ICAO

SAFETY

NORTH ATLANTIC SYSTEMS PLANNING GROUP (NAT SPG)

2021 Annual Safety Report

2022 Edition

International Civil Aviation Organization (ICAO) North Atlantic Region

2021 Annual Safety Report

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 will aim 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 (GANP).

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:

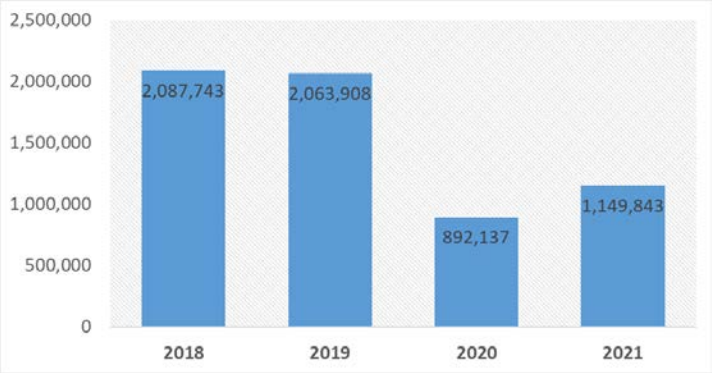
- **Clearly** define all accountabilities and responsibilities for the delivery of safety performance with respect to the provision of air navigation services and participation in the NAT SPG and its contributory bodies;
- **Support** the safety management activities that will result in an organizational 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.

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 NAT safety policy 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.

Executive Summary

The North Atlantic Region's eighth Annual Safety Report (ASR) is issued by ICAO's North Atlantic (NAT) Systems Planning Group (SPG) and presented in the following pages. This report covers calendar year 2021 which, as a result of the global health crisis, has posed the aviation industry with an unprecedented challenge. In 2021 the traditional methods for data analysis and validation have not been fully available. The data has been cross-checked to ensure the highest possible level of fidelity, but the data presented may require verification when the crisis allows and those reading this report should consider the results presented in that context.

The NAT SPG structure is established to study, monitor and evaluate the air navigation system in the NAT region taking into account changes to technology, changing traffic characteristics and traffic forecasts. The number of flight hours in the NAT HLA in 2021 was 1,149,843. This is a significant increase on that reported in 2020 (892,137 flight hours), but still not at the level of pre-COVID-19 years.



Safety Performance in the NAT HLA continues to be monitored by the measures and targets associated with Safety Key Performance Indicators (SKPIs) with targets based on three years of rolling data. This report premieres the new SKPIs for the NAT as devised by the NAT SKPI Review Project team in 2021 and accepted at NAT SPG/57.

While reduction in air travel caused by the COVID-19 pandemic is considered to be, the most significant contributor to the improved safety performance in 2021, the SKPIs are, for the most part, weighted to take into account overall traffic volumes and will adapt as the traffic flexes.

In the context of 29% traffic growth from 2020 to 2021, there has been an increase in overall vertical collision risk of 43% and lateral collision risk of 11%. This increase in collision risk estimate in the vertical dimension is attributed to an adjustment to the mathematical collision risk model to acknowledge the increased navigational accuracy of aircraft in the NAT HLA due to widespread GPS equipage.

The number of events scrutinized in 2021 was similar to that reviewed in 2020 with the profile of root causes similar and so, while the reduction in traffic needs to be taken into account, the benefits of near, real-time surveillance capability in the NAT has delivered significant benefits in the early detection and resolution of deviations in the vertical and lateral planes

The North Atlantic Scenario

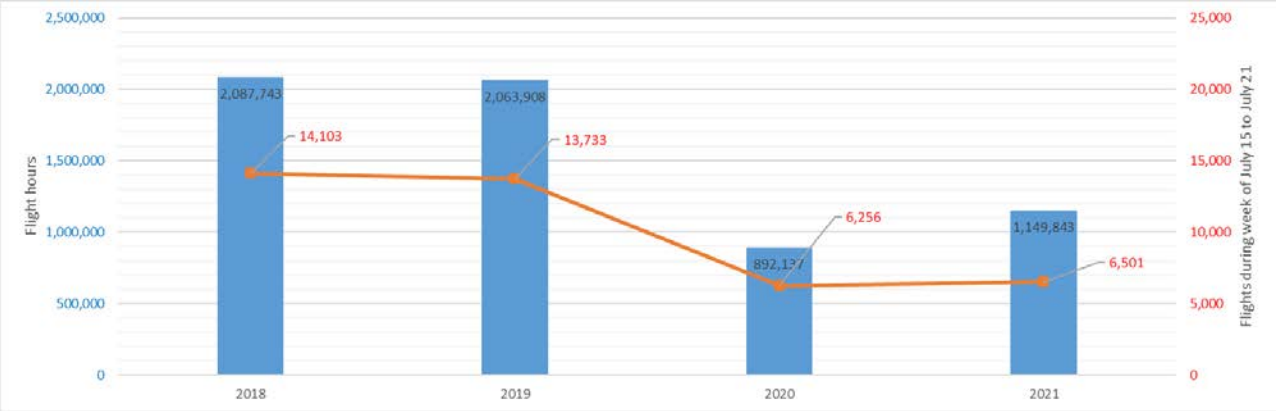
The airspace of the North Atlantic, which links Europe and North America, is the busiest oceanic airspace in the world. The NAT Region is a pioneer in the implementation of advanced procedures and technology supporting the progress of the global air navigation and aviation safety plans.

Traffic mainly flows in a broadly East-West orientation in a twice daily pattern where a daily organized track system takes account of airspace users' needs and weather patterns. NAT core traffic flow is almost exclusively jet transport aircraft that operate in the upper airspace in the en-route phase of flight.

Since March 2019, approximately 70% of the core NAT traffic has been able to make use of the surveillance capability offered by space based Automatic Dependent Surveillance-Broadcast (ADS-B) augmenting an increasing use of Automatic Dependent Surveillance-Contract (ADS-C). The number of flights eligible for the separation standards enabled by ADS-B has increased steadily since the capability was introduced.

Communication is, to a large extent, based on satellite-based data link, also referred to as Controller-Pilot Data Link Communications (CPDLC) with High Frequency radio being utilized less often. 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 although, as the NAT embraces new technologies this balance has begun to change.

The number of flight hours in the NAT HLA in 2021 was 1,149,843 which is an increase from the 892,137 hours in 2020. It is however still significantly below the flight hours before the COVID-19 pandemic. The NAT Economic, Financial and Forecast Group (NAT EFFG) estimates that in 2021, during the peak week of July 15 to July 21, approximately 6,501 flights crossed the North Atlantic. This figure was 6,256 for that same week in 2020.



Safety Performance Monitoring and Measurement

Note 1: In 2020 and 2021, the organization and conduct of all meetings of NAT SPG and its contributing bodies were heavily impacted by the consequences of the COVID-19 pandemic. Because of this, the events that occurred in the NAT HLA between July 2019 and June 2021, even though scrutinized in 2020 and 2021 by a small group of experts, could not be reviewed by the usual full NAT Scrutiny Group (NAT SG) membership during a face-to-face meeting.

Collision Risk Estimates

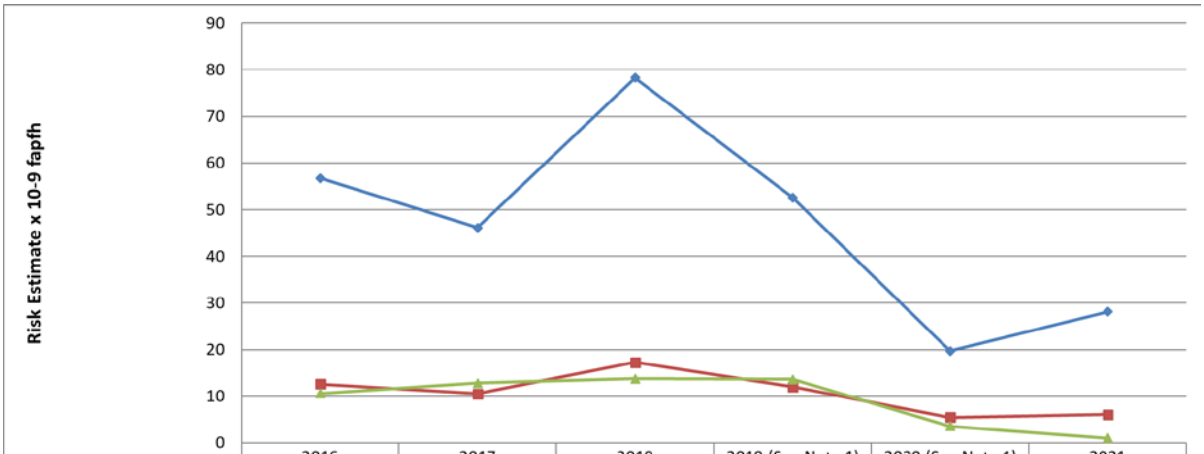
The estimated risk of a mid-air collision, referred to as Collision Risk Estimate (CRE), is reported in terms of fatal accidents per flight-hour (fapfh) and is calculated in the lateral and vertical planes. The model used for computation essentially assumes each aircraft is a box having a fixed x, y, and z orientation and approximates the risk of collision by integrating the crossing rate over the period when two boxes are close to each other in each dimension.

Estimates of Vertical and Lateral Collision Risk for 2021 in the NAT HLA are based on risk bearing events reported to the NAT Central Monitoring Agency (CMA) for the period January to December 2021. Flight activity data from five NAT Oceanic Control Areas (OCAs) was used in deriving an estimate of Vertical and Lateral Collision Risk. The risk estimates were calculated for the Middle zone (Gander and Shanwick OCAs), the North zone (the Reykjavik OCA), and the South zone (the New York East and Santa Maria OCAs) and then combined to derive a risk estimate for NAT HLA.

The Vertical Collision Risk Estimate for 2021 was estimated to be 28.1 x 10^{-9} fapfh for all NAT HLA. Figure 1 shows that this reduces by 78% to 6.1 x 10^{-9} fapfh with SLOP. The Vertical Collision Risk Estimates in 2021 both with the SLOP effect incorporated and without SLOP are higher in comparison to 2020 estimates. This increase in collision risk estimate in the vertical dimension is attributed to an adjustment to the mathematical collision risk model to acknowledge the increased navigational accuracy of aircraft in the NAT HLA due to widespread GPS equipage.

Figure 1 also presents the 2021 lateral risk estimate of 1.0 ×10^{-9} fatal accidents per flight hour. This represents a significant decrease of 72% compared to 2020.

The vertical CREs with and without SLOP are greater than the vertical Target Level of Safety (TLS) for operational and technical errors of 5 × 10^{-9} fatal accidents per flight hour (fapfh). However, the value of lateral CRE meets the TLS of 5 × 10^{-9} fapfh.



	2016	2017	2018	2019 (See Note 1)	2020 (See Note 1)	2021
Vertical CRE	56.8	46.1	78.3	52.6	19.7	28.1
Vertical CRE (with SLOP)	12.6	10.5	17.3	12	5.5	6.1
Lateral CRE	10.6	12.8	13.8	13.6	3.6	1.0

Figure 1 - Collision Risk Estimates in the NAT HLA (2016-2021)

Safety Key Performance Indicators (KPIs)

The NAT SPG has established Safety KPIs and associated targets for the NAT HLA. The NAT HLA performance in 2021 is shown the table below. The 2021 figures are shown in green where the performance meets the targets and red otherwise.

Safety KPI		Target	Previous rolling three-year period of performance (2018-2019-2020)	2018 Performance	2019 Performance	2020 Performance	2021 Performance
NAT.SKI.01	Number of accidents	0	n/a	0	0	0	**0**
NAT.SPKI.02a	Number of LHD events divided by number of flight hours flown in the NAT HLA	Reduction over previous rolling three-year period of performance	3.72×10^{-5}	2.87×10^{-5}	3.59×10^{-5}	4.71×10^{-5}	**4.61×10^{-5}**
NAT.SKPI.02b	Overall time of LHDs at unprotected flight level divided by total duration of flights in minutes	Reduction over previous rolling three-year period of performance	7.21×10^{-7}	6.95×10^{-7}	9.45×10^{-7}	5.23×10^{-7}	**6.23×10^{-7}**
NAT.SKPI.03a	Number of Lateral deviations divided by number of flight hours flown in the NAT HLA	Reduction over previous rolling three-year period of performance	5.57×10^{-5}	4.6×10^{-5}	5.71×10^{-5}	6.39×10^{-5}	**4.87×10^{-5}**
NAT.SKPI.03b	Overall time of lateral deviations on an unprotected profile divided by total duration of flights in minutes	Reduction over previous rolling three-year period of performance	1.27×10^{-6}	1.29×10^{-6}	1.70×10^{-6}	0.82×10^{-6}	**0.61×10^{-6}**
NAT.SKPI.04	Number of losses of separation events divided by number of flight hours flown in the NAT HLA	Reduction over previous rolling three-year period of performance	1.36×10^{-5}	1.87×10^{-5}	1.65×10^{-5}	0.56×10^{-5}	**0.522×10^{-5}**
NAT.SKPI.05a	Number of coordination errors divided by number of flight hours flown in the NAT HLA	Reduction over previous rolling three-year period of performance	1.87×10^{-5} (average for 2019-2020, as 2018 data not available)	No data	0.824×10^{-5}	2.91×10^{-5}	**1.83×10^{-5}**
NAT.SKPI.05b	Overall time of coordination errors spent at unprotected profile divided by total duration of flights in minutes	Reduction over previous rolling three-year period of performance	1.48×10^{-6} (average for 2019-2020, as 2018 data not available)	No data	0.162×10^{-6}	2.8×10^{-6}	**0.304×10^{-6}**
NAT.SKPI.06a	Collision Risk Estimate (CRE) in the vertical dimension	5×10^{-9} fapfh	n/a	17.3×10^{-9}	12×10^{-9}	5.5×10^{-9}	**6.1×10^{-9} (with SLOP)**
NAT.SKPI.06b	Collision Risk Estimate (CRE) in the lateral dimension	5×10^{-9} fapfh	n/a	13.8×10^{-9}	13.6×10^{-9}	3.6×10^{-9}	**1.0×10^{-9}**
NAT.SKPI.07	Regional Effective Implementation (EI) score in ANS for NAT provider States	-Maintain 85% or above until 2026 -Reach 95% by 2030	n/a	n/a	n/a	n/a	**89.21%**

Table 1 – Safety Key Performance Indicators (SKPIs) and associated targets (2018-2021)

Scrutiny of events (numbers in brackets are 2020 figures)

The NAT SG carried out the scrutiny of 166 (133) events which were reported to the NAT CMA as occurring in the NAT High Level Airspace (HLA) of the Oceanic Control Area (OCA) of Shanwick, Santa Maria, Reykjavik, New York East, Gander and Bodo during the year 2021. These events were categorized as follows:

- 53 (47) Large Height Deviations (LHDs)
- 56 (57) actual lateral deviations, including:
    - 23 (15) GNEs and
    - 5 (13) ATC Interventions where when the Air Traffic Controller (ATCO) caught and corrected a lateral deviation before it developed into a GNE
- 21 (26) coordination events, where coordination between two Units has not been correctly carried out, leading to a vertical, lateral or time event.
- 4 (1) longitudinal loss of separation events.
- 53 (30) prevented events where the ATCO prevented a deviation or an uncoordinated flight profile entering the airspace of another ANSP.

Note 2: It is important to note that the sum of the values will not equal to the number of events as one event can be counted in one or more dimensions.

It is worth noting that ATC interventions and preventions are positive indicators that the ATC system has recognized an error, often through data link equipage capabilities, warning the controllers in sufficient time to take pre-emptive action. Underlying causes of all lateral deviations (incipient or actual) are often identical – the magnitude depends upon the timeliness of identification and corrective action.

The review of these 166 events of 2021 showed that the top 10 contributing issues allocated to all events were (Arrows indicate relative position from 2020 report):

1. *Flight Plan vs. Clearance* where flying, or intending to fly the planned route instead of the cleared route contributed in 42 (25%) of the events of 2021. In most cases (32 out of the 42), deviations did not actually occur as they were prevented by an ATCO. ⬆
2. *Did not adhere to ATC clearances* in either the vertical or the lateral dimension where a crew, for no identifiable reason, operated a flight profile different to the ATC clearance (e.g. changed vertical profile or routed to a different waypoint which was not contained in the clearance or the filed flight plan or due to contingency) contributed to 28 (17%) of the 2021 events. ⬆
3. *ATC coordination* where an error occurring during the coordination between two ATC sectors or ANSPs contributed in 26 (16%) of the events of 2021. ⬇
4. *Weather* where weather conditions experienced during the flight contributed in 19 (11%) of the events of 2021. ⬌
5. *ATC Clearance,* where a clearance issue contributed in 15 (9%) of the 2021 events. This can for example be caused by ATC not issuing a clearance to an aircraft to match the coordinated profile or by the lack of an appropriate clearance. ⬆

6. *Dispatch*, where a flight plan issue contributed in 15 (9%) of the 2021 events. This can for example be an arrival route into an FIR or airport not filed as per the national AIP or flight plans filed incorrectly, causing the existence of multiple flight plans with different routes for one flight.

7. *ATC Pertinent message not actioned* where ATC response, on receipt of a pertinent message, was not actioned or a message was erroneously discarded contributed in 13 (8%) of the events of 2021.

8. *Crew-Other*, where a crew action contributed to 12 (7%) of the 2021 events but there is insufficient information or evidence to allocate any of the currently scrutinized causal factors.

9. *Incorrect Weather Contingency action* where crew deviated from their assigned clearance to avoid adverse meteorological conditions, but did not follow the correct procedures for in-flight contingencies in Oceanic Airspace contributed to 9 (5%) of the 2021 events.

10. *Readback/Hearback*, where incorrect read back or hear back of a clearance contributed to 8 (5%) of the 2021 events, as well as:

    Incorrect application of SLOP where a misapplication of SLOP by the crew contributed to an event contributed to 8 (5%) of the 2021 events.

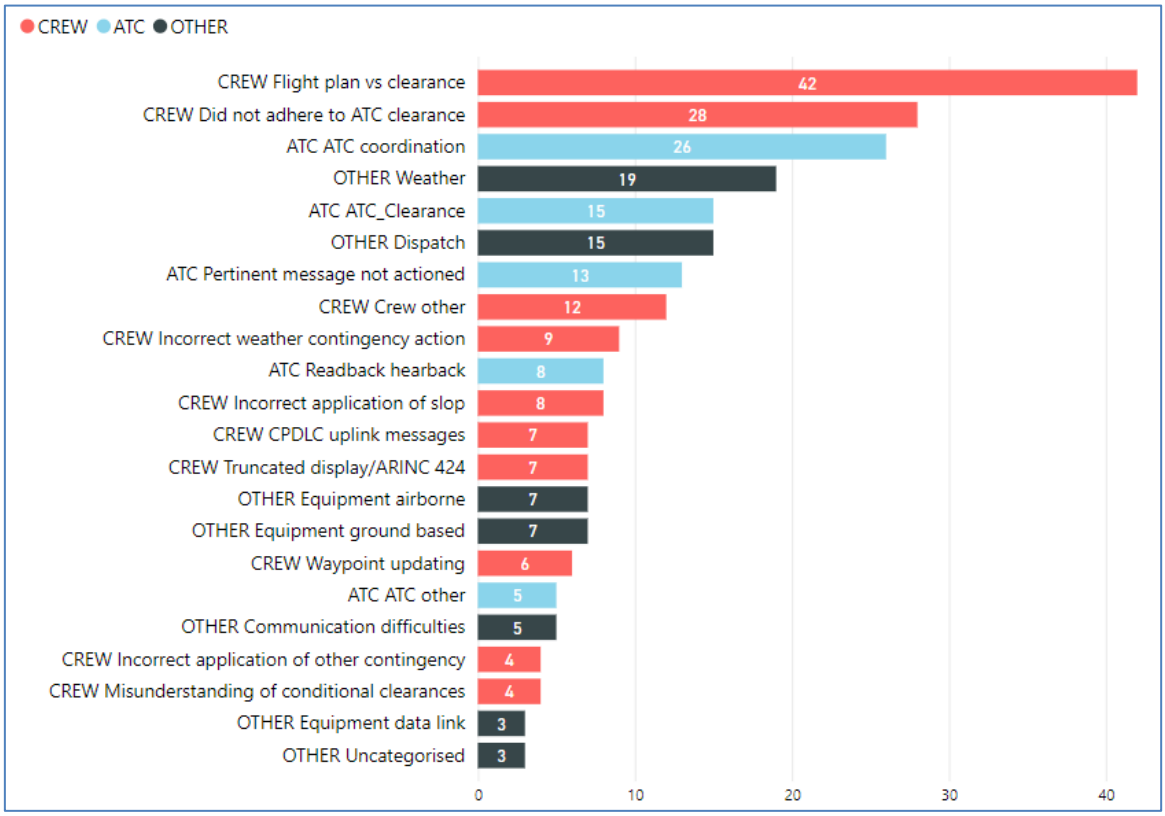


Figure 2: Contributing issues to events in the NAT HLA in 2021

Prevented deviations for all event types were classified according to the implemented mitigations used to avert a deviation. The results of this classification are presented in Figure 3, demonstrating that the practice of requiring position reporting of "NEXT and NEXT +1" and the "CONFIRM ASSIGNED ROUTE" CPDLC message sets (UM137/DM40) are proving to be of benefit.

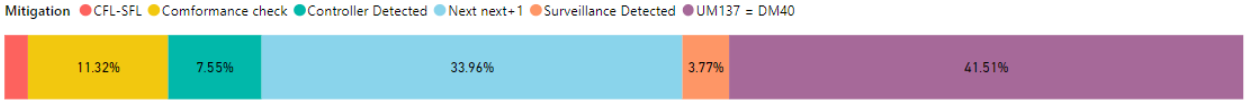


Figure 3: Mitigations used for prevented deviation events in 2021

NAT regional priorities

The reduced volume of air traffic in 2021 continues to shape the priorities for the region as it grows back to pre-COVID levels. The immediate benefits of the implementation of Space-Based ADS-B into the NAT in 2019, have been somewhat restricted by the global health crisis which continued to stifle global aviation through 2021. As the industry commenced its rebuild in late 2021 and into 2022, the experience gained with ADS-B allowed the NAT SPG to agree and endorse the goals, objectives and priorities in support of the NAT 2030 Vision.

The NAT 2030 Vision states that "Through collaboration, we lead the way in the provision of safe Oceanic Air Traffic Management Services by leveraging emerging technologies in the North Atlantic in order to realize maximum efficiencies and ensure optimized seamless airspace provision."

The NAT 2030 Vision is evidence of the willingness of all organisations within or bordering the region to work collaboratively to improve the operating environment. The Vision is sympathetic to the changing environment and allows the deliverables to be flexed and reprioritised to deliver the widest benefit for the region over the next decade.

In 2021, Airbus tested its Wake Energy Retrieval plans across the NAT under the "fello'fly" project proving savings in fuel and CO_2 of 5% and paving the way for further implementations and benefits in Continental airspace in the middle of the decade.

In 2021, the "footprint" for NAT tracks was safely reduced, by firstly trialling "Nil Track" days and secondly, by removing the need for NAT tracks below flight level 330. This initiative enabled by expanded utilization of Space-Based ADS -B, sought to provide operators with the ability to flight plan and fly random routes while taking advantage of newly implemented operational capabilities in the NAT.

In addition, the Project Team established for the removal of Oceanic Clearances works towards the removal of Oceanic Clearances by 2023 to align the Concept of Operations in the NAT with global methods of operation. In doing so, the Project Team are working across States to test the template for regional safety cases and developing the regional safety arguments in parallel to the States' own individual processes for approval of a change.

In VOLCEX21 in November of 2021, Delta Air Lines, along with the Shanwick ANSPs tested the use of Dynamic Airborne Reroute Procedure (DARP) to make use of existing CPDLC message sets to deliver greater flexibility and enhanced levels of safety when ATC are required to reroute flights.

In monitoring the performance of flights crossing the NAT, guidance has been developed for operators, ANSPs and States to manage potential non-compliant airframes when data link performance dips below the established targets with the aim of removing inconsistencies in the reporting and management of non-compliance reports and identifying improvements that can be made to "the system", both in the air and on the ground.

Testing to understand ADS-B capability to monitor height-keeping performance of flight crossing the NAT also concluded that a great opportunity existed to increase the sample size and gain greater confidence in the height keeping capability of aircraft flying within the NAT and around the globe. The tests have led to the commencement of the implementation of a new height monitoring system in the NAT.

The NAT Vision 2030 targets "New Entrant" Operators into the region in the latter half of the decade, but in order to demonstrate the flexibility of the region to respond to changes in our industry convened the New Entrant Readiness Project Team at the June 2021 meeting of the NAT SPG to assist in the management of requests for novel flights within the region's airspace.

The NAT2030 vision provides the framework for the region to continue to adapt its services and develop new ways of working to leverage emerging and innovative technologies. The NAT SPG structure ensures that the region implements improvements to its airspace provision while building and enhancing the levels of safety the region has become accustomed to.

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Appendix A

ADS-B	Automatic Dependent Surveillance - Broadcast
ADS-C	Automatic Dependent Surveillance – Contract
ANS	Air Navigation Service
ATC	Air Traffic Control
ATS	Air Traffic Service
CPDLC	Controller-pilot data link communications (data link)
EFFG	Economic, Financial and Forecast Group
fapfh	Fatal Accidents per Flight Hour
GASP	Global Aviation Safety Plan
GNE	Gross Navigation Error
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
OCA	Oceanic Control Area
OTS	Oceanic Track System
RVSM	Reduced Vertical Separation Minimum
SKPI	Safety Key Performance Indicator
SLOP	Strategic Lateral Offset Procedure

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