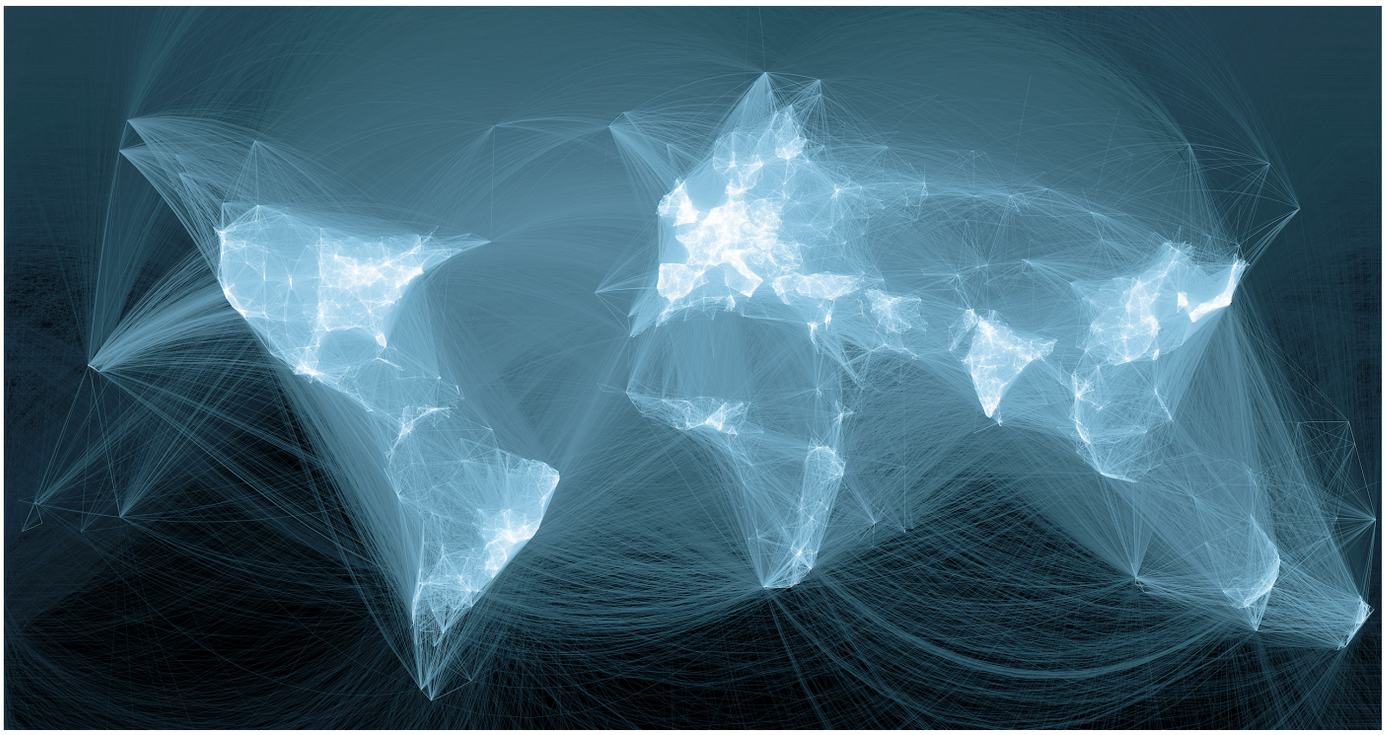
ICAO

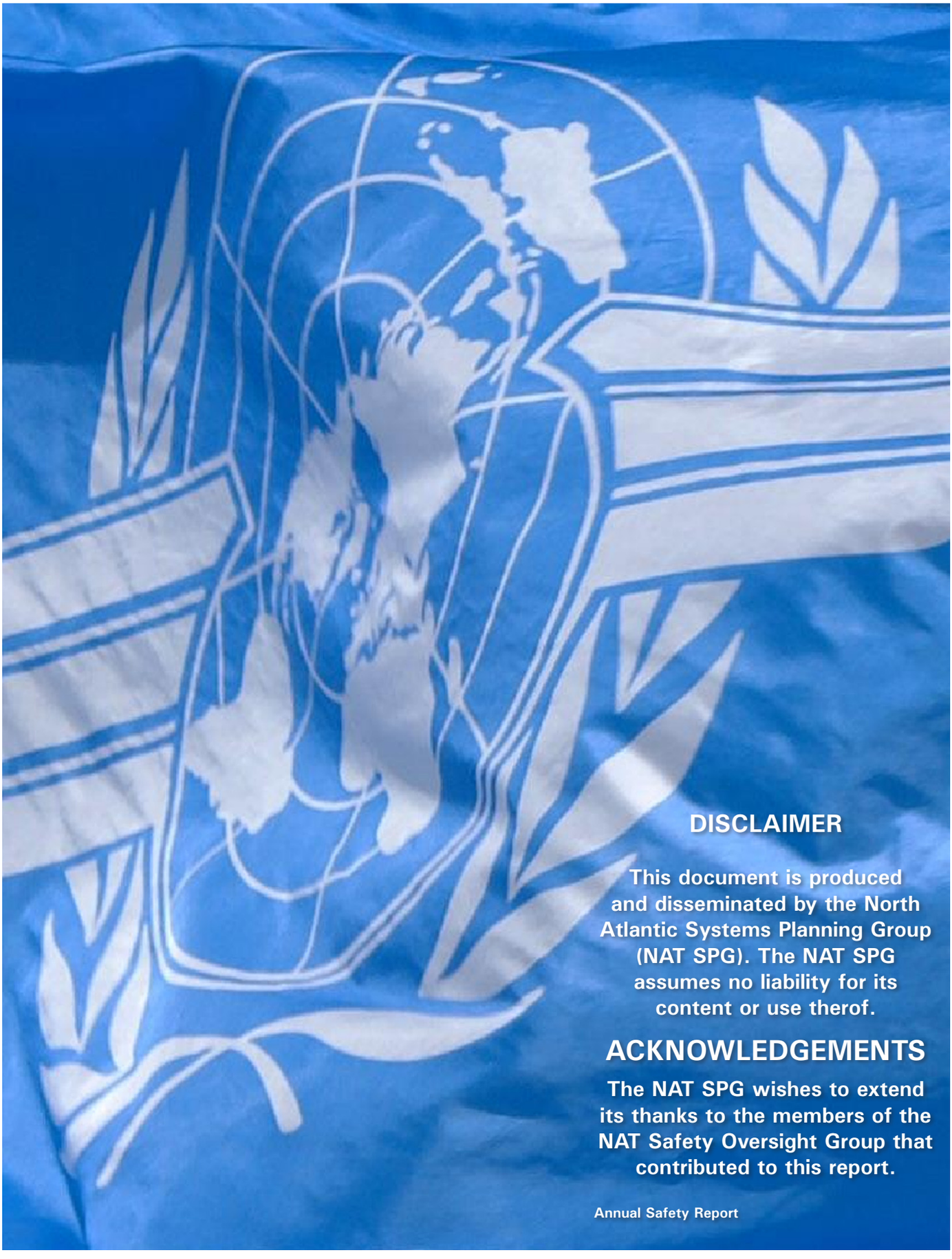
SAFETY

North Atlantic Region

2016 Annual Safety Report

June 2017





DISCLAIMER

ACKNOWLEDGEMENTS

The NAT SPG wishes to extend its thanks to the members of the NAT Safety Oversight Group that contributed to this report.

Annual Safety Report

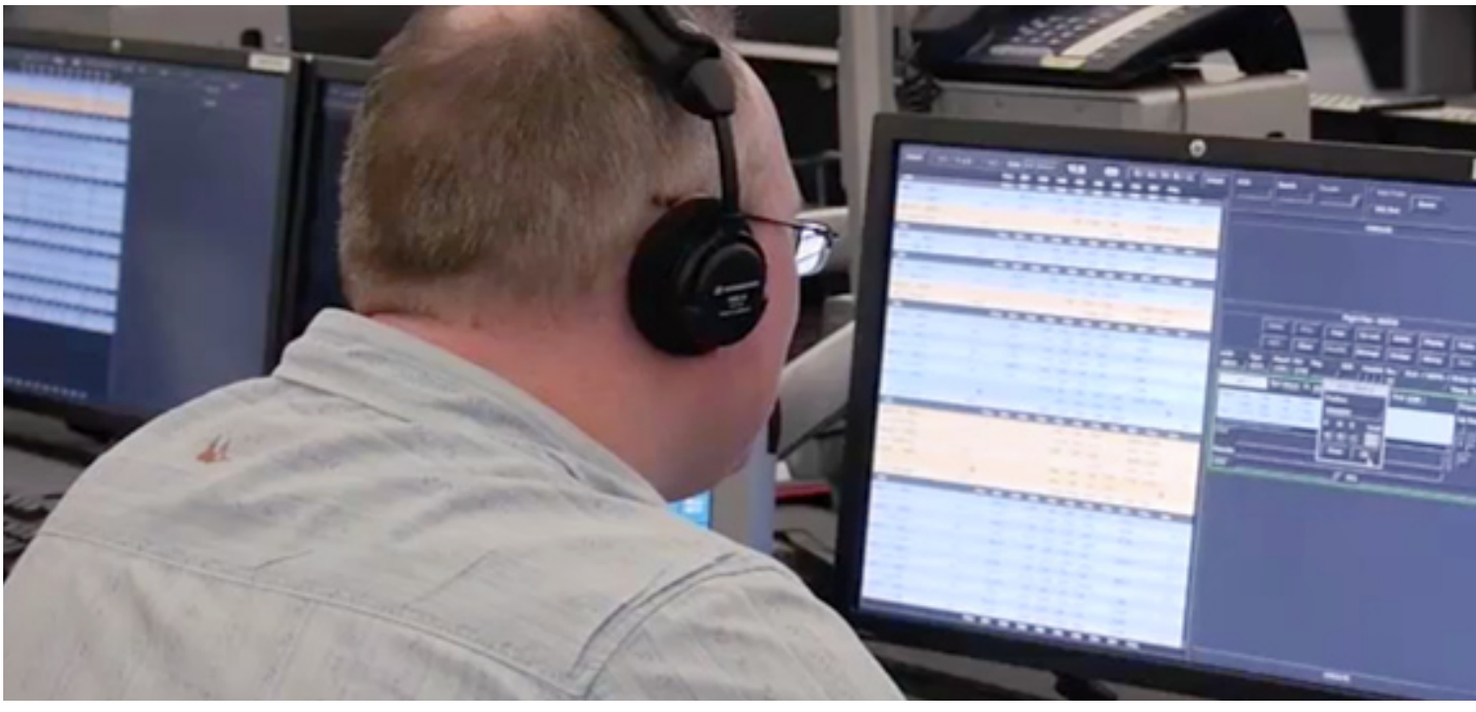
Contents

Executive Summary

The North Atlantic Region's fourth annual safety report is issued by ICAO's North Atlantic (NAT) Systems Planning Group (NAT SPG). As stipulated in its terms of reference, the NAT SPG shall continuously study, monitor and evaluate the air navigation system in the NAT Region in light of changing traffic characteristics, technological advances and updated traffic forecasts. This report is based on data from January to December 2016 and provides basic information on the Region, its safety principles, and its risks. The report also describes some of the NAT SPG's collaborative safety management efforts.

The management of safety in the NAT Region is partly conducted by the use of safety Key Performance Indicators (KPIs) that have been developed and established by the NAT SPG. For the year 2016, targets were met for 3 of 5 KPIs and the Region continues on track to meet an additional 2 targets in 2019 (see Table 3 for more detailed information).

The use of Strategic Lateral Offset Procedure (SLOP) is an important safety initiative. If there was better utilization of SLOP, the vertical risk would have been significantly improved. The use of SLOP should be encouraged at all NAT related user forums. See Figure 2 for more detailed information.



The North Atlantic Scenario

The airspace of the North Atlantic, which links Europe and North America, is the busiest oceanic airspace in the world. The NAT Economic, Financial, and Forecast Group (NAT EFFG) estimates that in 2016, during the peak week of July 15 to July 21, approximately 12,682 flights crossed the North Atlantic. The NAT EFFG expects traffic in this Region to grow at a rate of 5.3 % over the next 5 years, as shown in Table 1 below. This projection increased from an estimate of 3.6% growth noted in last year's report. Figure 1 below further illustrates these projections. While the composite 20-year projection from 2016 to 2036 is still 3.6%, this year's growth is a good illustration of increased demand in the busiest oceanic airspace in the world, and the importance of the safety work of the NAT Safety Oversight Group (SOG). The NAT SOG is responsible to the NAT SPG for safety oversight in the NAT Region.

	Actuals					Forecast				
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
TOTAL	10,139	10,386	11,012	11,563	12,682	13,515	14,099	14,709	15,480	16,392
Year to year change		2.4%	6.0%	5.0%	9.7%	6.6%	4.3%	4.3%	5.2%	5.9%
5-year % change	**29.3% Total 5-Year Growth**									
5-year Year to year % change	**5.3% Average Year to Year Growth**									

Table 1: Forecasts of aircraft movements in the ICAO NAT Region during the Peak Week of July 15- 21

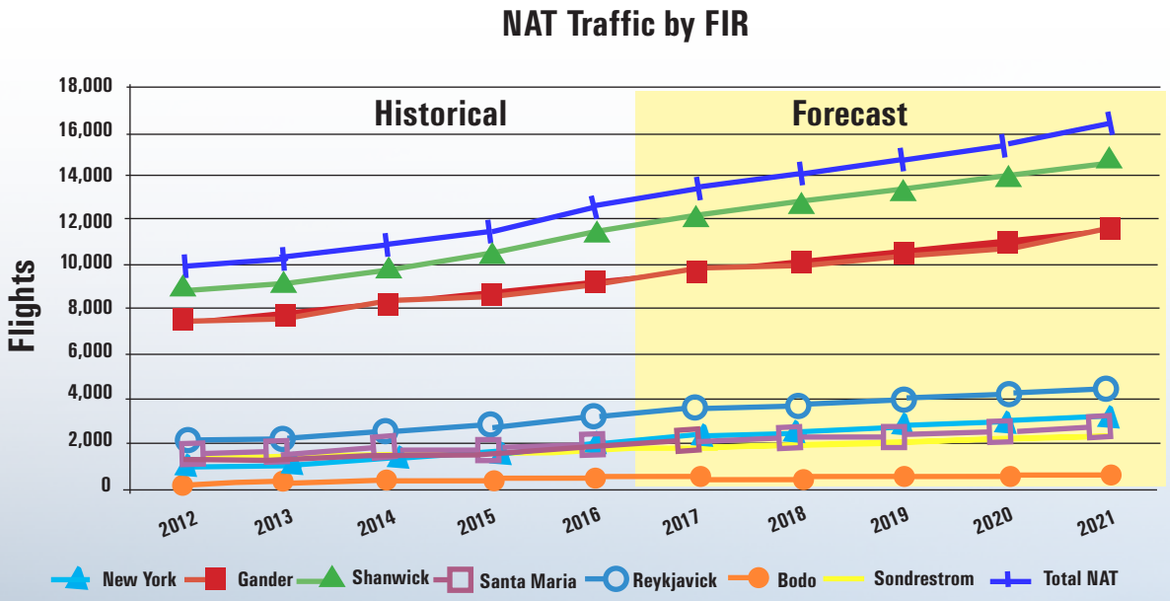


Figure 1. *NAT Traffic by FIR*

Traffic mainly flows in a broadly East-West orientation in a twice daily pattern, whose timing reflects the needs of passengers in North America and Europe, and where a daily organized track system takes account of airspace users' needs and weather patterns. This core traffic operates for a large part without radar surveillance and increasingly with the use of Automatic Dependent Surveillance-Contract (ADS-C) and Automatic Dependent Surveillance-Broadcast (ADS-B). Communication is to a large extent based on High Frequency radio but increasingly on satellite based data link, also referred to as Controller-pilot data link communications (CPDLC). This makes any comparison with the domestic airspace of North America and Europe difficult. NAT core traffic flow is almost exclusively jet transport aircraft that operate in the upper airspace in the en-route phase of flight. This leads to air traffic management and operation that is fundamentally different in concept to typical domestic operations, with a greater focus on strategic rather than tactical techniques.

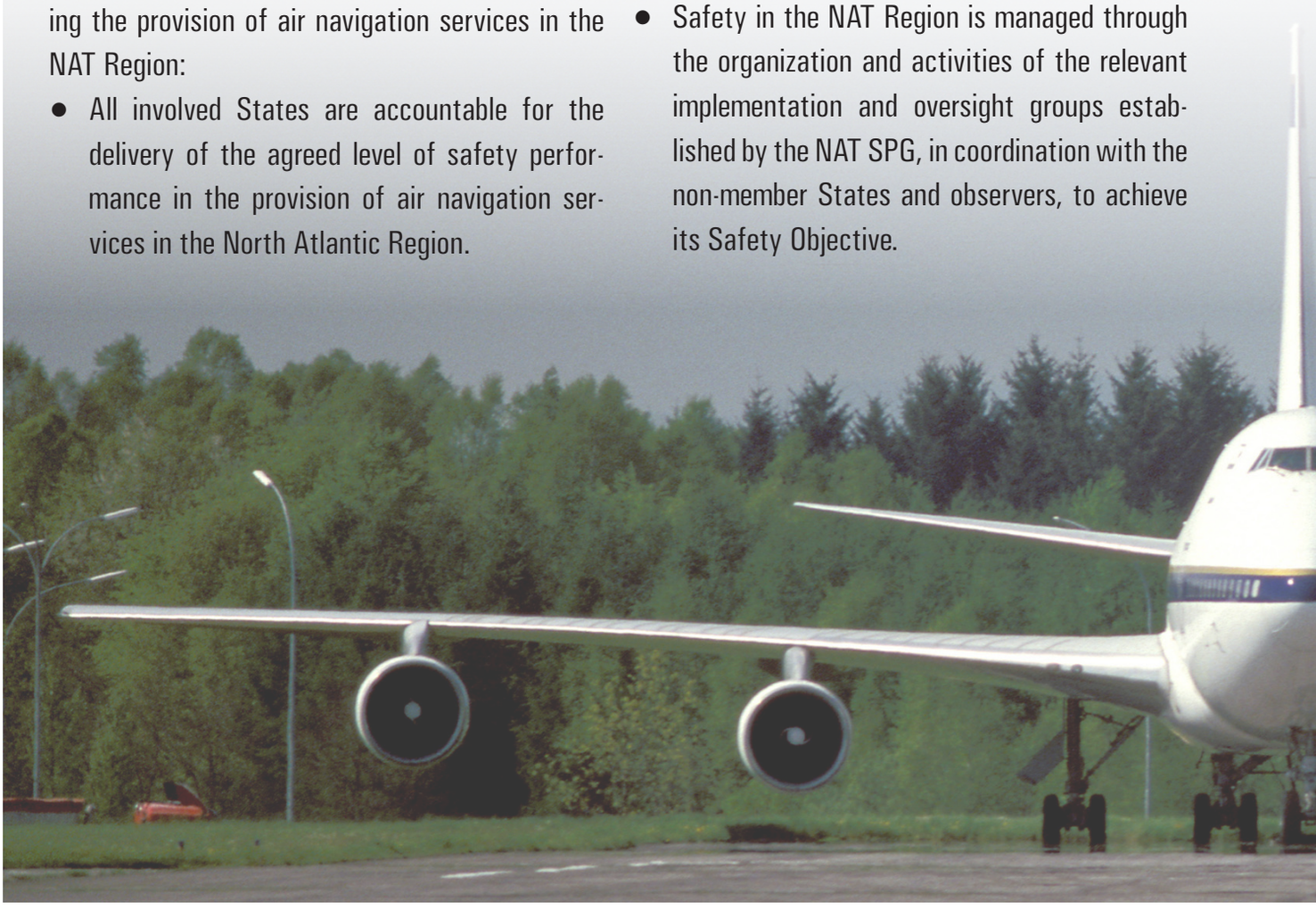
Safety Policy

Safety is the NAT SPG's core business function. The NAT SPG is committed to developing, implementing, maintaining and constantly improving strategies and processes to ensure that all our aviation activities take place under a balanced allocation of organizational resources. The NAT SPG aims to achieve the highest level of safety performance and meet regional safety objectives in line with national and international standards, the Global Aviation Safety Plan (GASP), and the Global Air Navigation Plan.

Objective

The objective of the NAT SPG member States is to maintain and, where possible, improve the agreed safety standards in all activities supporting the provision of air navigation services in the NAT Region:

- All involved States are accountable for the delivery of the agreed level of safety performance in the provision of air navigation services in the North Atlantic Region.
- All involved States are accountable for the delivery of the agreed level of safety performance in aircraft operations in the North Atlantic Region.
- Safety in the NAT Region is managed through the organization and activities of the relevant implementation and oversight groups established by the NAT SPG, in coordination with the non-member States and observers, to achieve its Safety Objective.



Guiding Principles

The NAT SPG will act to:

- Clearly define all accountabilities and responsibilities for the delivery of safety performance with respect to the provision of air navigation services and participation in the NAT SPG and its contributory bodies;
- Support the safety management activities that will result in an organizational culture that fosters safe practices, encourages effective safety reporting and communication, and actively manages safety within the NAT Region;
- Share safety related data, knowledge and expertise with concerned stakeholders;
- Disseminate safety information and NAT operating requirements to stakeholders;
- Establish and implement hazard identification and risk management processes in order to eliminate or mitigate the safety risks associated with air navigation services supporting aircraft operations in the North Atlantic Region;
- Establish and measure NAT Region safety performance against agreed safety standards; and
- Continually improve our safety performance through safety management processes.

Safety Performance

Table 2 below lists the most common event types reported in the NAT High Level Airspace (HLA)[1]. The three most common errors that led to these events are given with their respective frequencies.

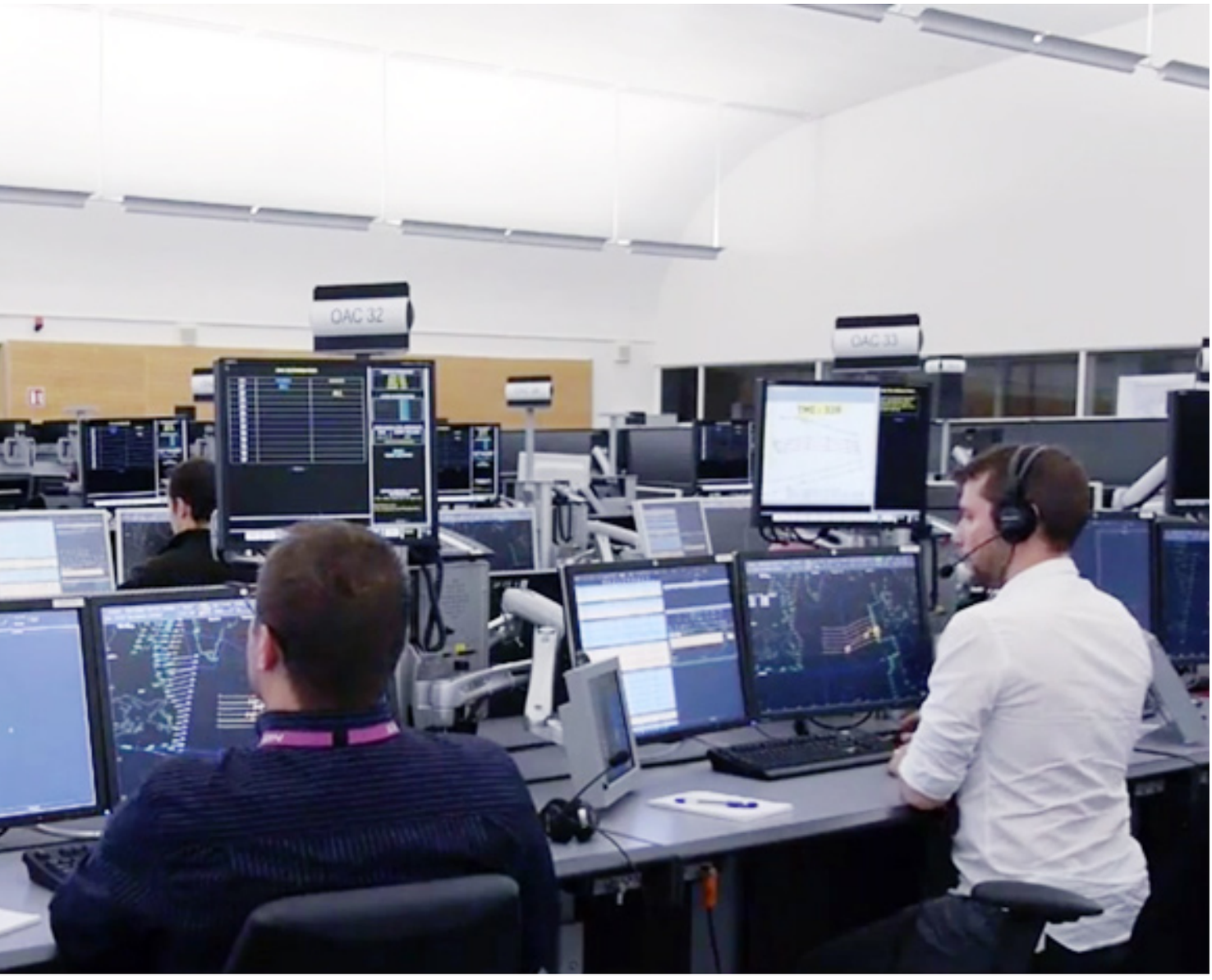
2016 Reported Events		Top 3 errors as defined by the NAT SG
Vertical Large Height Deviations (LHDs)	**105**	ATC Coordination Error **(17)**
		ATC Failure to correctly record, coordinate, or follow through on FL changes and/or other clearances **(17)**
		Entry to RVSM airspace at an incorrect level **(5)**
Lateral deviation < 25 Nautical Mile (NM)	**58**	Crew error (**19**)*
		Incorrect transcription of ATC clearance or re-clearance into the FMS (**11**)*
		Wrong information faithfully transcribed into the FMS (**9**)*
ATC Interventions *and* Preventions to prevent a Gross Navigation Error (GNE)	**144**	

***Table 2**. Most common errors within the NAT HLA*

** - identified by ATC*

[1] Airspace between FLs 285 and 420 inclusive, formerly Minimum Navigation Performance Specification (MNPS) airspace

Note that ATC interventions and preventions are positive indicators that the ATC system has recognized error, often through data link equipage capabilities, warning the controllers in sufficient time to take preemptive action. ATC Interventions are events where the Air Traffic Controller (ATCO) caught and corrected a lateral deviation before it developed into a GNE. An ATC Prevention is an event where the ATCO intervened to prevent a lateral deviation. Underlying causes of all lateral deviations (incipient or actual) are often identical – the magnitude depends upon the timeliness of identification and corrective action.



Safety Key Performance Indicators (KPIs)

The NAT SPG has established eleven Safety KPIs and corresponding targets for the ICAO NAT Region. Targets are reviewed annually by the NAT SOG. The NAT Region's performance in 2016 against the KPIs and targets is shown in **Table 3** below.

Safety performance in the vertical and lateral dimensions is evaluated according to the estimated collision risk, which is calculated in units of fatal accidents per flight hour (FAPFH) x 10^{-9} and compared to the Target Level of Safety (TLS) of 5 x 10^{-9} in the vertical dimension and 20 x 10^{-9} in the lateral dimension.

Safety KPI			Target	2012 Value	2013 Value	2014 Value	2015 Value	2016 Value
i	Number of hull loss events		0	0	0	0	0	0
ii	Number of Airborne Collision Avoidance System (ACAS) Resolution Advisory (RA) events		Target not set	1	1	1	1	1 (+ 1 below HLA)
iii	Number of LHD events involving data link equipped aircraft		1) Not exceeding 85 events per year by 2018 (total LHDs)	42[2]	54	69	74	78 (incl. +8 equipped but not in use)
iv	Number of LHD events involving non data link equipped aircraft		2) Eliminate LD LHD events by end of 2018 (total LHDs)	51	51	32[3]	26	19
v	Number of minutes that data link equipped aircraft spent at the wrong flight level		Target not set	490[4]	153	288	116	209
vi	Number of minutes that non data link equipped aircraft spent at the wrong flight level		Target not set	251	69	315[5]	144	60
vii	Performance in the vertical dimension against the vertical TLS		5 x 10^{-9} fapfh[6]	16.8 x 10^{-9} fapfh	11.5 x 10^{-9} fapfh	15.9 x 10^{-9} fapfh	16.4x10^{-9} fapfh	12.6x10^{-9} fapfh
viii	Number of GNE events involving data link equipped aircraft	GNEs ≥ 25 NM	Target not set	6	4	8	11	4
		GNEs ≥ 10 NM < 25 NM	Target not set	9	8	18	26	22
		Total GNEs DL a/c	Target not set	15	12	26	25	26
ix	Number of GNE events involving non data link equipped aircraft	GNEs ≥ 25 NM	Target not set	22	12	23	4	10
		GNEs ≥ 10 NM < 25 NM	Target not set	12	16	24	8	31
		Total GNEs non DL a/c	Target not set	45	28	47	12	41
x	Performance in the lateral dimension against the lateral TLS		20 x 10^{-9} fapfh	0.0 x 10^{-9} fapfh	0.2 x 10^{-9} fapfh	0.0 x 10^{-9} fapfh	0.0 x 10^{-9} fapfh	8.0 x 10^{-9} fapfh[7]
xi	Number of losses of separation		Target not set	44	32	42	46	55

Table 3: *NAT Safety KPIs 2016*

[2] Note - Not routinely reported. May be estimated from supporting event data but inconsistently available.
[3] For this number "data link equipped" is to be read as "equipped and using datalink for communication"
[4] Includes 3 very long duration events (total 383 minutes) where aircraft were CPDLC/ADS-equipped but not logged on
[5] Includes one very long duration event (127 minutes)
[6] Incorporating the effects of Strategic Lateral Offset Procedure
[7] Based on revised lateral Collision Risk Modelling approved by NAT SOG

Risk Estimates

Risk in the North Atlantic airspace is understood in terms of lateral and vertical collision potential. Lateral and vertical collision risk is estimated using occupancy data for the heavily traveled NAT routes between North America and Europe. NAT routes include organized tracks and random routes. This year, lateral and vertical occupancies were derived using data received from all Oceanic Control Areas (OCAs) with the following results:

Vertical Risk

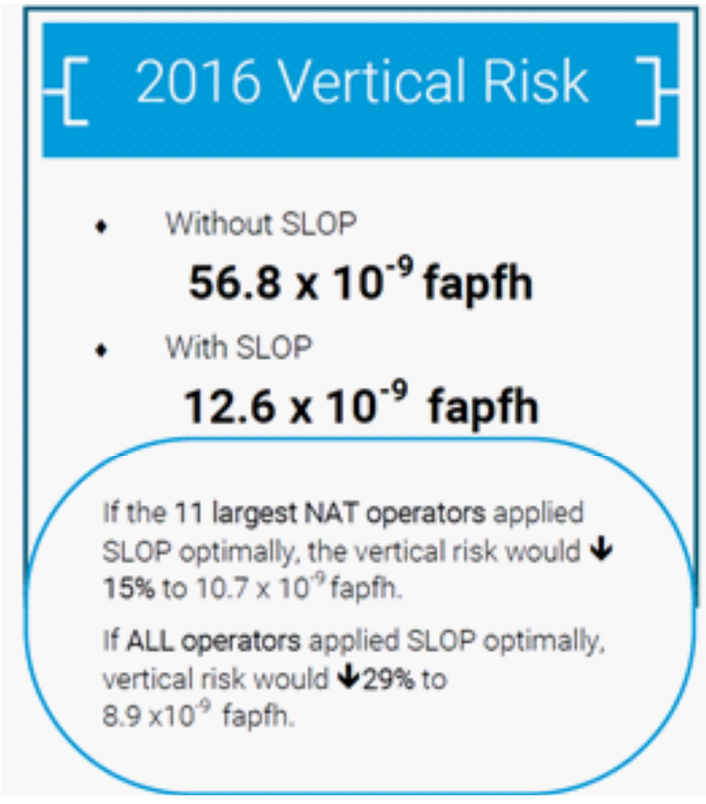


Figure 2: *2016 Vertical Risk with and without SLOP*

In 2016, vertical risk was significantly mitigated by use of the Strategic Lateral Offset Procedure (SLOP). This mitigation has been tracked since 2007 and has been very effective in curbing the upward trajectory of vertical risk in the Region. For 2016, the combined vertical operational collision risk estimate of 56.8 x 10–9 fapfh reduces by 78% to 12.6 x 10–9 fapfh with SLOP factored in. This is a 23% decrease from the 2015 vertical risk estimate with SLOP included. However, it is still higher than the vertical Target Level of Safety, which is 5 x 10–9 fapfh. As noted in **Figure 2**, it is estimated that the universal use of SLOP, considered independently of any other factor, would further reduce Vertical Collision Risk dramatically, to a level that approaches the TLS.

Reduced Vertical Separation Minimum (RVSM) Vertical Operational Collision Risk Estimates are put in historical context in **Table 4** and **Figure 3** below. They illustrate an overall downward trend in risk since 2009.

RVSM Vertical Operational Collision Risk Estimate

(Fatal accidents per flight hour x 10^{-9})

Year	OTS	Random	Combined	Including SLOP
2016	13.7	80.4	56.8	12.6
2015	12.6	110.4	77.4	16.4
2014	25.4	101.9	68.3	15.9
2013	24.2	62.4	48.0	11.5
2012	13.9	147.0	91.4	16.8
2011	69.0	100.2	86.2	23.9
2010	34.2	102.3	71.4	23.3
2009	15.0	100.9	61.6	27.2

Table 4. *RVSM Vertical Operational Collision Risk Estimates*

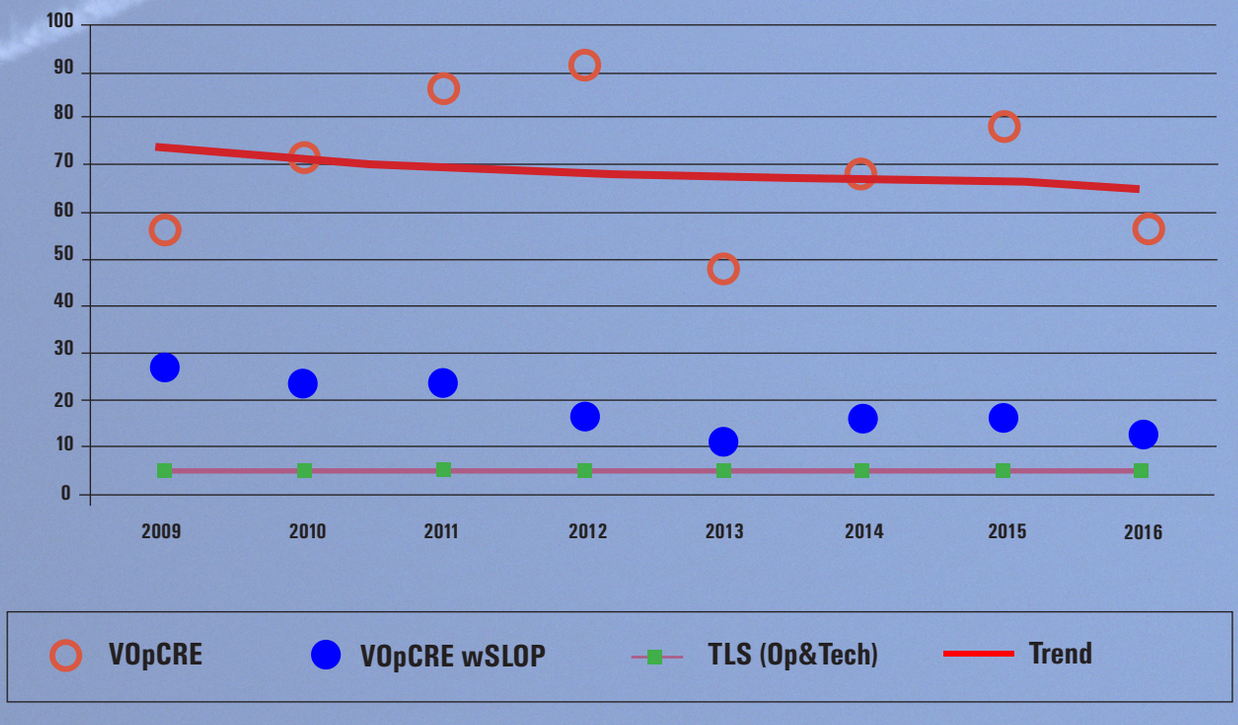


Figure 3. *RVSM Vertical Operational Collision Risk Estimates*

Large Height Deviations

The NAT SPG has targeted vertical risk specifically for the last several years through an emphasis on reducing LHD events. At its 49th meeting in 2013, the NAT SPG agreed to a NAT Vertical Risk Reduction Implementation Plan and established targets for vertical risk. The NAT SPG Conclusion 49/16 – Target levels for the vertical risk, was as follows:

That:

a) long duration (LD) LHDs in the vertical dimension are defined as those events which are 10 minutes or more;

b) the definition of LD LHD be reviewed annually in order to maintain improvement in reduction to LHDs;

c) a target is to reduce the number of LHDs in the NAT RVSM airspace over a three year rolling average;

d) a target is to reach a total number of LHD events within the NAT RVSM airspace by 2018 not exceeding 85 per year;

e) a target is to reduce the total number of minutes associated with the three longest LHDs within the NAT RVSM airspace;

f) a target is to eliminate the number of LD LHD events within the NAT RVSM airspace by the end of 2018; and

g) the NAT SOG request trend-specific action when any adverse trend develops.

In 2016, there were 82 LHDs events at RVSM levels and 105 in the entire NAT airspace, which includes the HLA (shown in brackets in the text and in **Table 5** below). This is a decrease from last year. Based on the three year rolling average (2013-2015), the Region is on target for meeting the 2018 goal.

LHD Data		2010	2011	2012	2013	2014	2015	2016	2018 (Long Term Target)
# of EVENTS	# of LHDs Within RVSM (within entire NAT)	115 (138)	88 (107)	128 (163)	102 (128)	92 (116)	100 (120)	82 (105)	85
	# of LD LHDs (10mins +) within RVSM[8]	13	14	15	3	5	6	8[9]	0
	# of LHDs (< 10mins) within RVSM	102	74	113	99	87	94	74[10]	
TIME	# of LHD minutes within RVSM	621	707	718	217	266	260	333	
	# of LD LHD (10mins +) within RVSM	409	582	564	42	171	170	284	0

Table 5. *LHD Summary Report*

[8] Beginning in the 2017 reporting period, the time threshold for an LD LHD will be 20 minutes as agreed by NAT SOG/15
[9] Including 6 events of duration 11-19 minutes
[10] Including 2 events of duration 11-19 minutes

An LHD that results in a loss of separation is considered to be risk bearing. Collision Risk Estimates include only risk bearing LHDs in NAT HLA. In **Figure 4** below, this "risk bearing" factor is compared to all LHDs in HLA in historical context. It is also compared to the number of LHDs attributed to aircrew and ATC errors.

There were 47 operational risk-bearing LHDs during 2016, resulting in a total duration of 269 minutes at the incorrect flight level and 50 uncleared flight levels crossed. The two longest duration events accounted for a total of 62% of the total time spent at the wrong flight level. Removing these two events would reduce the overall vertical risk by 52% from 56.8 to 27.56 x 10-9 fapfh.

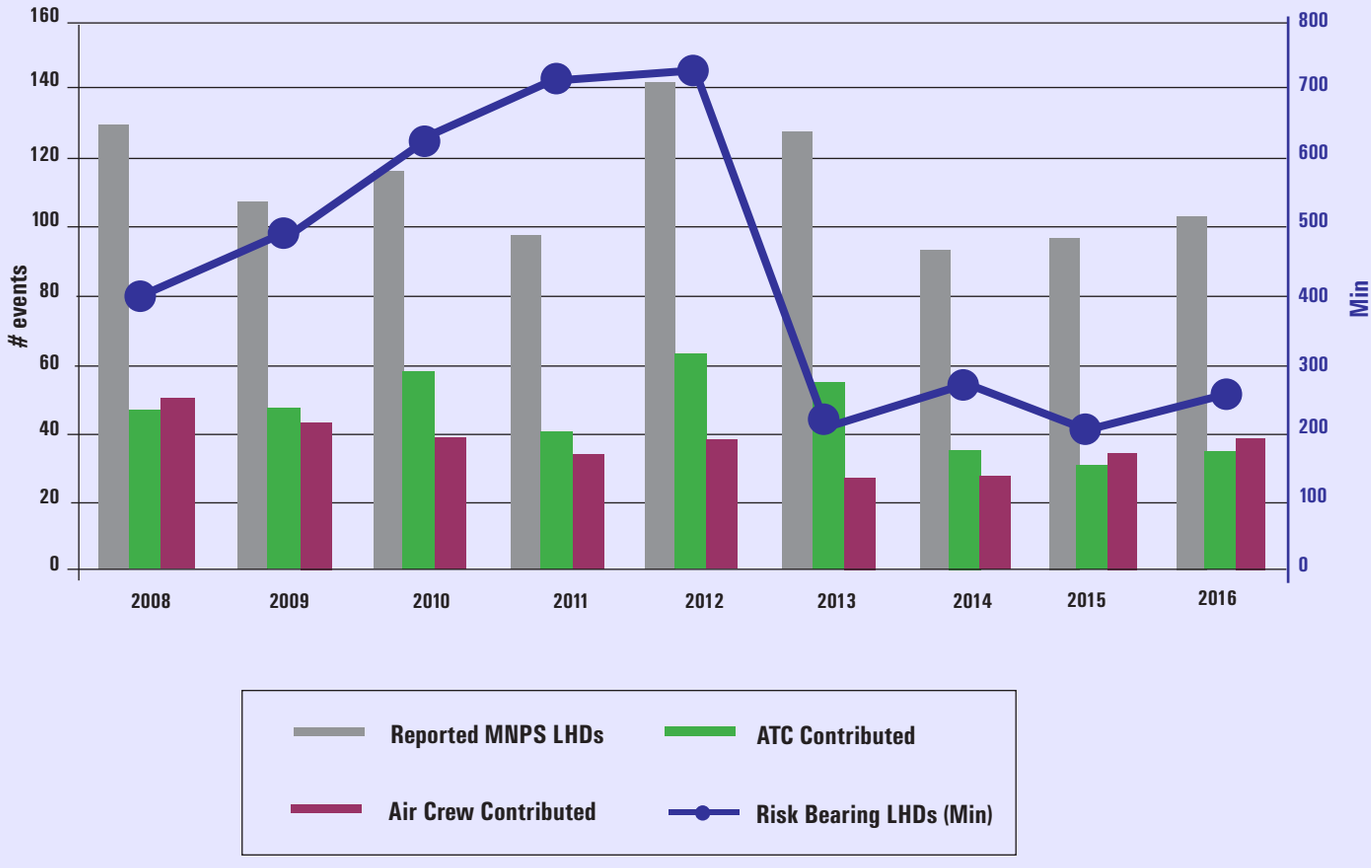


Figure 4. 2016 Number of LHD Events[11]

[11] MNPS airspace is now HLA

Lateral Risk

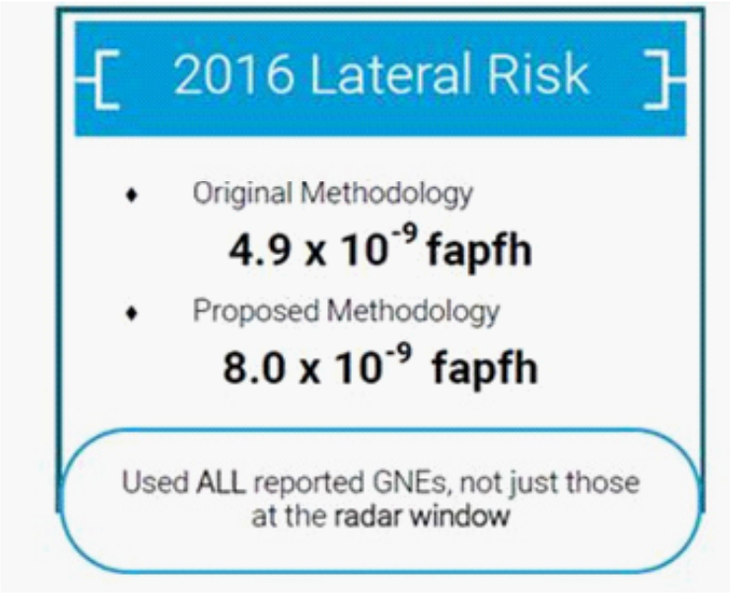


Figure 5: *2016 Lateral Risk at a Glance*

In 2016, Lateral Risk Estimates were calculated using two methodologies: the existing methodology using risk-bearing GNEs observed at the radar monitoring windows, and one proposed based on all reported GNEs. The lateral collision risk for the year using the original methodology was estimated at 4.9 x 10-9, well below the TLS of 20 x 10-9. The risk calculated using the proposed methodology, which encompassed all GNEs, was estimated at 8.0 x 10-9, which is still below the TLS but represents an increase in comparison to the original methodology.

The new methodology was designed to cast a broader net and thus it is not surprising that the proposed value is greater than the original. There were eight risk-bearing deviations that contributed t owards the lateral collision risk estimate using the new methodology with a total of eleven tracks crossed and 187 minutes spent unprotected due to lateral deviations during 2016. The time spent by aircraft in unprotected profiles had the biggest impact on the estimated lateral collision risk, with three deviations reported via HF radio or unknown communication channels contributing 96% of 2016 lateral collision risk.

Historical information shown below indicates that in 2016 Lateral Collision Risk rose again after several years of near or at zero frequency. Even given that the methodology for collecting risk information changed, it is important for the NAT Region to monitor this indicator closely over the next several years to see if there is in fact an upward trend or if the increase is an artifact of the change in calculations.

Lateral Risk Estimates

(Fatal accidents per flight hour x 10^{-9})

Year	OTS	Random	All MNPS
2016	0.9	13.4	8
2015	0	0	0
2014	0	0	0
2013	0	0.4	0.2
2012	0	0	0
2011	0	1.2	0.7
2010	0	0.3	0.2
2009	0	0	0

Table 6. *Lateral Risk Estimates*


CIRCUIT BREAKER
TAT TEST
ALTERNATE FLAPS
BACK REST MUST BE IN NORMAL FLIGHT POSITION WHEN SEAT IS MOVING OUTBOARD

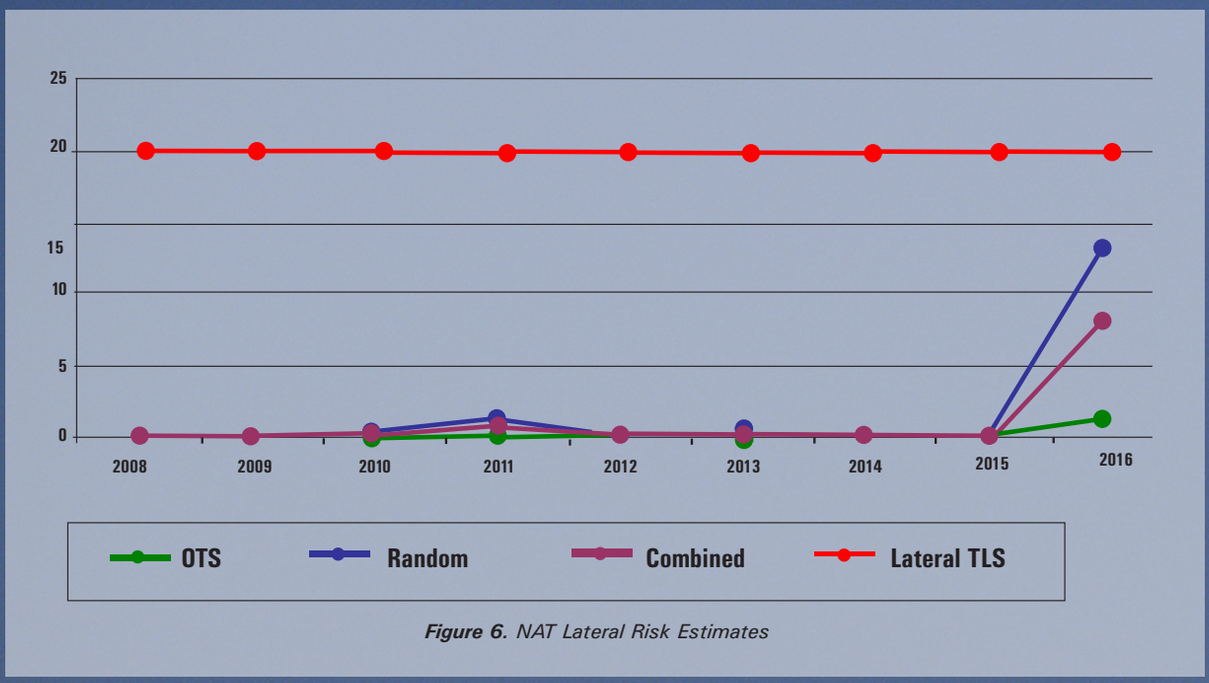


Figure 6. *NAT Lateral Risk Estimates*

Alignment with the Global Aviation Safety Plan

The 2017-2019 GASP sets out a continuous improvement strategy for States and Regions to implement over the next 15 years through the establishment of core, and then more advanced, aviation safety systems. The target dates and the broad objectives are set out below:

Target Date	Broad Objective
(a) Near-Term (by 2017)	Effective Safety Oversight
(b) Mid-Term (by 2022)	ICAO State safety program implementation
(c) Long-Term (by 2028)	Predictive risk management

All NAT provider States have met the near-term objective of the GASP and are working toward the mid-term and long-term objectives, particularly in the areas of proactively managing risks through the identification and control of existing or emerging safety issues. All of the NAT member States contribute experts to the NAT SPG, or one or more of its various subgroups, and so support the overall management of safety in the Region. The Region's safety policy (presented previously in this report) is enhanced by the agreement of member States to use the information shared at NAT SOG meetings for the purposes of education and for making safety improvements within the Region. This has paved the way for members to discuss and share information and act upon it within the framework of the NAT SPG.

The NAT SPG assigned the task of reviewing the current safety KPIs and proposing new safety KPIs and targets to the NAT SOG. This is an on-going task for the NAT SOG which the group revisits at each of its meetings. The NAT Central Monitoring Agency (CMA), which is the Regional Monitoring Agency for the NAT region, collects NAT event data and uses it along with the NAT SG and the NAT MWG to assess safety performance within the Region.

The NAT reporting requirements have gradually expanded to meet the needs of system risk assessment, understanding of operational errors, and informing the safety assessments involved with reductions in separation. Formal reporting requirements have been introduced through the Conclusions of the NAT SPG. In order to ensure that the necessary data would be available to inform discussion of future developments, the NAT SPG recognized that these reporting responsibilities needed to be organized and easily accessible. Therefore, in 2015 the NAT SPG developed and endorsed the NAT Consolidated Reporting Responsibilities Handbook (NAT Doc 010). This document compiles relevant reporting requirements and guidance previously agreed to by the NAT SPG member States as outlined in the conclusions from its first meeting in 1965 through its 51st meeting in June 2015.

NAT Regional Priorities

A number of ANS initiatives are on-going in the NAT Region. In line with the safety policy and as stipulated in the terms of reference and the work structure of the NAT SPG, it is imperative that acceptable safety management documents are provided in relation to system developments in the NAT Region. The agreed policy as stated above is to maintain and where possible improve the agreed safety standards in all activities. In this regard, the safety work that provides confidence that upcoming initiatives do not negatively affect the safety of the ICAO NAT Region, is ongoing. Work undertaken by the NAT Regional subgroups on a number of significant initiatives in the ICAO NAT Region in 2016, included:

a) Reduced Lateral Separation Minima between FANS equipped aircraft (RLatSM) Trials (Phase 1);

b) The NAT Data Link Mandate (DLM) implementation (Phase 2A); and

c) The implementation planning for Performance Based Communication and Surveillance (PBCS) for applications of reduced separations.

Following are short summaries of the projects, stipulating how the NAT States will collaboratively ensure or have ensured (depending on the status of the project) the safe implementation and application on a regional level.

Reduced Lateral Separation Minima between FANS equipped aircraft (RLatSM)

An operational trial of RLatSM assigned half degree track spacing to suitably equipped aircraft (equipped with CPDLC and making position reports via ADS-C). The goal of RLatSM is to decrease fuel cost to airlines by providing the opportunity for better flight profiles within the NAT and without a negative impact on collision risk.

The RLatSM Phase 1 trial commenced November 12, 2015 in the Gander and Shanwick OCAs. NAV CANADA, overseen by Transport Canada, led the project in conjunction with United Kingdom's NATS. RLatSM Phase 2 implementation was expected to begin in fall 2016; however Phase 2 Implementation was postponed and firm implementation dates have not yet been determined. Iceland's Isavia has planned to participate in the trial commencing with Phase 2.

Safety Improvements with Data Link in the NAT Region

In June 2014, the NAT CMA began to record information on each safety occurrence report and its relation to the use of data link. Figure 7 provides a sample of this evaluation from occurrence reports contributing toward vertical operational risk. The results show the time spent at wrong flight level and number of flight levels crossed incorrectly decreased by 62 and 57 percent, respectively, for risk-bearing events reported via data link for calendar year 2016 compared with the similar data observed for year 2014. As more aircraft are equipped with data link capability, we expect this trend to continue.

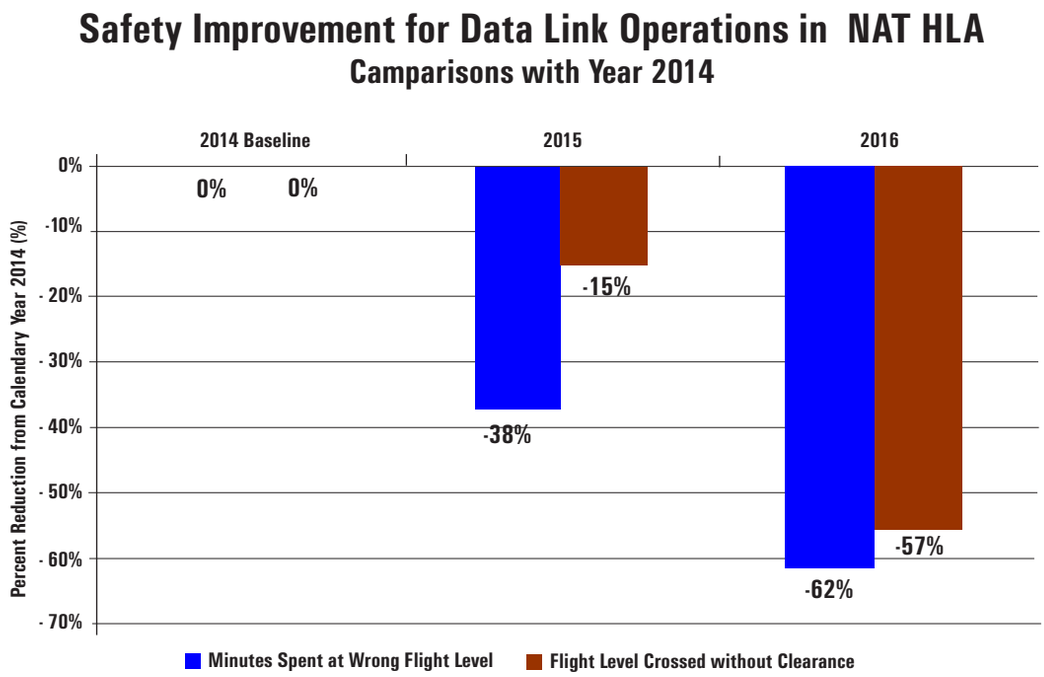


Figure 7. Safety Improvement with Data Link

A Look Ahead

The NAT SPG is laying the groundwork towards enabling a seamless separation approach throughout the NAT Region. As such, the NAT SPG is planning to coordinate through its working structure the development of all required procedures, analyses, and planning

documents related to Air Traffic Service (ATS) surveillance-enabled services using space-based Automatic Dependent Surveillance–Broadcast (SB ADS-B) planned for February 2018. The ANSPs providing services in the Gander and Shanwick OCAs, NAV CANADA and NATS, have begun coordinating on a common implementation strategy.

Conclusion

Traffic levels are forecast to rise significantly and consequently the initiatives underway are of particular importance in order to ensure safety risk does not increase. In this context, the NAT Region reaffirms its commitment to continuously improving the safety of aviation operations.

While the NAT Region continues to make progress toward achieving its safety targets, LHDs and vertical risk continue to be of specific concern. At the same time, the NAT Region continues to conduct the safety analyses and operational trials necessary to introduce new technologies and procedures intended to increase both the safety and the efficiency within the busiest oceanic airspace.

Appendix A

Abbreviations

ACAS	Airborne Collision Avoidance System
ADS-B	Automatic Dependent Surveillance - Broadcast
ADS-C	Automatic Dependent Surveillance - Contract
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
DLM	Data Link Mandate
FAPFH	Fatal Accidents per Flight Hour
FL	Flight level
GASP	Global Aviation Safety Plan
GNE	Gross Navigation Error
HF	High Frequency
HLA	High Level Airspace
ICAO	International Civil Aviation Organization
KPI	Key Performance Indicator
LD LHD	Long Duration LHD
LHD	Large Height Deviation
NAT	North Atlantic
NAT CMA	North Atlantic Central Monitoring Agency
NAT EFFG	North Atlantic Economic, Financial, and Forecast Group
NAT MWG	North Atlantic Mathematicians Working Group
NAT SG	North Atlantic Scrutiny Group
NAT SOG	North Atlantic Safety Oversight Group
NAT SPG	North Atlantic Systems Planning Group
RMA	Regional Monitoring Agency
RA	Resolution Advisory (per ACAS/TCAS)
RVSM	Reduced Vertical Separation Minimum
SLOP	Strategic Lateral Offset Procedure
TLS	Target Level of Safety