Implementation Plan

for Application of GNSS Based Lateral Separation

Within the Reykjavik CTA below F285

Version 0.2

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1 Introduction

1.1 In 2013 Isavia gained approval for an operational trial of application of Global Navigation Satellite Systems (GNSS) -based lateral separation below F285 over and in the vicinity of Greenland. 20 NM separation between aircraft using any means of communication was implemented on 5 July 2013. A plan to implement 7 NM and 15 NM separation reliant on Direct Controller Pilot Communications (DCPC) Very High Frequency (VHF) has however not materialized due to delays in obtaining the necessary approvals in Denmark. All approvals were finally received in February 2015.

1.2 In November 2014 the International Civil Aviation Organization (ICAO) published the GNSS separation minima in the *Procedures for Air Navigation Services Air Traffic Management* (PANS-ATM Doc 4444) and as a consequence there is no need any more to run an operational trial and normal use of the separation minima should begin.

1.3 The application of lateral separation between non-Minimum Navigation Performance Specifications (MNPS) approved aircraft has always been very restrictive due to the fact that the only separation available for this purpose in the North Atlantic Region (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 below the MNPS airspace and often results in aircraft choosing to remain in uncontrolled airspace 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.

1.4 The 120 NM separation stems from an era when navigation was via Dead Reckoning and communications were only possible via High Frequency (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.

1.5 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 the standards were subsequently included in the PANS-ATM in November 2014 along with publication of an implementation guidance Circular 334.

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 new GNSS-based separation minima should be implemented within the Reykjavik Control Area (CTA) below F285. Utilizing those reduced separation standards would facilitate a huge improvement in Air Traffic Management, for non-MNPS approved aircraft operating below the MNPS airspace, resulting in reduced fuel burn and greenhouse gas emissions and increased safety. The separation cannot yet be implemented within MNPS airspace because of the lax navigation requirements that are specified for the MNPS airspace as compared to the assumptions that were made in the SASP collision risk modelling.

1.8 In connection with the ADS-B implementation program in Greenland, Direct Controller Pilot Communications (DCPC) transceivers are being installed in several locations. Those are in addition to extensive DCPC VHF facilities in Iceland and the Faroe Islands. This communication capability will enable the application of the GNSS-based lateral separation minima that require DCPC VHF.

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

1.10 The implementation process is conducted in accordance with the guidelines provided in ICAO Circular 334 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 and IMG. c) Aircraft operators via publican of an AIC. 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	Isavia will conduct a Safety Assessment in accordance with Icelandic regulatory requirements before the new lateral separation standards are implemented. This

identification of controls and mitigators;	activity needs to be completed before approval is granted by the Icelandic regulator.
Step 5b) implementation plan;	This document is the implementation plan.
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 *Safety Management Manual* (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 low level 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	This does not apply to this project.

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 the *Manual on Airspace Planning Methodology for the Determination of Separation Minima* Doc 9689.	
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;	A trial has been ongoing in Greenland since 5 July 2013.
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.
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.

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 aircraft when deemed beneficial by the controller:

- 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 below the MNPS airspace 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 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.

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).

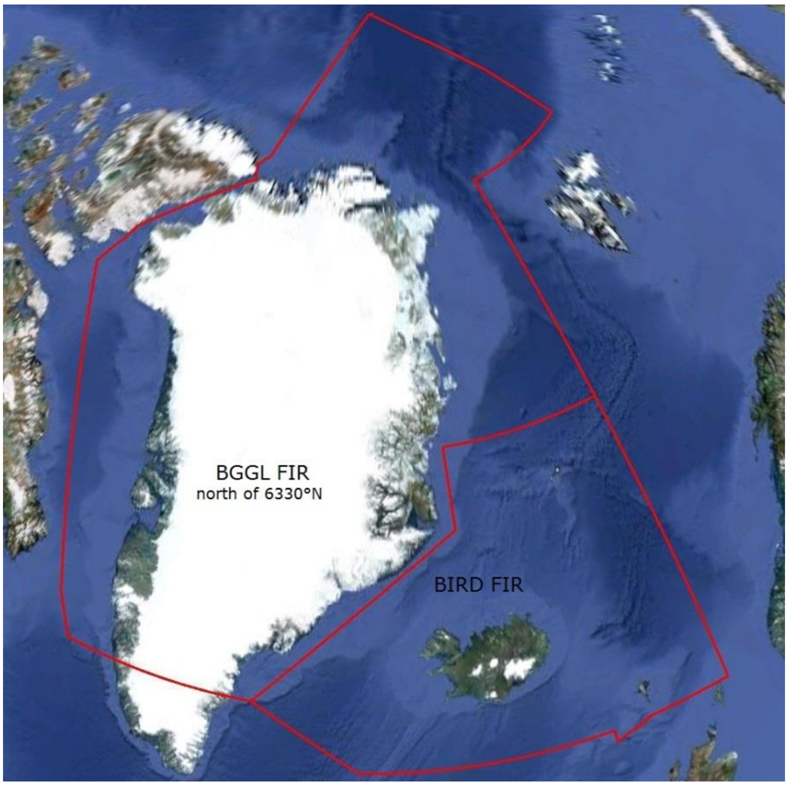


Figure 1:Reykjavik CTA within Reykjavik and Greenland FIRs

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.

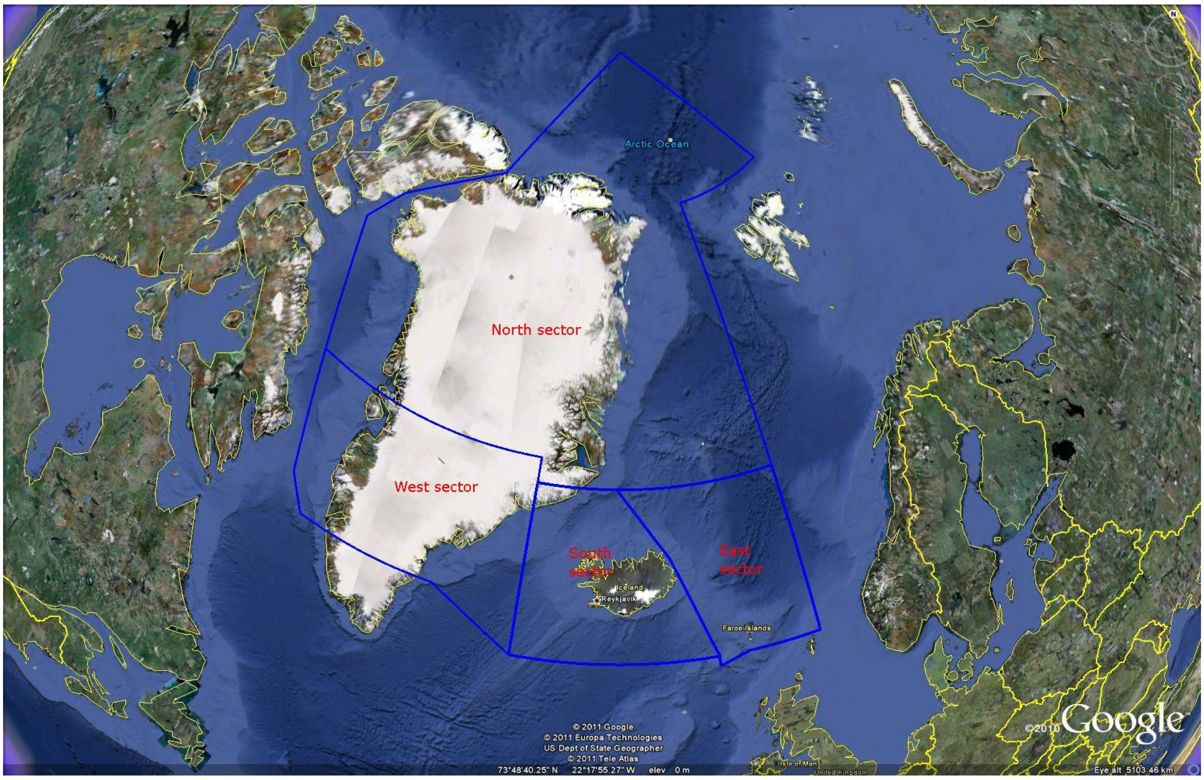


Figure 2:Reykjavik CTA

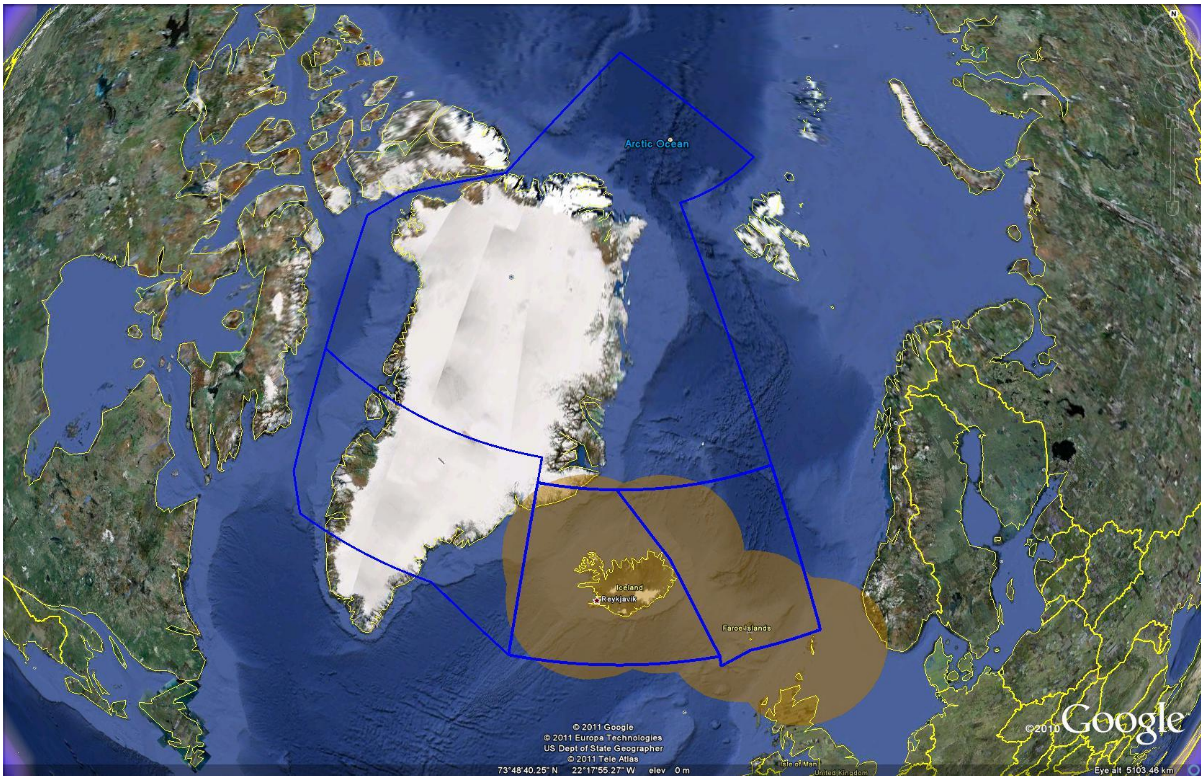


Figure 3: Current radar and ADS-B coverage

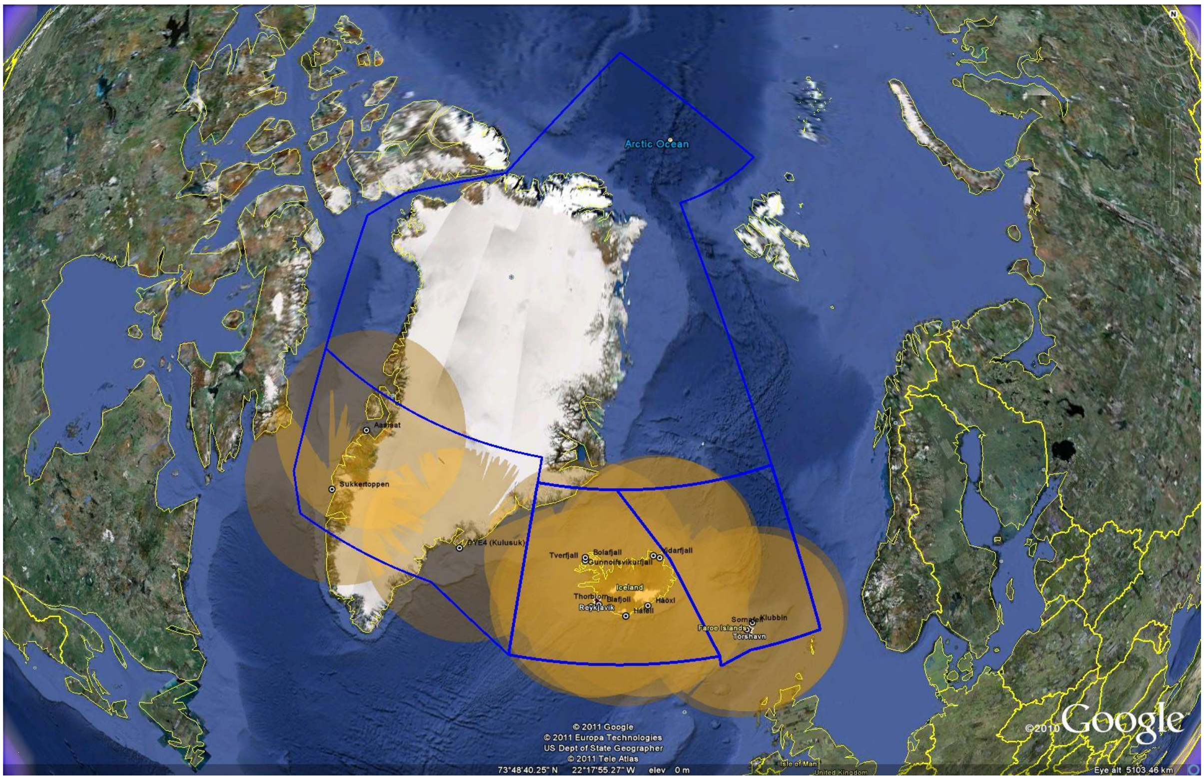


Figure 4: Estimated future ADS-B and DCPC VHF coverage at jet levels

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 in the Reykjavik CTA above F285 as a means of reducing collision risk and is now standard operating procedure in the entire NAT Region. SLOP is not allowed below F285 in the Reykjavik CTA.

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.

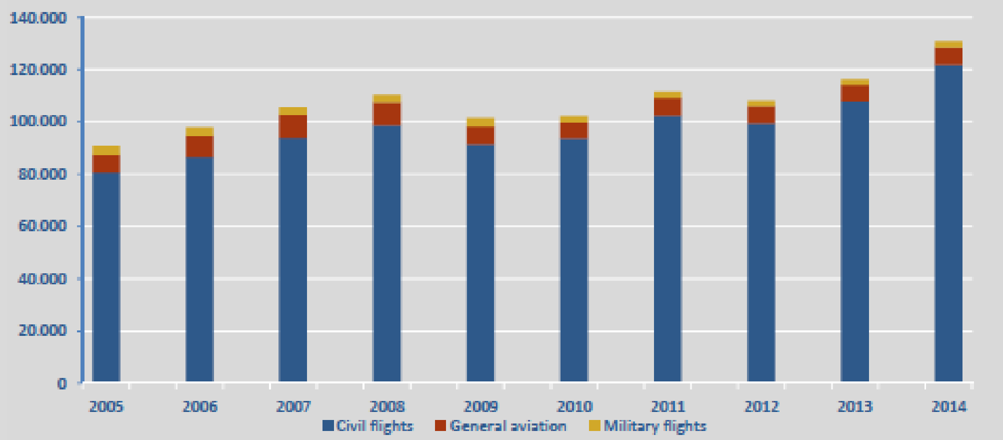
4.1.2 The major traffic flow between Europe and North America takes place in two distinct traffic flows during each 24-hour period due to passenger preference, time zone differences and the imposition of night-time noise curfews at the major airports. The majority of the Westbound flow leaves European 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 Oceanic area during the years 2005 to 2014 (excluding the Icelandic domestic traffic):

Traffic in the Reykjavík Oceanic area 2005 - 2014

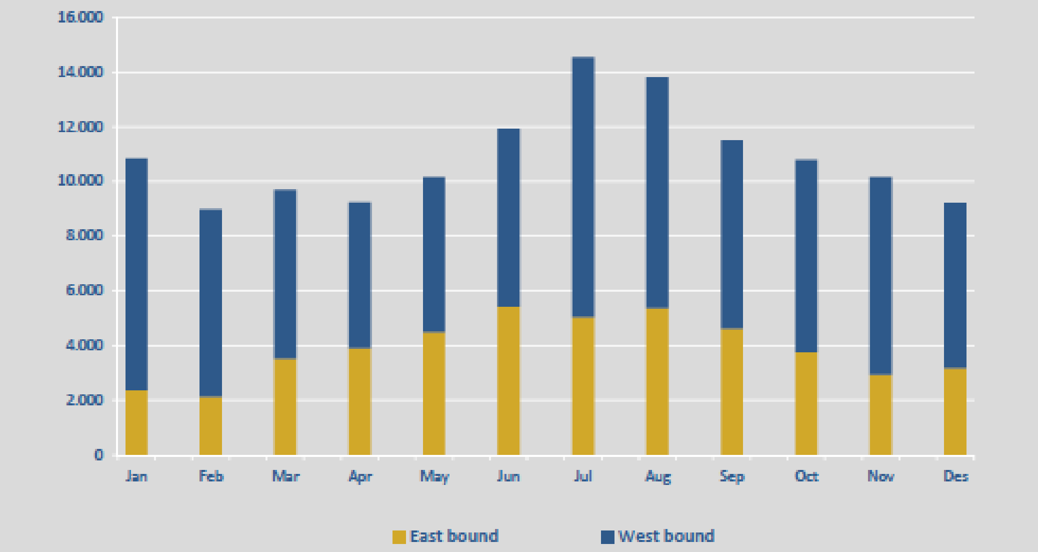
Year	To/from Iceland	Overflights	Total	Change
2005	27.814	63.156	90.970	7,5%
2006	32.046	65.828	97.874	7,6%
2007	34.014	71.400	105.414	7,7%
2008	30.625	79.741	110.366	4,7%
2009	24.703	76.800	101.503	-8,0%
2010	25.596	76.679	102.275	0,8%
2011	28.584	82.905	111.489	9,0%
2012	30.469	77.529	107.998	-3,1%
2013	33.063	83.263	116.326	7,7%
2014	37.472	93.384	130.856	12,5%

Year	Civil flights	General aviation	Military flights	Total	% Civil	% General	% Military
2005	80.743	6.766	3.461	90.970	88,8%	7,4%	3,8%
2006	86.608	8.056	3.210	97.874	88,5%	8,2%	3,3%
2007	93.775	9.016	2.623	105.414	89,0%	8,6%	2,5%
2008	98.816	8.578	2.972	110.366	89,5%	7,8%	2,7%
2009	91.429	6.768	3.306	101.503	90,1%	6,7%	3,3%
2010	93.707	6.049	2.519	102.275	91,6%	5,9%	2,5%
2011	102.374	6.809	2.306	111.489	91,8%	6,1%	2,1%
2012	99.466	6.487	2.045	107.998	92,1%	6,0%	1,9%
2013	107.930	6.374	2.022	116.326	92,8%	5,5%	1,7%
2014	121.795	6.566	2.495	130.856	93,1%	5,0%	1,9%



Traffic in the Reykjavík Oceanic Area 2014

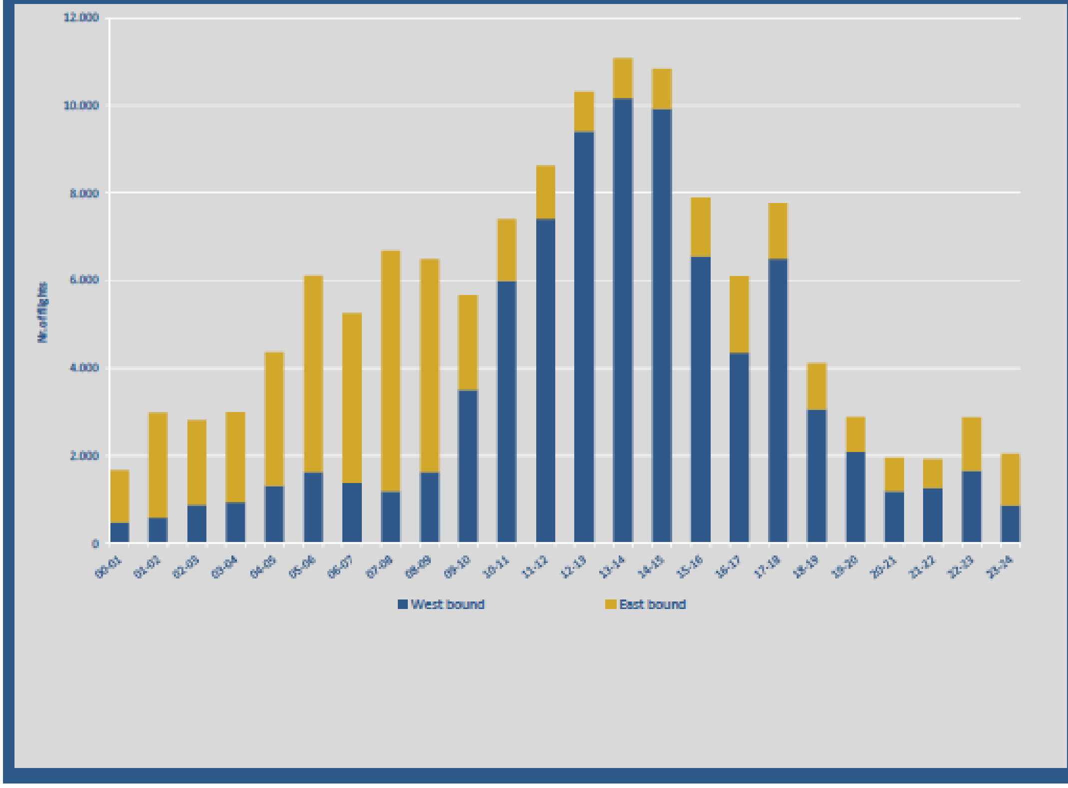
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Des	Total
East bound	2.372	2.128	3.510	3.919	4.495	5.429	5.037	5.384	4.634	3.757	2.952	3.177	46.794
West bound	8.468	6.853	6.180	5.312	5.665	6.510	9.509	8.424	6.878	7.019	7.206	6.038	84.062
Total	**10.840**	**8.981**	**9.690**	**9.231**	**10.160**	**11.939**	**14.546**	**13.808**	**11.512**	**10.776**	**10.158**	**9.215**	**130.856**



Hourly distribution of the traffic in the Reykjavik Oceanic Area 2014

Hour	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10	10-11	11-12
West bound	487	588	885	935	1.316	1.637	1.395	1.197	1.636	3.513	5.993	7.415
East bound	1.192	2.402	1.938	2.058	3.052	4.472	3.861	5.478	4.851	2.149	1.409	1.218

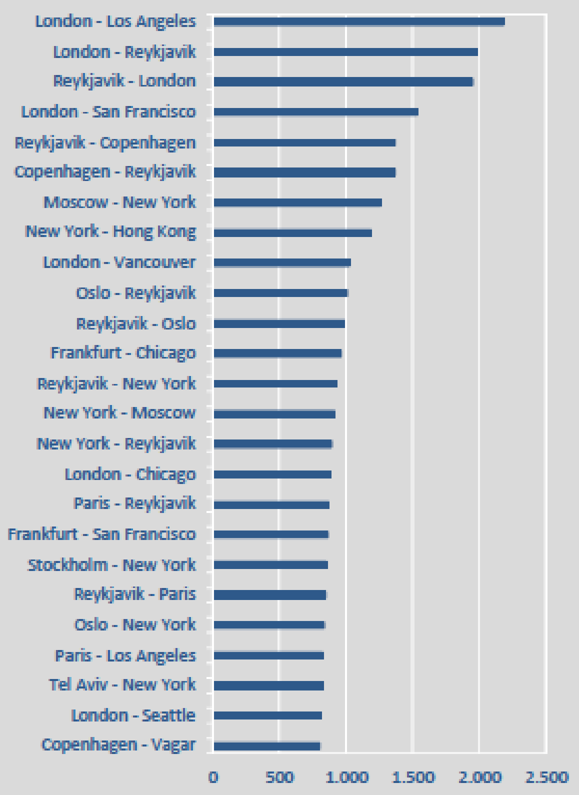
Hour	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22	22-23	23-24
West bound	9.414	10.165	9.926	6.553	4.352	6.493	3.067	2.091	1.193	1.270	1.662	880
East bound	898	915	904	1.346	1.747	1.271	1.045	799	759	654	1.214	1.170



Main City Pairs 2014

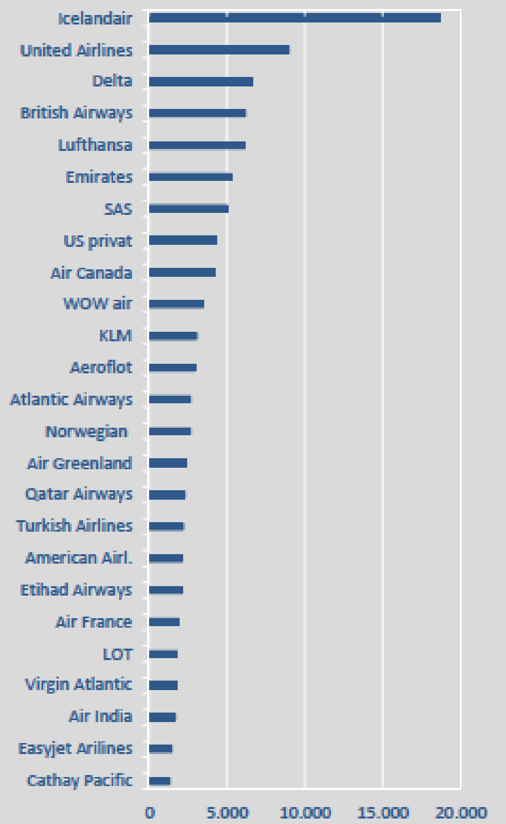
London - Los Angeles	2.181
London - Reykjavik	1.980
Reykjavik - London	1.949
London - San Francisco	1.533
Reykjavik - Copenhagen	1.368
Copenhagen - Reykjavik	1.366
Moscow - New York	1.261
New York - Hong Kong	1.191
London - Vancouver	1.025
Oslo - Reykjavik	1.008
Reykjavik - Oslo	989
Frankfurt - Chicago	962
Reykjavik - New York	924
New York - Moscow	915
New York - Reykjavik	894
London - Chicago	882
Paris - Reykjavik	867
Frankfurt - San Francisco	863
Stockholm - New York	851
Reykjavik - Paris	845
Oslo - New York	835
Paris - Los Angeles	824
Tel Aviv - New York	823
London - Seattle	813
Copenhagen - Vagar	801

Total number of city pairs 4.278



Main Operators in the Icelandic Oceanic area 2014

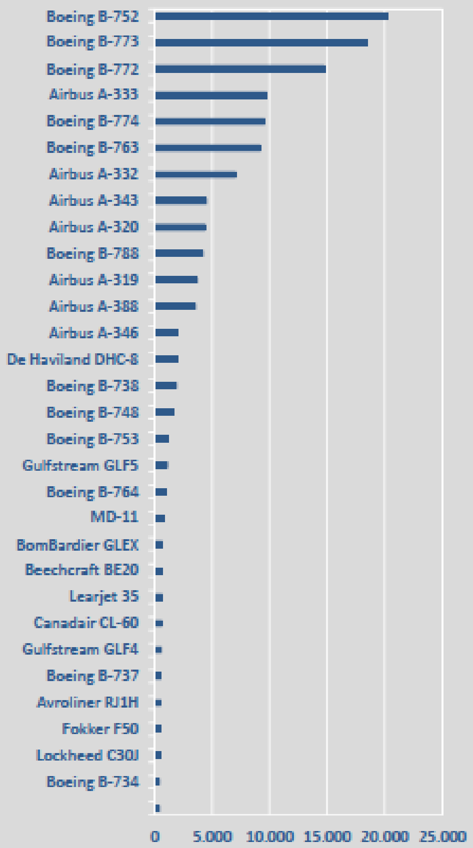
Operator	Nr.of flights	Part
Icelandair	18.644	14,25%
United Airlines	8.989	6,87%
Delta	6.600	5,04%
British Airways	6.174	4,72%
Lufthansa	6.162	4,71%
Emirates	5.254	4,02%
SAS	5.024	3,84%
US privat	4.337	3,31%
Air Canada	4.166	3,18%
WOW air	3.483	2,66%
KLM	3.038	2,32%
Aeroflot	2.942	2,25%
Atlantic Airways	2.673	2,04%
Norwegian	2.650	2,03%
Air Greenland	2.342	1,79%
Qatar Airways	2.292	1,75%
Turkish Airlines	2.189	1,67%
American Airl.	2.143	1,64%
Etihad Airways	2.132	1,63%
Air France	1.885	1,44%
LOT	1.772	1,35%
Virgin Atlantic	1.762	1,35%
Air India	1.678	1,28%
Easyjet Arilines	1.430	1,09%
Cathay Pacific	1.325	1,01%
Others	29.770	22,75%
	130.856	**100,00%**



Main Aircraft types in the Icelandic Oceanic area 2014

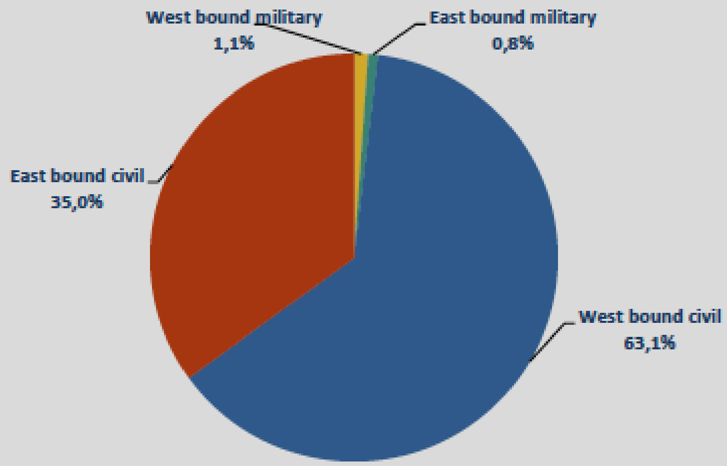
Aircraft type	Nr.of flights	Part
Boeing B-752	20.198	15,4%
Boeing B-773	18.370	14,0%
Boeing B-772	14.757	11,3%
Airbus A-333	9.743	7,4%
Boeing B-774	9.542	7,3%
Boeing B-763	9.161	7,0%
Airbus A-332	7.054	5,4%
Airbus A-343	4.533	3,5%
Airbus A-320	4.414	3,4%
Boeing B-788	4.217	3,2%
Airbus A-319	3.678	2,8%
Airbus A-388	3.554	2,7%
Airbus A-346	2.012	1,5%
De Haviland DHC-8	2.006	1,5%
Boeing B-738	1.889	1,4%
Boeing B-748	1.592	1,2%
Boeing B-753	1.146	0,9%
Gulfstream GLF5	1.076	0,8%
Boeing B-764	929	0,7%
MD-11	808	0,6%
BomBardier GLEX	695	0,5%
Beechcraft BE20	678	0,5%
Learjet 35	677	0,5%
Canadair CL-60	642	0,5%
Gulfstream GLF4	593	0,5%
Boeing B-737	551	0,4%
Avroliner RJ1H	526	0,4%
Fokker F50	508	0,4%
Lockheed C30J	479	0,4%
Boeing B-734	417	0,3%
Boeing C-17	403	0,3%
All flights	130.856	100,0%

Total number of aircraft types: 278

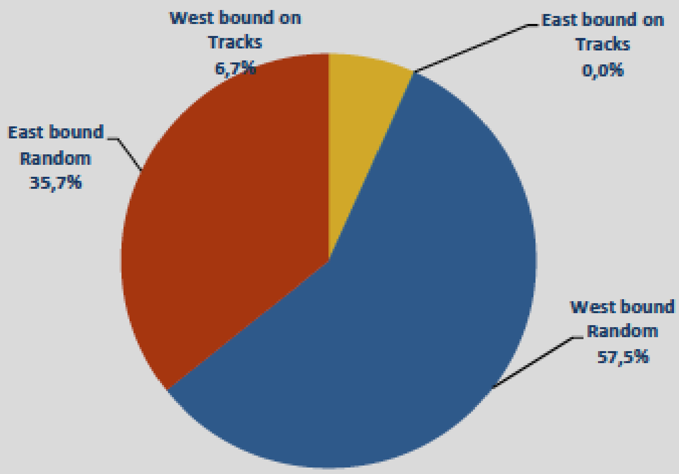


Traffic Analysis 2014

West bound military	East bound military	West bound civil	East bound civil	Total
1.478	1.017	82.584	45.777	130.856



West bound on Tracks	East bound on Tracks	West bound Random	East bound Random	Total
8.822	45	75.240	46.749	130.856

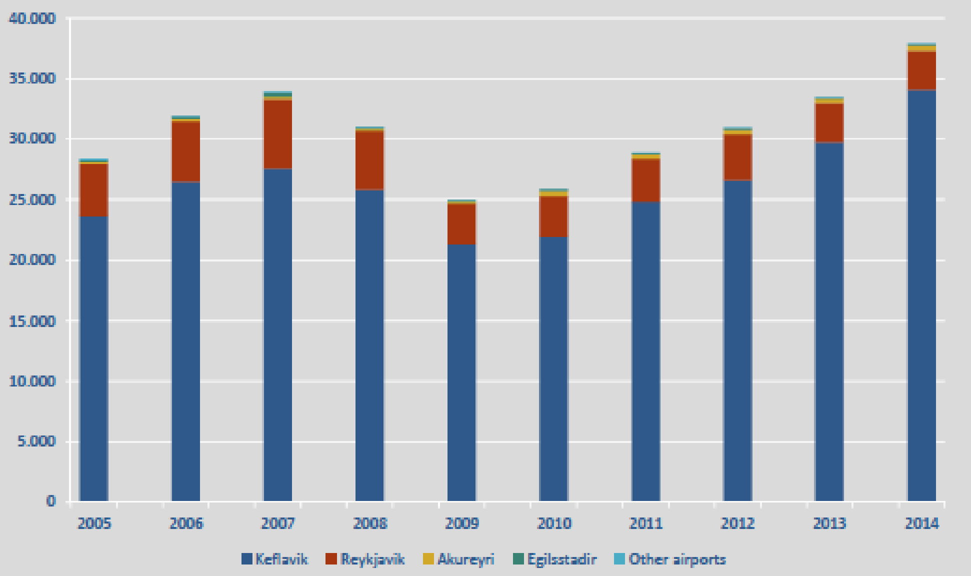


4.1.4 Following are a few key figures concerning the Iceland international aircraft movements and domestic traffic:

International a/c movements in Icelandic airports with scheduled services 2014

Airport	Schedule / Charter service	Other flights	Total	Change 14/13	Part
Keflavik	29.315	4.754	34.069	14,6%	89,9%
Reykjavik	1.361	1.872	3.233	-0,7%	8,5%
Akureyri	391	60	451	26,7%	1,2%
Egilsstadir	45	79	124	61,0%	0,3%
Other airports	0	5	5	-16,7%	0,0%
Total	**31.112**	**6.770**	**37.882**	**13,3%**	**100%**

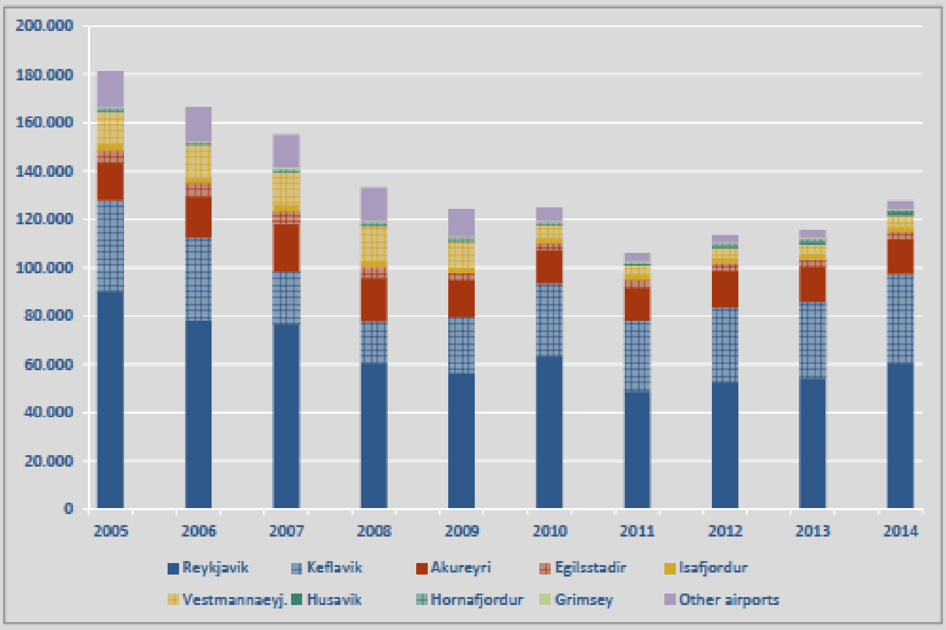
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Keflavik	23.648	26.479	27.583	25.833	21.307	21.942	24.849	26.612	29.741	34.069
Reykjavik	4.300	5.014	5.716	4.868	3.392	3.360	3.547	3.775	3.255	3.233
Akureyri	198	171	198	157	131	408	344	384	356	451
Egilsstadir	114	236	368	126	118	142	114	127	77	124
Other airports	114	41	24	5	9	31	2	4	6	5
Total	**28.374**	**31.941**	**33.889**	**30.989**	**24.957**	**25.883**	**28.856**	**30.902**	**33.435**	**37.882**



Domestic a/c movements in Icelandic airports with scheduled services 2014

Airport	Schedule/ Charter service	Other flights	T&G landings	Total	Change 14/13	Part
Reykjavik	16.266	5.493	38.688	60.447	11,4%	47,4%
Keflavik	216	7.235	29.410	36.861	17,4%	28,9%
Akureyri	5.557	4.410	4.298	14.265	-1,9%	11,2%
Egilsstadir	2.467	802	28	3.297	3,9%	2,6%
Isafjordur	1.272	602	0	1.874	-7,6%	1,5%
Vestmannaeyj.	1.940	2.034	926	4.900	17,8%	3,8%
Husavik	862	24	356	1.242	10,1%	1,0%
Hornafjordur	912	174	0	1.086	-0,7%	0,9%
Grimsey	474	24	0	498	-8,8%	0,4%
Other airports	2.868	163	26	3.057	-2,7%	2,4%
Total	**32.834**	**20.961**	**73.732**	**127.527**	**10,4%**	**100,0%**

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Reykjavik	89.973	77.872	76.565	60.519	56.069	62.978	48.681	52.162	54.276	60.447
Keflavik	37.798	34.597	21.769	17.183	23.416	30.475	29.396	31.261	31.391	36.861
Akureyri	15.544	16.971	19.580	18.007	14.819	13.556	13.462	15.006	14.536	14.265
Egilsstadir	5.102	5.532	5.574	4.468	3.440	3.140	3.440	3.439	3.174	3.297
Isafjordur	2.480	2.144	2.638	2.468	2.046	2.066	1.908	2.010	2.028	1.874
Vestmannaeyj.	13.498	13.714	13.194	14.599	11.034	5.142	4.022	4.136	4.159	4.900
Husavik	32	42	254	46	6	32	20	718	1.128	1.242
Hornafjordur	1.552	1.288	1.282	1.276	1.372	1.345	1.182	1.100	1.094	1.086
Grimsey	594	524	662	688	558	558	468	556	546	498
Other airports	14.851	13.737	13.546	13.945	11.372	5.648	3.514	3.020	3.143	3.057
Total	**181.424**	**166.421**	**155.064**	**133.199**	**124.132**	**124.940**	**106.093**	**113.408**	**115.475**	**127.527**



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 2014 93% of the traffic in the Reykjavik CTA was on random tracks and 7% was on the NAT tracks. During 2014 the westbound NAT tracks entered the Reykjavik CTA 151 days while the eastbound NAT tracks entered the Reykjavik CTA only 4 days.

4.2.6 With implementation of NAT Data link mandate phase 2a on 5 February 2015 FANS compatible data link is required to fly at F350-390 inclusive on the NAT tracks.

4.3 Greenland, Faroe Islands and low level traffic

4.3.1 Following are a few key figures for the year 2014 concerning domestic traffic in Greenland, traffic departing from or arriving to airports in Greenland and the Faroe Islands and traffic in the Reykjavik CTA below F285.

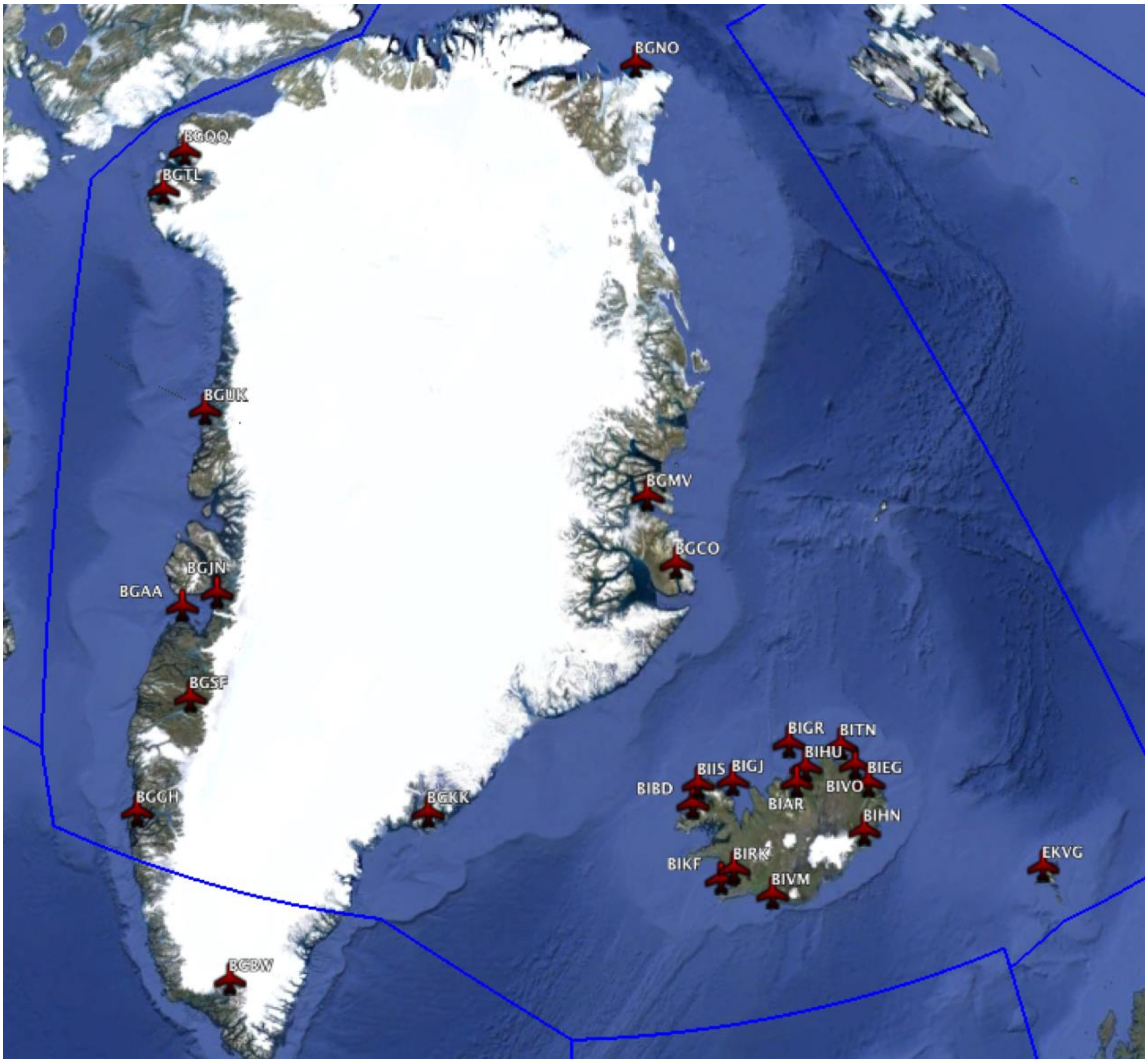


Figure 5: Airports with more than 10 yearly movements

Airport	Departures	Airport	Arrivals
BIKF	17144	BIKF	17186
BIRK	8026	BIRK	8024
BIAR	3223	BIAR	3167
EKVG	1479	EKVG	1466
BIEG	1365	BIEG	1365
BGSF	907	BGSF	874
BIVM	862	BIVM	860
BIIS	683	BIIS	677
BGGH	596	BGGH	595
BIHN	499	BIHN	495
BGJN	494	BGKK	479
BGKK	481	BGJN	475
BIHU	444	BIHU	442
BGBW	349	BGBW	407
BIBD	308	BIBD	316
BGTL	288	BGTL	272
BGUK	228	BIVO	263
BGCO	197	BGUK	239
BITN	196	BGCO	197
BIVO	158	BITN	123
BIGJ	69	BGQQ	72
BGQQ	65	BIGJ	66
BGNO	60	BGNO	58
BGMV	28	BIGR	42
BIGR	26	BGMV	26
BGAA	19	BGAA	25

Table 1: Number of Departures and Arrivals with more than 10 yearly movements

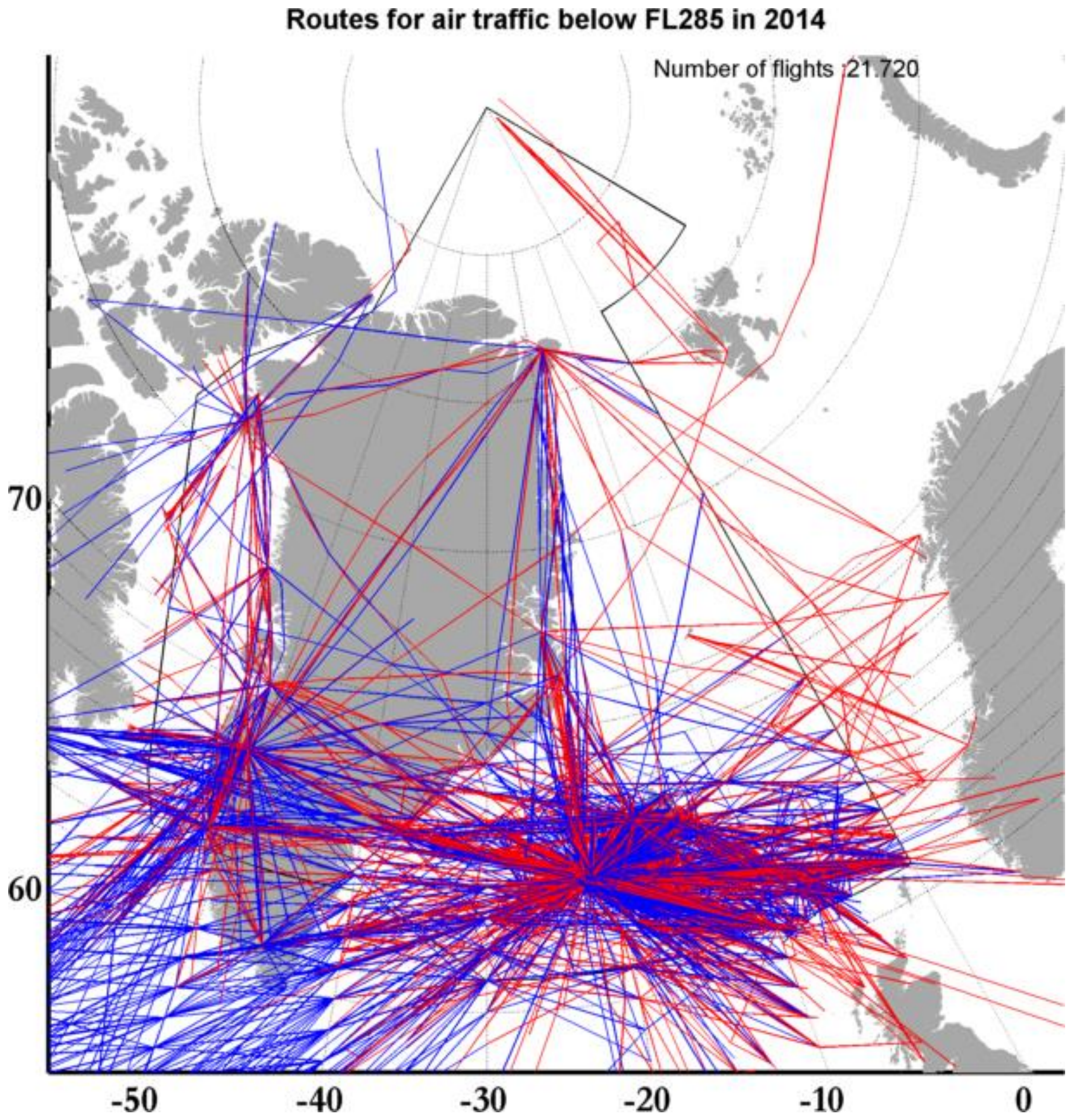


Figure 6: Flights below F285

(Blue = Westbound, Red = Eastbound)

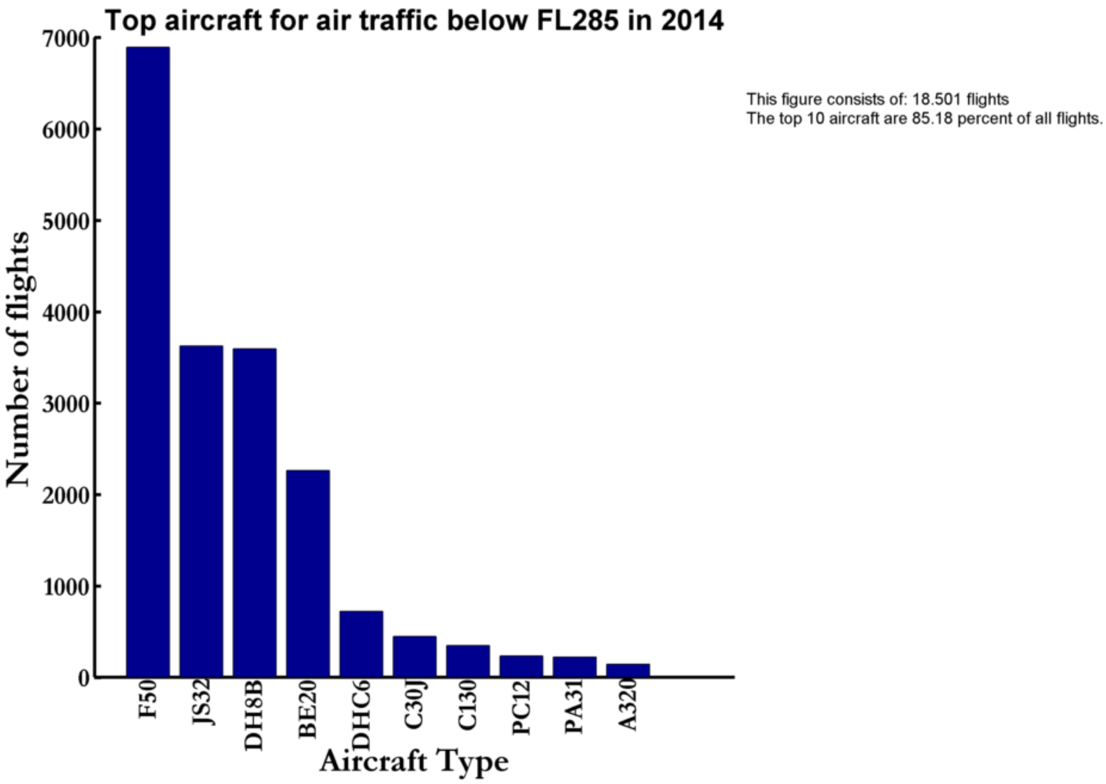


Figure 7: Top aircraft operating below F285

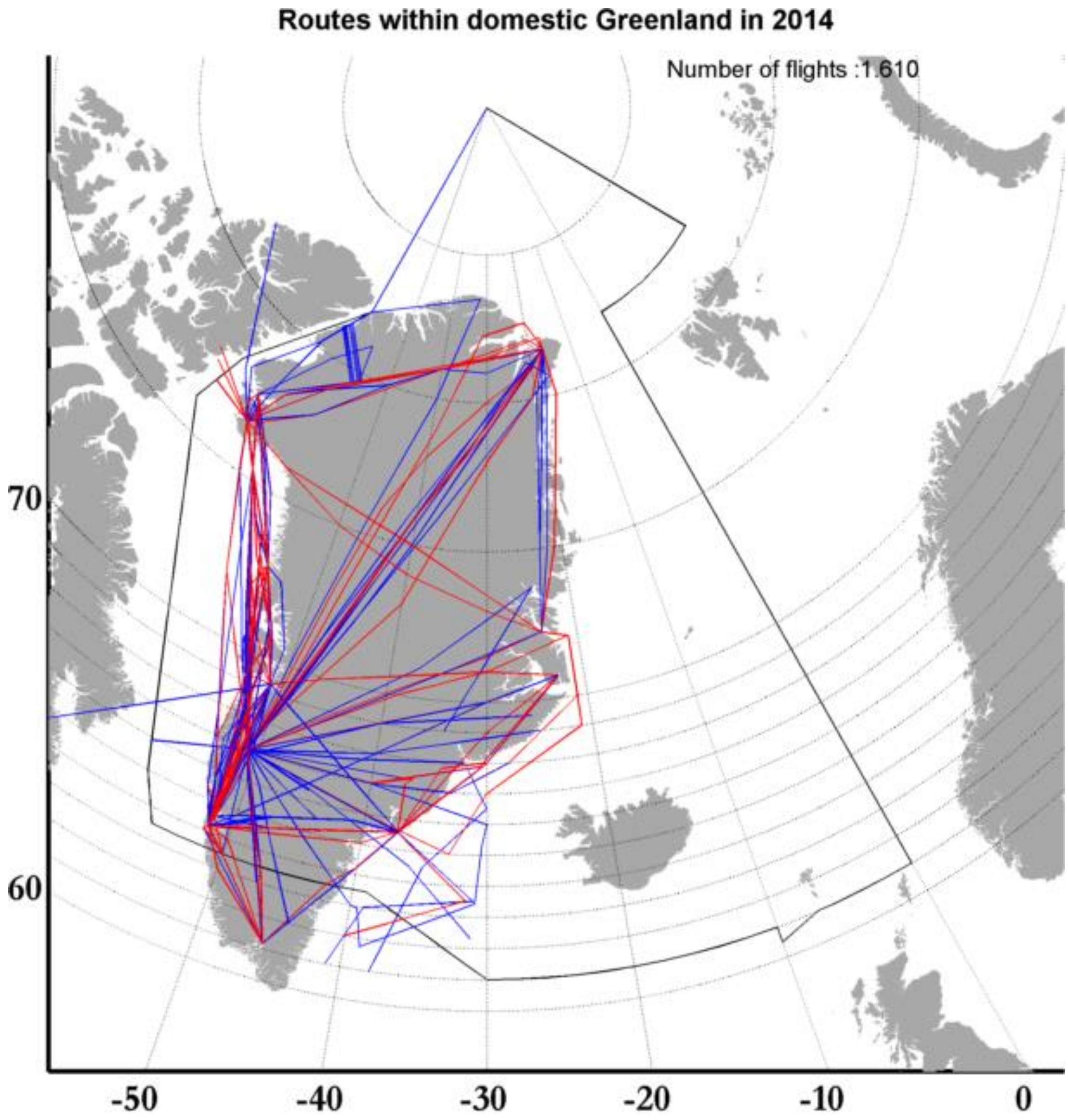


Figure 8: Domestic Greenland routes

(Blue = Westbound, Red = Eastbound)

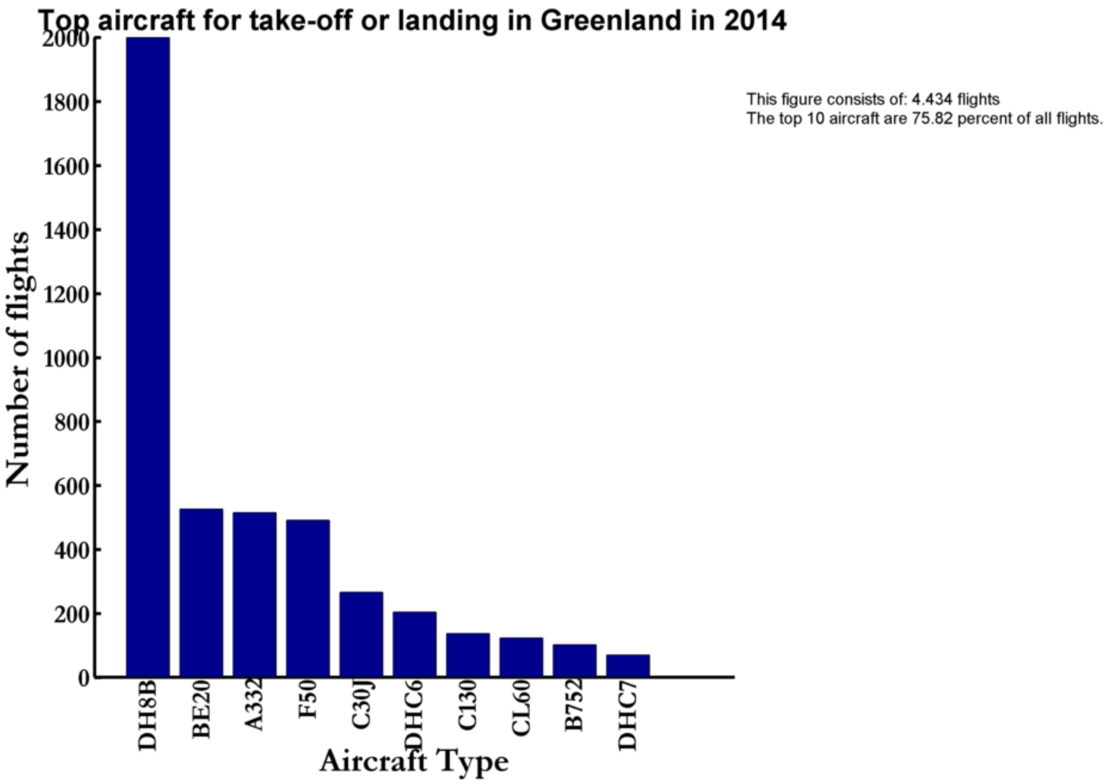


Figure 9: Top aircraft operating in Greenland

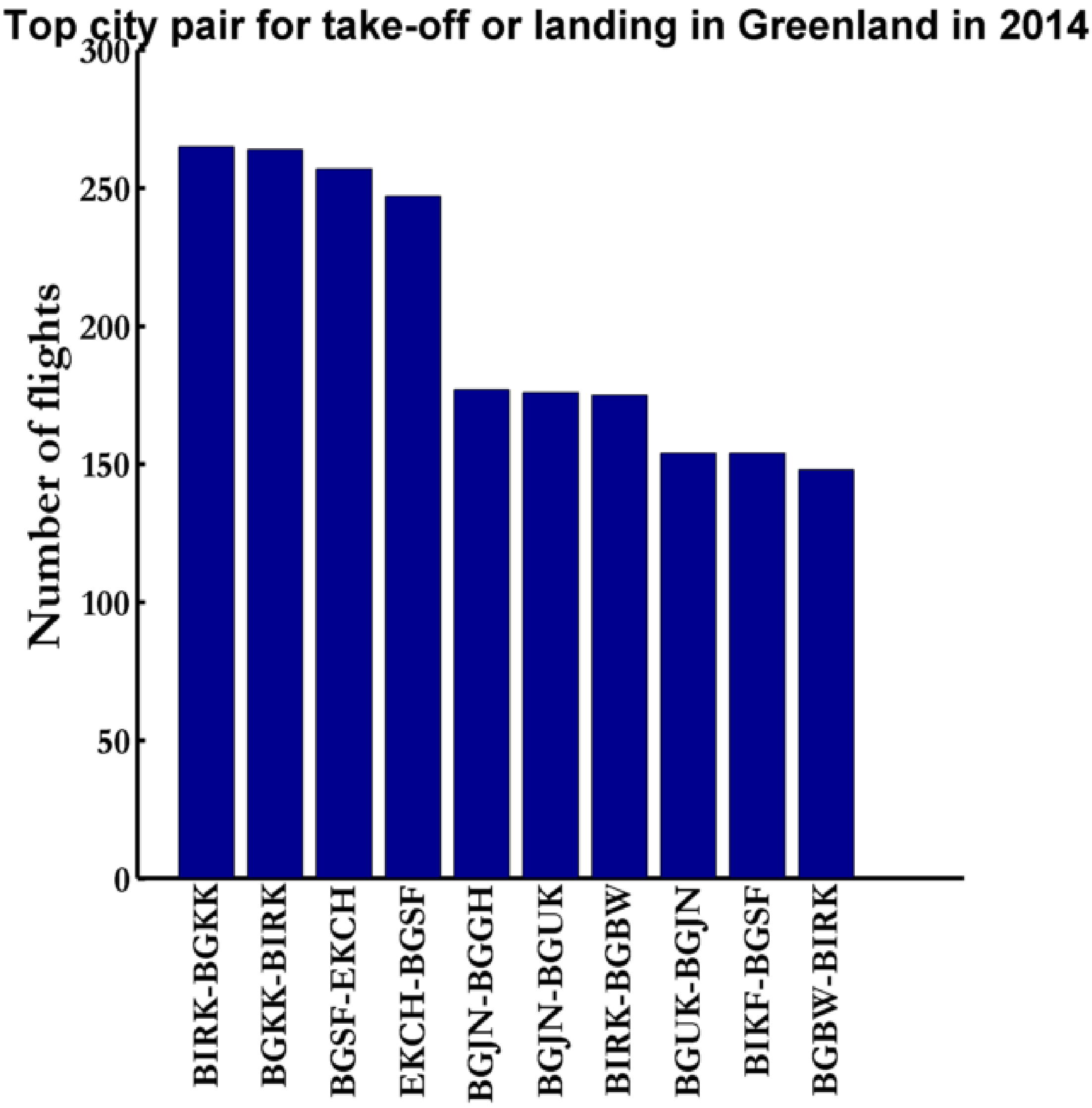


Figure 10: Top city pairs for aircraft operating in Greenland

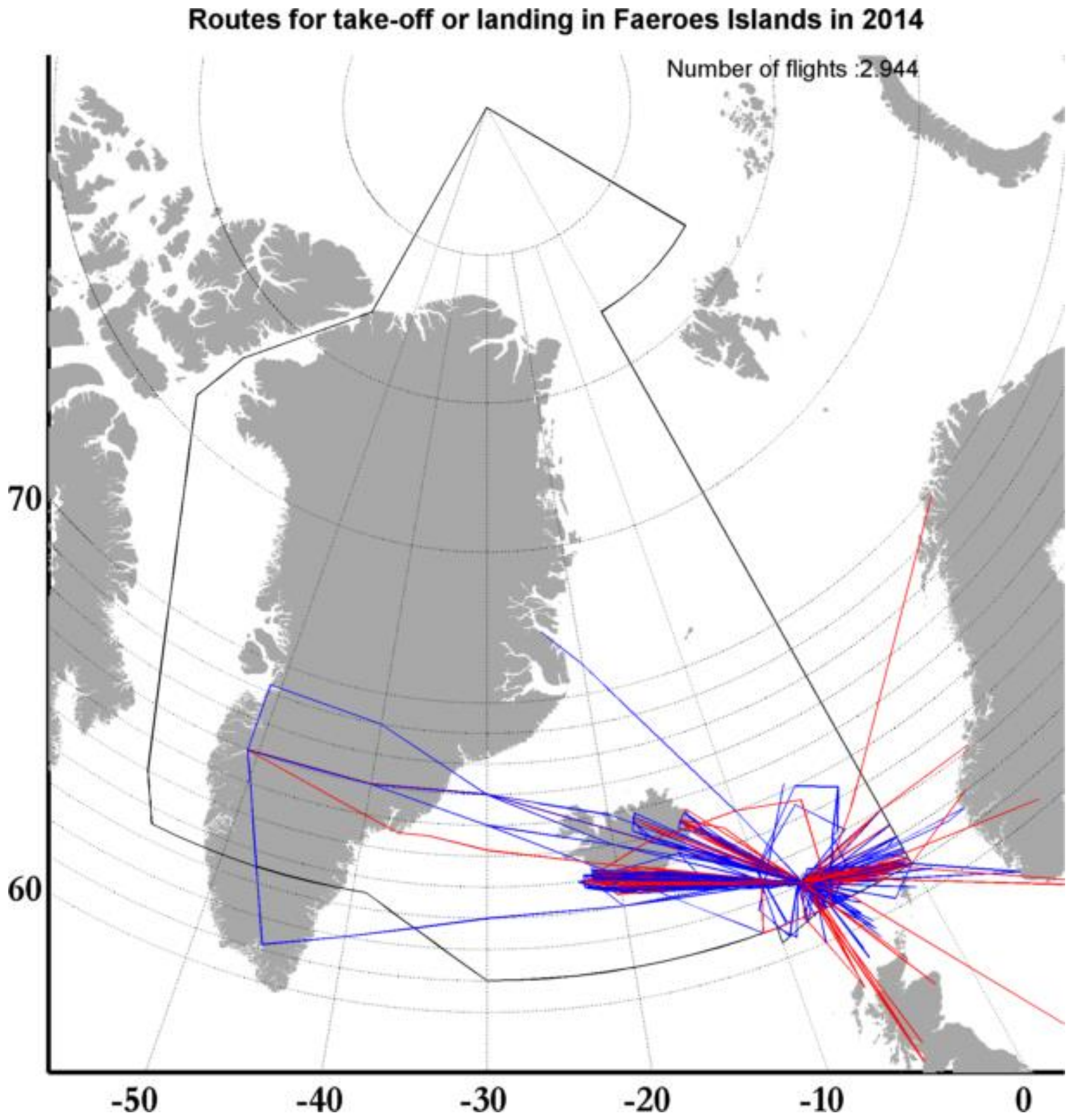


Figure 11: Faroe Island routes

(Blue = Westbound, Red = Eastbound)

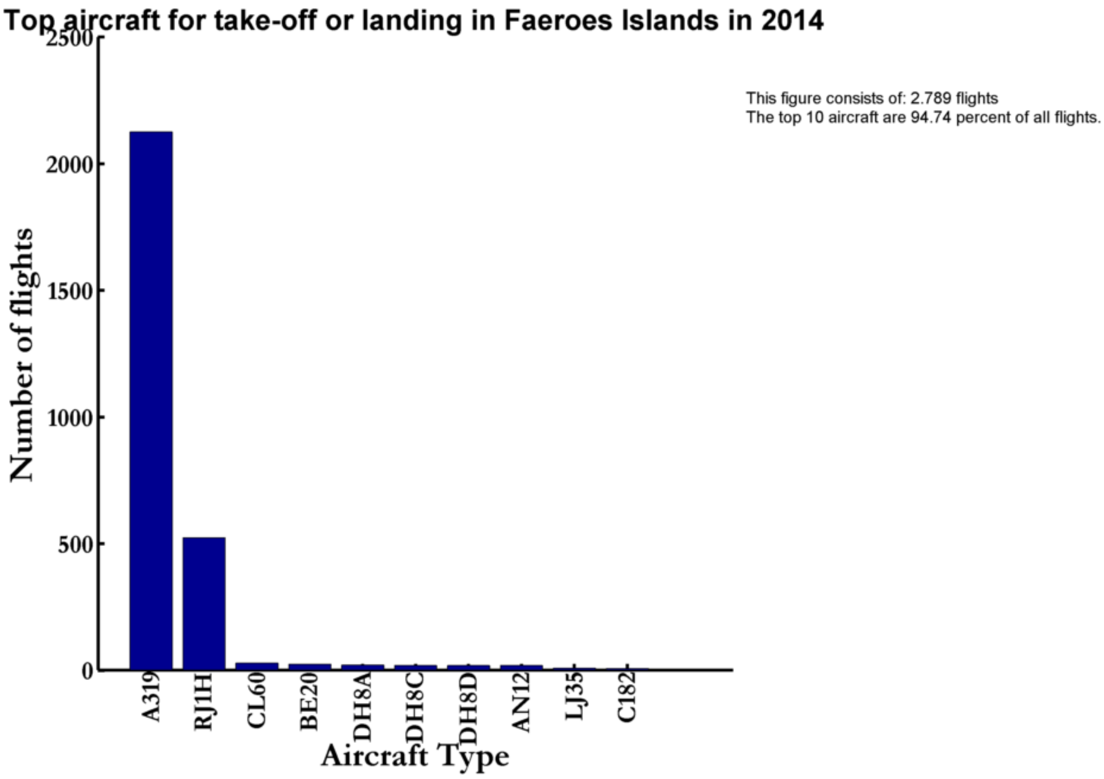


Figure 12: Top aircraft operating in the Faroe islands

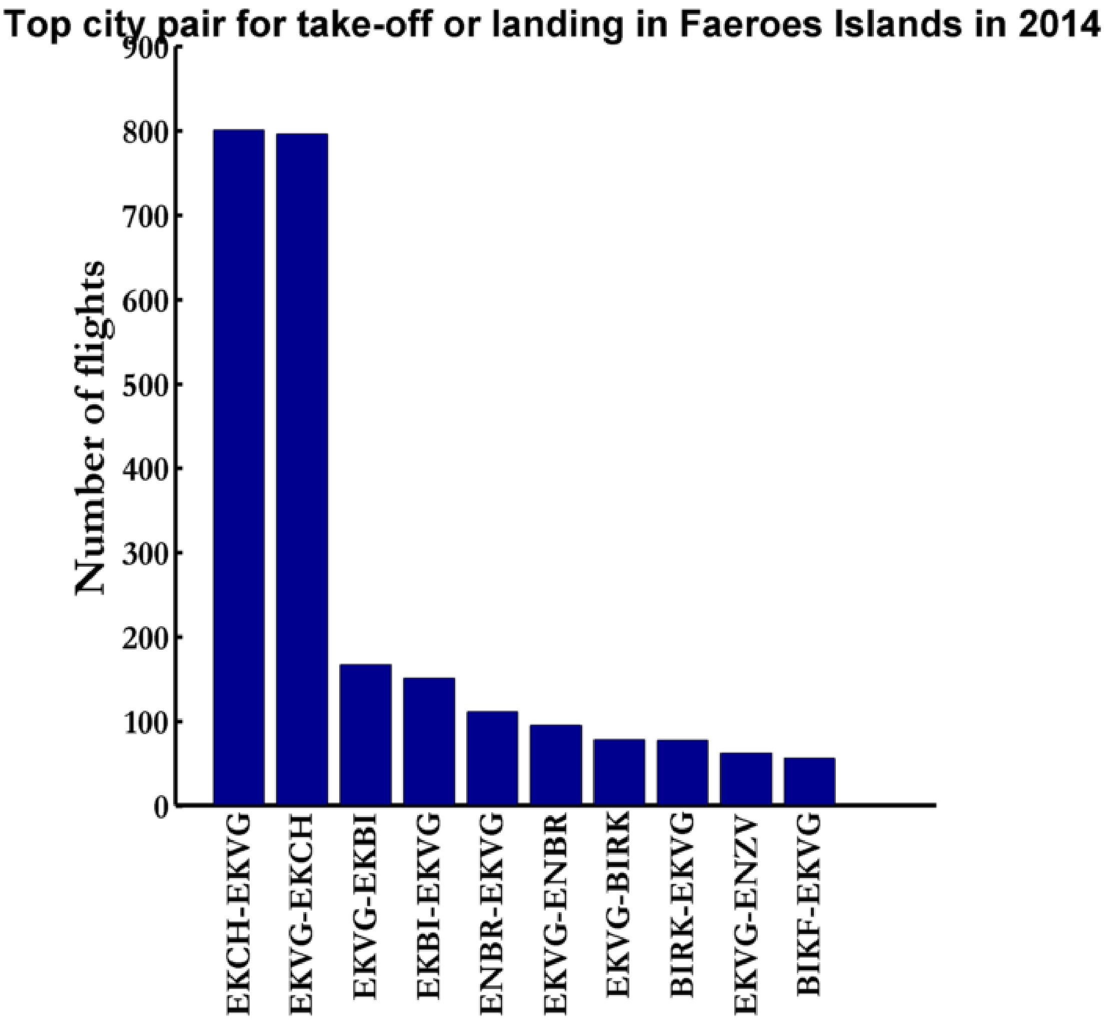


Figure 13: Top city pairs for aircraft operating in the Faroe Islands

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:
  - Direct controller pilot VHF voice communications will be established in spring 2015.
  - 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 for Inmarsat equipped aircraft).
  - 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). About 55% of all traffic 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 Edmonton, Gander, Shanwick, Scottish, Stavanger, Bodö 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 Murmansk, 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 12 January – 31 December 2014. The results were as follows:

	12. Jan 2014 – 31. Dec 2014	
MNPS only	1.595	0,9%
X, G	42.707	23,8%
X, RNP10	2.147	1,2%
X, RNP4	73	0,1%
X, G, RNP10	40.353	22,5%
X, G, RNP4	5.757	3,2%
X, RNP10, RNP4	420	0,2%
X, G, RNP10, RNP4	86.538	48,2%
Total MNPS FPLs	**179.590**	
GNSS equipage	175.355	97.6%
RNP10 equipage	129.458	72.1%
RNP4 equipage	92.788	51.7%
MNPS only	1.595	0.01%
GNSS and/or RNP10 and/or RNP4	177.995	99.1%

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 12 January 2014 to 31 December 2014. Domestic flights within Iceland were excluded. The result is:

Total number of non-domestic non-MNPS flight plans:	16.671	
GNSS equipped non-domestic non-MNPS flights:	14.596	87.5%

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 period 12 January to 31 December 2014. The result is that out of the total number of flights which is 11.525 the number of flights equipped with GNSS ("G" in FPL Item 10a) is 10.894 or 94.5%.

5.3 Surveillance

5.3.1 ATS Surveillance service is currently provided with radar and ADS-B as follows:

a) There are seven SSR radar stations; five stations in Iceland, one station in the Faroe Islands and one station in the Shetland Islands (see figure 9 below).

b) There are eight ADS-B stations in eight different locations in Iceland already in operation having similar range to the radar range in figure 9..

c) There are four ADS-B stations in two locations in the Faroe Islands that are scheduled to enter operation in March 2015.

d) There are ten ADS-B stations in five locations in Greenland that are scheduled to enter operation in March 2015.

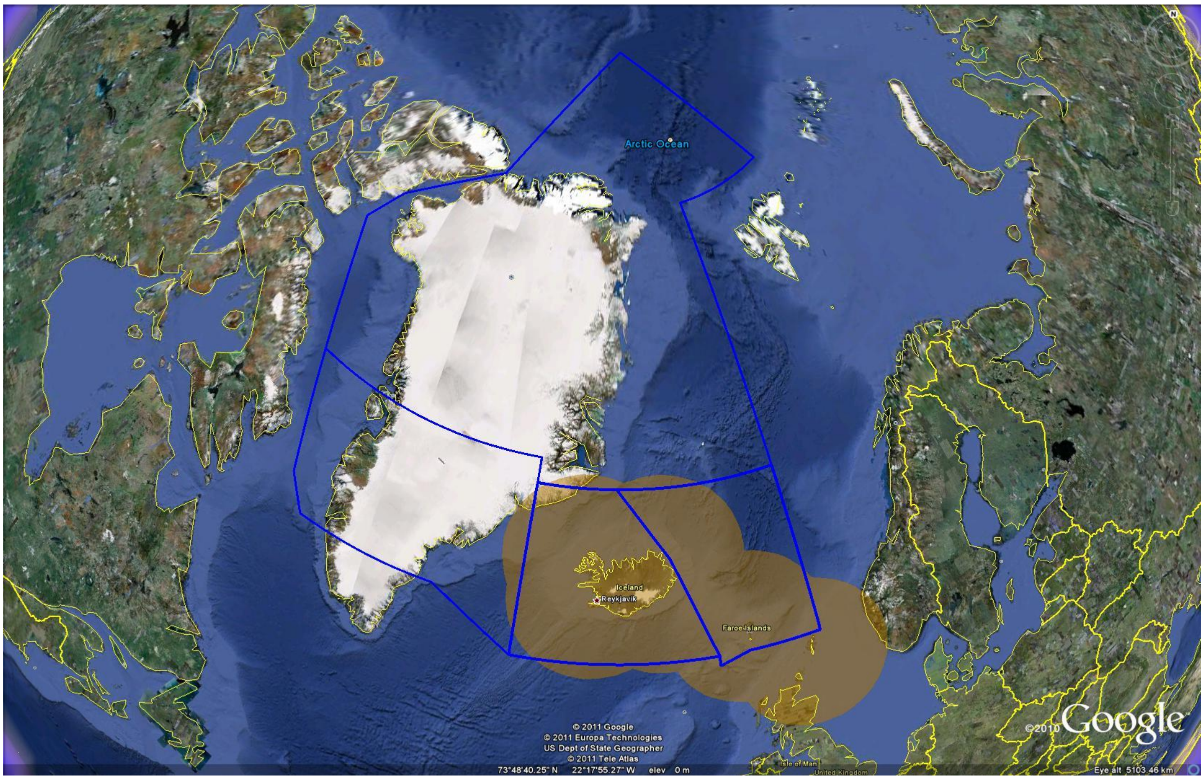


Figure 14: Current radar and ADS-B coverage at jet levels

5.3.2 The radar and ADS-B 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 and this will also soon be the case with the West sector. The ATS Surveillance 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.

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

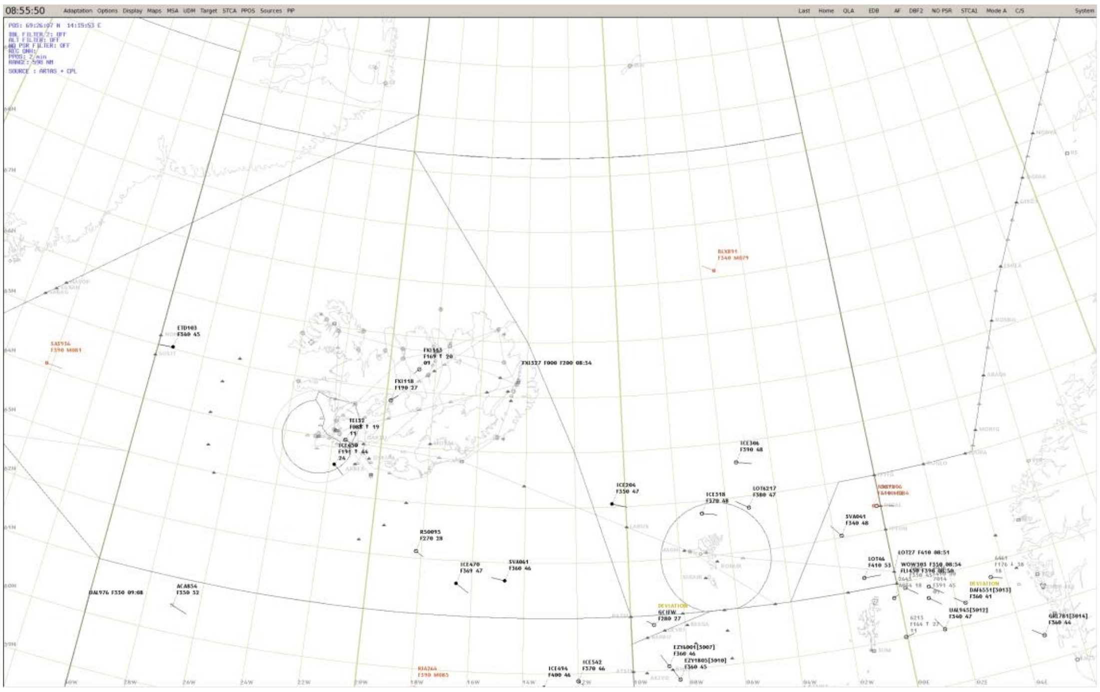


Figure 15: Integrated Situation Display System (ISDS)
(special print colors are shown)

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- and ADS-B data processing.
  - Air situation picture showing both radar, ADS-B 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 implementation of the following lateral separation standards below F285 in the Reykjavik CTA:

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

b) 15 NM lateral separation between GNSS equipped aircraft on intersecting and 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.

c) 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 be applied on a tactical bases by controllers when deemed to benefit the traffic.

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;

c) Where applicable, authorization from the appropriate authority has been obtained; and

d) If any portion of the flight is planned to be conducted under IFR, it refers to GNSS receivers that comply with the requirements of Annex 10, Volume I.

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.

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, also during the operational trial in Greenland.

6.8 The separation in 6.1 is less than the separation currently applied in the adjacent Edmonton, Gander, Shanwick, Murmansk and Bodö 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 was effected with Gander prior to commencement of the operational trial to obtain approval for the application of the new separation for those flights within the area of common interest.

6.10 Implementation of the separation in 6.1 is scheduled to be completed before end-of-year 2015. 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 Reykjavik CTA 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 ICAO Circular 334 *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 the new separation standards were subsequently published in the PANS-ATM in November 2014. The SASP safety assessment is contained in Chapter 3 of the document and the SASP implementation hazard log is contained in Attachment A of Circular 334.

8.1.2 Circular 334 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 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 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 Circular 334 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. (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. d) If any portion of the flight is planned to be conducted under IFR, it refers to GNSS receivers that comply with the requirements of Annex 10, Volume I.
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. (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. (Circular paragraph 3.6.8 refers).	For the application of this separation DCPC VHF voice communications will be prescribed.
There is no surveillance requirement.	Surveillance will be by means of position

Results are intended to apply to a procedural separation environment, however surveillance would reduce the mid-air collision risk calculated by the modeling. (Circular paragraph 3.6.9 refers).	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. (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.
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. (Circular paragraph 3.6.11 refers).	The AIC will specify 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. (Circular paragraph 3.6.17 refers).	The AIC will specify 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. For aircraft equipped with an RNP capable navigation system the pilot shall select an RNP value of RNP 2 or better in enroute mode or ensure that the CDI scaling is 5 NM or less.
Implementation of a lateral separation standard of 15 NM requires appropriate monitoring to ensure the rate of lateral deviations larger than 7.5 NM is less than 1E-5 and occupancy does not exceed 0.3 for opposite direction traffic. The LLD rate can be expressed as the total time aircraft deviate more than half the separation standard divided by the total	Continuous reporting and monitoring results of incidents, events and observations is a standard routine activity for all operations in the Reykjavik center. The assumed traffic density is much higher than the actual traffic density in the Reykjavik CTA below F285. The aircraft operating in the airspace are much smaller than the A380.

flight hours. The “occupancy” is defined as “the parameter of the collision risk model which is twice the count of aircraft proximate pairs in a single dimension divided by the total number of aircraft flying the candidate paths in the same time interval”. (Circular paragraph 3.6 refers). 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. (Circular paragraph 3.6.19 refers).	

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 (Circular 334 paragraph 3.6.12 refers).

8.2.4 The results of the collision risk modeling for typical navigation error are documented in the 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 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 Circular 334 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. (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. (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. (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; b) GNSS equipment and capabilities are commensurate with flight crew qualifications; c) where applicable, authorization from the appropriate authority has been obtained; and d) If any portion of the flight is planned to be conducted under IFR, it refers to GNSS receivers that comply with the requirements of Annex 10, Volume I.

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: $\alpha = 6 \times 10^{-5}$ when direct controller-pilot communication (DCPC) is available, and $\alpha = 2 \times 10^{-4}$ when communication between controllers and pilots is accomplished through a third party (Ref. 3.7.8). (Circular 334 paragraphs 3.7.19 and 3.7.25 refer).

8.3.4 The results of the collision risk modeling are documented in the 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, $\alpha = 6 \times 10^{-5}$) yielded $\text{Prob}\{collision\} = 4.24 \times 10^{-10}$, and the pair ($S = 20$ NM, $\alpha = 2 \times 10^{-4}$) yielded $\text{Prob}\{collision\} = 4.91 \times 10^{-10}$. 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 Circular 334 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 with no requirement for surveillance to be present. (Circular paragraph 3.8.2.2 refers).	The separation will be applied to GNSS equipped aircraft where ATS surveillance service cannot be provided.
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	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:

receiver. (Circular paragraph 3.8.2.4 refers).	a) the presence of relevant serviceable GNSS equipment on board the aircraft; and b) GNSS equipment and capabilities are commensurate with flight crew qualifications; c) where applicable, authorization from the appropriate authority has been obtained; and d) If any portion of the flight is planned to be conducted under IFR, it refers to GNSS receivers that comply with the requirements of Annex 10, Volume I.
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. (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 assumed to be such that the aircraft will comply with any climb/descend 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. (Circular paragraph 3.8.2.6 refers).	Controllers working a procedural airspace with different means of communication are trained in taking into account the controller intervention capability when applying separation. This is a routine part of the job in diverse airspace such as the Reykjavik CTA. The quality of HF communications is for example constantly monitored and different rules apply depending on the HF quality.
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. (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. (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	The AIC will specify the following: If the letter "G" has been included in Item 10 of the FPL the pilot shall immediately

established within five minutes of the start of the outage. (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. (Circular paragraph 3.8.2.10 refers).	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. (Circular paragraph 3.8.2.15 refers).	The AIC will specify 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. For aircraft equipped with an RNP capable navigation system the pilot shall select an RNP value of RNP 2 or better in enroute mode 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. (Circular paragraph 3.8.2.18 refers).	The assumed traffic density is much higher than the actual traffic density in the Reykjavik CTA 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 (Circular 334 paragraph 3.8.2.10 refers).

8.4.4 The results of the collision risk modeling for typical navigation error are documented in the 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 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 Circular 334 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 Assessment of the SASP Hazard Log

9.1 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).
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 four separate sectors, North,, West, South and East. The amount of low level traffic is small enough to be easily handled by those four 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.
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. 1b) Third party VHF and HF communications will be used for the application of the 20 NM lateral separation. 2) All Isavia controllers are already fully trained regarding communication procedures and communication performance.

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

A paragraph 5.4.1.1.4 has been added to the PANS-ATM stating that "When an aircraft turns onto an ATS route via a flyover waypoint, a separation other than the normally prescribed lateral separation shall be applied for that portion of the flight between the flyover waypoint where the turn is executed and the next 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.

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.
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.

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 in en-route mode
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 (Doc 9613).
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.

d) If any portion of the flight is planned to be conducted under IFR, it refers to GNSS receivers that comply with the requirements of Annex 10, Volume I.

Subject 8 – 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.

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) When conflict probe systems are used they 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.

Subject 9 – 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.
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 10 – 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.
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 11 – 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 12 – 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.
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 13 – 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) AIP Iceland specifies that SLOP is not allowed below F285 in the Reykjavik CTA.

— END —