Areas can only be derived for turns up to 120° for low altitude transitions and turns up to 70° for high altitude transitions. However, it should be noted that monitoring of aircraft performing fly-by turns has revealed that some aircraft perform turns that take the aircraft outside the theoretical transition area mentioned above.
SASP global controls and/or mitigators None
Regional and local controls and/or mitigators required 1) The turning behaviour of RNAV aircraft must be included in the training curriculum of air traffic controllers. 2) The turning behaviour of RNAV aircraft must be accounted for in airspace design.

Subject 11 – Airspace design and fly-by turns

Isavia implementation:

1) The turning behavior of RNAV aircraft will be covered in controller training before the separation is implemented.
2) The turning behavior of RNAV aircraft will be accounted for in airspace design. The following criteria will be used:

The values in the following table were calculated based on the formulas and assumptions documented in ED-75B section 3.2.5.4.1. The table lists the distance from a fly-by waypoint, at which an aircraft may be expected to initiate and complete a turn and the distance the aircraft may be expected to be displaced from a fly-by waypoint when it passes abeam the waypoint.

	Fly-by turns below F195		Fly-by turns above F195	
Track change in degrees	Start/end of turn in NM from fly-by waypoint	Track distance abeam the waypoint in NM	Start/end of turn in NM from fly-by waypoint	Track distance abeam the waypoint in NM
5	3,6	0,1	4,1	0,1
10	3,6	0,2	8,2	0,4
15	3,6	0,2	12,3	0,8
20	3,6	0,3	16,5	1,4
25	3,6	0,4	20,0	2,2
30	3,6	0,5	20,0	2,6
35	3,6	0,6	20,0	3,1
40	3,6	0,6	20,0	3,5
45	3,6	0,7	20,0	4,0
50	4,0	0,9	20,0	4,4
55	4,5	1,1	20,0	4,9
60	5,0	1,3	20,0	5,4
65	5,5	1,6	20,0	5,8
70	6,0	1,9	20,0	6,3
75	6,6	2,2	N/A	N/A
80	7,2	2,6	N/A	N/A
85	7,9	3,1	N/A	N/A
90	8,6	3,6	N/A	N/A
95	9,4	4,1	N/A	N/A
100	10,2	4,8	N/A	N/A
105	11,2	5,5	N/A	N/A
110	12,3	6,4	N/A	N/A
115	13,5	7,4	N/A	N/A
120	14,9	8,6	N/A	N/A

Subject 12 – Strategic Lateral Offset Procedure (SLOP)
Hazard Loss of separation.
Unsafe Event (cause) Pilot applies an offset that exceeds the SLOP criteria.
Analysis The Strategic Lateral Offset Procedure is published in PANS-ATM section 16.5. The procedures allows the appropriate authority to authorize a SLOP of up to 2 NM in airspace where lateral separation or route spacing is 30 NM or more and a SLOP up to 0.5 NM where lateral separation or route spacing is between 6 NM and 30 NM. If one or both aircraft apply a lateral offset that is larger then the values specified above in the direction of the other aircraft, the result could be significant erosion of the actual separation between the aircraft.
SASP global controls and/or mitigators The Strategic Lateral Offset Procedure is published in PANS-ATM section 16.5.
Regional and local controls and/or mitigators required a) Strategic lateral offset procedures should be implemented on a regional basis after coordination between all States involved. b) The routes or airspace where application of strategic lateral offsets is authorized, and the procedures to be followed by pilots, shall be published in aeronautical information publications (AIPs) and promulgated to air traffic controllers.
Isavia implementation: a) SLOP has already been implemented in the NAT region. b) Isavia will publish in the AIP that SLOP is not allowed below F285 in the Reykjavik CTA. This will also be detailed in the AIC with the following text: SLOP is not allowed in airspace where the applied lateral separation is less than 30 NM. Since the lateral separation may be as low as 7 NM below F285 in the Reykjavik CTA the following applies: Aircraft shall not apply SLOP below F285 in the Reykjavik CTA. Aircraft shall maintain the center line of the cleared track in accordance with Annex 2 requirements.

11 Trial Objectives and Success Criteria

11.1 The need for the change is specified in paragraph 2.1 and accordingly the objectives of the trial are:

a) Reduce the need of aircraft to have to accept large reroutes or other restrictions to gain access to controlled airspace.

b) Reduce the tendency of aircraft to remain in uncontrolled airspace below F195 rather than having to accept large reroutes or other restrictions to gain access to controlled airspace.

c) Increase the probability of aircraft achieving optimum routing and flight levels to avoid severe weather conditions such as turbulence and icing.

d) Reduce fuel consumption and greenhouse gas emissions by providing optimum routing and flight levels.

e) Maintaining the lateral collision risk within the target level of safety (TLS) and without negative impact on collision risk in the vertical or longitudinal dimensions.

11.2 The capability of Isavia to quantify the success of items a) – d) above is limited since it is not known how many aircraft have avoided entering controlled airspace due to the reasons described in paragraph 2.1. Isavia will nevertheless attempt to establish if aircraft in Greenland domestic operations are more frequently opting to enter controlled airspace.

11.3 Isavia will explore the possibility of estimating the standard deviation of lateral track keeping accuracy of the target aircraft population using available radar data.

11.4 The goal of the trial is to provide confidence for all stakeholders to decide whether the trial should become operational by testing key safety assumptions using data from the operational trial.

11.5 The trial shall therefore be successful if stakeholders feel suitably informed to make a "go"/"no go" decision. The stakeholders include:

- Reykjavik OACC
- Icelandic Civil Aviation Administration (the Regulator)
- NAT groups (SPG, IMG, ATMG, SARSIG)

11.6 The scope of the trial is to apply 7/15/20 NM lateral separation between GNSS equipped aircraft on intersecting and non-intersecting tracks using appropriate communications and collecting data in order to support the goal of the trial (see above).

11.7 The questions and metrics associated with determining the success of the operational trial are shown in the table below. These metrics shall be assessed during the trial, in order to answer the relevant questions and determine whether the goal of the trial has been met.

Success criteria for the operational trial

QUESTIONS		**METRICS, DETAILS & TARGETS**	
Safety	No lateral, vertical or longitudinal errors attributed to the trial.	i) Longitudinal	Scrutinize each longitudinal error to determine if the application of the 7/15/20 NM lateral separation instead of 120 NM + gentle slope rules has had an effect on the error. Target = No longitudinal errors attributed to the trial.
		ii) Vertical	Scrutinize each vertical error to determine if the application of the 7/15/20 NM lateral separation instead of 120 NM + gentle slope rules has had an effect on the error. Target = No vertical errors attributed to the trial.
		iii) Lateral	Scrutinize each lateral error to determine if the application of the 7/15/20 NM lateral separation instead of 120 NM + gentle slope rules has had an effect on the error. Target = No lateral error attributed to the trial.
	No additional adverse safety events due to the trial	Failures to meet crossing restrictions for flight level changes do not increase due to the application of the 7/15/20 NM lateral separation. Scrutinize each failure to meet a crossing restriction to determine if the application of the 7/15/20 NM lateral separation instead of 120 NM + gentle slope rules has had an effect on the error. Target = No increase in failures to meet crossing restrictions due to the application of the 7/15/20 NM lateral separation.	
	Any safety and operational benefits connected with the application of the 7/15/20 NM lateral separation	The application of the 7/15/20 NM lateral separation should enable aircraft to operate more efficiently in controlled airspace than was possible before with the 120 NM lateral separation. This should also increase the probability of aircraft achieving optimum routing and flight levels to avoid severe weather conditions such as turbulence and icing Attempt to establish if aircraft in Greenland domestic operations are more frequently opting to enter controlled airspace. Target = Aircraft choose more frequently to operate in controlled airspace due to the application of the 7/15/20 NM lateral separation.	
Aircraft equipage	Aircraft navigation equipage remains equal or improves	Collect aircraft navigation equipage data to ensure that the equipage levels, as indicated in section 5.2.8, remain constant or improve.	

12 Conclusions

12.1 Reserved for the outcome of the NAT scrutiny process.

– END –