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INFORMAL SOUTH PACIFIC ATS CO-ORDINATING GROUP
(ISPACG/35)

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Future of the Ocean 2035 (FOTO35) Program Overview & Alignment with the ICAO North Atlantic Region (NAT) 2030 Vision

(Presented by FAA)

SUMMARY

This paper provides an overview of Future of the Ocean 2035 (FOTO35), the newest oceanic program at the FAA. Originally submitted to the ICAO NAT IMG/58 in April 2021, the paper explains both its alignment with the NAT2030 vision matrix and its strategic goals to enhance seamless global oceanic ATM operations.

1. Introduction

1.1. This paper aims to inform the meeting of a new oceanic program at the United States (U.S.) Federal Aviation Administration (FAA), Future of the Ocean 2035 (FOTO35). The paper was originally submitted to the fifty-eighth meeting of the ICAO North Atlantic Region (NAT) Implementation Management Group (IMG) in April 2021 to communicate that its program goals, objectives, and initiatives align with those of a comparable NAT effort, the NAT2030 vision. Given that FOTO35 intends to globally harmonize with all ICAO regional plans, the FAA would like to introduce this paper to the Informal South Pacific ATS Coordinating Group (ISPACG). The paper will first provide an overview of FOTO35, an explanation of the four program goals, shortfalls they intend to address, and their respective initiatives and objectives. The subsequent section will demonstrate how its goals, objectives and initiatives align with those identified in the NAT2030 vision matrix.

1.2. It is the intent of the FAA that FOTO35 will effectively enhance the way oceanic air traffic management is conducted, benefit airspace users and society at-large, and promote further global harmonization among neighboring Air Navigation Service Providers (ANSPs). Seamless end-to-end operations, improved operational safety and efficiency for users, and increased situational awareness of emerging users– which are all to be enabled and enhanced by new and improved automation capabilities – are just a few of the intended outcomes, similarly outlined in the NAT2030 vision, which FOTO35 aims to achieve.

2. Program Overview

2.1. This section provides an overview of the FOTO35 program. It summarizes the assessments and discussions that ultimately resulted in the formation of the focus areas and program goals, as well as some of the activities that have taken place since the goals were finalized.

2.2. *Vision Development*

Prior to the COVID-19 pandemic, the International Civil Aviation Organization (ICAO) forecasted that the aviation sector would contribute upwards of one trillion U.S. dollars to the total world gross domestic product by 2026. As the aviation industry recovers from the negative effects of COVID-19, the FAA and its international partners must be prepared to accommodate an increasing number of flights, new technological capabilities in the cockpit, and other advancements that may enhance oceanic air traffic management (ATM). With control over 24 million square miles of delegated airspace, the FAA manages and controls the largest volume of delegated oceanic airspace in the world. To maintain the most sophisticated and advanced oceanic air traffic management system in the world and to provide new and improved services to FAA customers, the FAA has recognized that it must adapt to new technologies to meet the evolving needs of the broader aviation industry. In response to these changes in aviation and technology, as well as in light of business and societal motivations, the FAA Air Traffic Organization (ATO) tasked its International Office with forming a new oceanic air traffic management (ATM) vision looking ahead to 2035 and beyond. The ultimate tangible result of this effort was establishment of the Future of the Ocean 2035 (FOTO35) program. This program intends to enhance services for all current and future oceanic-system stakeholders by exploring, leveraging, and implementing advanced technologies in communications, navigation, and surveillance (CNS); weather observation and forecasting; artificial intelligence applications; collaborative decision-making; and new aircraft separation standards and procedures.

2.3. *Needs Assessments*

A core team of program, operational and safety experts was established to conduct a needs assessment. The current state of the oceanic ATM system was examined. Both existing and forecasted shortfalls applicable to the areas of safety, operational and technical capabilities, and user requirements were identified. These broad-area shortfalls were further categorized as safety, efficiency, capacity, environmental impact, flexibility, predictability, and degree of airspace access needs.

2.4. The outcomes of the needs assessment were used as a baseline to develop a vision to support oceanic air traffic system strategic planning up to the year 2035 and beyond. Throughout 2020 and the early months of 2021, this FOTO35 core team held numerous discussions to identify the system capabilities, functionalities and requirements necessary to enhance the current ATM system, to define the desired future system state, and to satisfy the requirements necessary to adequately address the shortfalls. In summary, the core team determined that implementing enhancements to the following focus areas would address most, if not all, of the shortfalls:

- Tactical operations;

- Delegated separation;
- Four dimensional optimal trajectories;
- Enhanced separation procedures;
- Automation contingency and resiliency; and
- Accommodation of new and emerging users.

For example, the needs assessment identified the inability of oceanic controllers to safely issue weather deviations in certain scenarios. This shortfall was then placed into the 'tactical operations' focus area for future discussion. To implement the aforementioned enhancements, it was realized that improvements to communications, surveillance, automation, and infrastructure performance and capabilities are necessary. The FOTO35 core team compared the current state of the oceanic ATM system to the desired future state requirements and then conducted a gap analysis. To ensure both a comprehensive and succinct approach, the analysis was concentrated on these focus areas that were ultimately developed into the following four FOTO35 program goals:

(1) Optimized Dynamic End-to-End Trajectory Operations (referenced as "4DT")

(2) Enhance Oceanic Separation Procedures

(3) Safely Integrate Emerging Users and Space Operations

(4) Implement Improved Oceanic ATM Automation

The result of the gap analysis was to identify the specific needs and requirements necessary to achieve the capabilities outlined in the desired future state. In summary, the analysis identified the need for improvements in oceanic communications, surveillance and automation capabilities. For example, the team confirmed that the current communication system is not integrated with the air traffic management system. As a result, interoperability with partner ANSPs is limited. Controllers also have multiple, independent communication paths and modes at their workstations. FOTO35 analysis, research and development aims to ultimately eliminate these issues in the desired future state by providing controllers with a communications suite fully integrated with the air traffic management system. Other examples of identified shortfalls, gaps, and desired future state capabilities from this analysis are outlined in the program goals section.

2.5. The first five years of program development will concentrate on assessing stakeholder needs, researching performance specifications and conducting stakeholder outreach to ensure seamless, efficient operations and harmonization.

2.6. The FOTO35 core team has begun general outreach and socialization efforts within the FAA. So far, the program has been well received. Throughout 2021, FOTO35 will continue to socialize its program goals and vision with the global aviation community. This external outreach has already been initiated with stakeholders, such as the International Air Transport Association (IATA), and ICAO regional representatives. Additionally, a series of Technical Interchange Meetings (TIMs) with

industry stakeholders and various objectives, such as establishing a FAA 4DT working group, have been outlined as major milestones in the short-term. The FOTO35 core team has already participated in a TIM held by the FAA ASEPS program, which addresses applications of space-based Automatic Dependent Surveillance – Broadcast, as well to discuss its intentions with industry from an oceanic surveillance perspective. The FOTO35 core team will use the input from various stakeholders when developing high-level requirements for future objectives and initiatives and when conducting further assessments with other FAA offices and stakeholders.

3. Program Goals

3.1. This section offers a more detailed explanation of the four FOTO35 program goals and their intentions. While the improved automation goal is listed as fourth, it has been determined that successful improvement of oceanic automation will help enable achieving the other three program goals: global optimized dynamic end-to-end trajectory operations, reduced separation standard values and novel application of separation minima, and emerging user integration. The FAA is committed to leveraging both new and existing CNS technologies and capabilities through other programs as well, such as ASEPS, which will ultimately contribute to the success of these four program goals.

3.2. *Implementing Global Optimized Dynamic End-to-End Trajectory Operations*

While the current communication, navigation, and surveillance (CNS) capabilities in the oceanic environment keep the operation sustainable, there is potential for improvement that will better benefit oceanic users. To assist industry in mitigating common inefficiencies, such as less-than-optimal trajectories negatively affecting flight performance and resulting in extra fuel burn, the FOTO35 program aims to implement optimized dynamic end-to-end trajectory operations in the oceanic environment. Doing so will enhance operator abilities to fly closer to desired flight profiles with minimal ATC intervention and constraints, reduce fuel burn, costs and carbon emissions, and enable operators to leverage real-time data to modify flight plans and optimize their routes. Additionally, implementation of 4DT concepts and systems would harmonize with other FAA and partner ANSP ATM programs, systems and plans, such as Time-Based Flow Management (TBFM), the En Route Automation Modernization (ERAM) system, or the Single Europe Sky ATM Research (SESAR) Implementation Plan when an oceanic flight returns to the radar environment. This harmonization effort would effectively enhance and enable not only a true international end-to-end operation for airspace users, but also seamless airspace transitions between ANSPs.

3.3. FOTO35 intends to provide the oceanic environment with the ability to meet similar CNS performance standards as the domestic environment when applicable and practical. A multitude of updates to communications, surveillance, automation, and infrastructure capabilities will be necessary to truly implement 4DT operations in the oceanic environment to the intended extent. However, these capabilities are not the only requirements FOTO35 will need to take into account. The future ability to provide equipped airspace users with predictable 4D trajectories will depend on additional factors. These factors include the ability of flight planning systems to enable airspace user participation in Collaborative Decision Making (CDM). An additional requirement is that domestic ATM systems, such as the FAA ERAM system and those of

affected European ANSPs, be able to accommodate agreed-upon time, entry point, and altitude for flights between domestic or offshore airspace and oceanic airspace. This would allow the domestic portion of a flight's trajectory to be adjusted during flight to accommodate the oceanic portion of the 4D preferred trajectory without contention.

3.4. FOTO35 plans to leverage expected CNS and automation improvements to ensure that 4D trajectories can be more easily and flexibly achieved to better reflect desired user profiles. For example, the characteristics of the Extended Projected Profile (EPP), the predicted trajectory of the aircraft that can be downlinked via ADS-C or equivalent systems, are concepts and capabilities which FOTO35 aims to advance in collaboration with industry and partner ANSPs to leverage future seamless airspace boundaries and transitions. In addition to exploring the characteristics of the EPP, FOTO35 intends to optimize usage of user-preferred routes (UPRs) and explore new optimal oceanic routing concepts that will effectively eliminate the need for continued oceanic routing clearances. In terms of route flexibility, FOTO35 intends to leverage new technologies, connected to flight deck avionics, which could allow for more dynamic in-flight reroute capabilities, especially when taking into account factors such as weather, traffic and fuel burn. FOTO35 also aims to take advantage of current technologies to enhance procedures and standards already implemented. This includes, for example, taking into account the variation in capabilities between ultra-long-range narrow body airframes (e.g., A321XLR) and traditional wide bodies (e.g., B77W), as well as those between newer and older airframes (e.g. B789 and MD11).

3.5. FOTO35 has outlined three major objectives that will ultimately contribute to accomplishing the goal of implementing optimized dynamic end-to-end trajectory operations in the oceanic environment. First, the FAA must achieve consensus with industry and other ANSPs on a true definition of 4DT. A unified definition is currently lacking due to differing interpretations of the term, especially between oceanic and domestic 4DT. It is the intention of the FOTO35 program to develop a 4DT needs-analysis for industry as well, before developing a business and implementation plan for 4DT in FAA airspace. FOTO35 plans to then finalize 4DT procedure and system requirements. In doing so, the FAA will conduct various operational trials before finalizing requirements with the international community and incorporating those requirements into future oceanic automation system development efforts. All of this must be completed before working towards the final objective, which calls for implementation of global optimized dynamic end-to-end trajectory operations in the oceanic environment. In this final stage, the FAA plans to integrate 4DT into the system at its ATC facilities, conduct training for its controllers, and carry out demonstrations of 4DT operations in coordination with industry and other like-minded ANSPs that wish to participate.

3.6. *Enhancing Oceanic Separation Procedures*

FOTO35 aims to enhance the current oceanic separation standards and procedures in place via a multitude of future CNS and automation capabilities. Included in the potential list of separation-related improvements is the possibility of implementing real-time, low-latency voice communications, which will ultimately improve operational safety and efficiency for both oceanic users and controllers. By leveraging these future CNS and automation technologies, the FAA will be able to implement a host of separation-related enhancements. Potential candidates include application of horizontal-radial separation procedures, use of on-demand tactical-

maneuver capabilities, increased accommodation and resolution of critical aircraft contingency scenarios, improved departure and arrival ATC services into remote oceanic airports, and efficient management of pair-wise aircraft performance differences (e.g., tactical maneuvers around blocking aircraft). In alignment with the FOTO35 vision, ATC tactical separation will use future enhanced surveillance and communication capabilities that will be applied by the controller and FAA automation when operationally advantageous. In specific airspace volumes, such as congested or complex areas (e.g., areas in which frequent convective weather requires aircraft to request deviations), these new communication and surveillance capabilities will enable flexible tactical separation techniques. Tactical separation may also be applied in operational situations when advantageous. New technologies, automation, and procedures will be leveraged to detect and avoid conflicts and to ensure required separation.

3.7. In the current environment, under most circumstances, oceanic controllers are unable to apply more flexible and efficient separation procedures between aircraft. There also still remain potential risks in isolated scenarios and situations, such as when attempting to issue a weather deviation or when there is an in-flight emergency. Additionally, the current oceanic automation system does not allow controllers to utilize target-to-target separation. By enhancing application of oceanic separation standards and procedures, FOTO35 would effectively provide controllers and users the flexibility to manage evolving scenarios, including weather phenomena and other operational events that are managed through appropriate and agreed plans with minimum adverse operational results. It would also be doing so by leveraging new and advanced tools to enhance global proactive management of potentially adverse operational events, as specified in the NAT 2030 vision.

3.8. Given the current shortfalls, FOTO35 has outlined three primary objectives in order to enhance separation standards and procedures as specified in the FOTO35 vision and in a manner that aligns with NAT priorities. First, two initiatives have been identified as necessary in order to achieve the objective of incorporating safety and efficiency gains in specific oceanic scenarios. The first of these initiatives is to leverage existing technical reporting systems, such as ADS-C or SATCOM, to implement improved separation procedures, as well as to gather communications, surveillance, and separation value requirements for enhanced separation procedures. Following these activities, FOTO35 will begin the second objective: to develop improved technologies and procedures based on these requirements which will safely reduce separation standards and enhance procedures. This will be accomplished following the successful socialization of these new standards and procedures among both industry and ANSP stakeholders. Once new standards and procedures are well received and adjusted to incorporate feedback from stakeholders, these requirements will be incorporated into future automation system development, similar to the approach outlined in the previous 4DT section. This results in the initiation of the final stage of implementing enhanced separation standards and procedures. FOTO35 will leverage new communications and surveillance technologies deemed necessary to enhance standards and procedures into the updated automation systems. Appropriate FAA organizations will then monitor system performance to ensure satisfaction of previously specified requirements.

3.9. *Safely Integrating Emerging Users and Space Operations*

As new technologies in aviation emerge, the FAA must be prepared to accommodate

them and apply them to improve system performance. Space vehicles, unmanned aircraft systems (UAS), supersonic aircraft, and unmanned high-altitude balloons are just a few of the emerging oceanic airspace users presently operating or expected within the next fifteen years. In fact, some of these users already operate there. Today, automation systems around the world are incapable of efficiently and effectively managing and monitoring these emerging airspace users. FOTO35 aims to change that. For example, the current oceanic ATM system is unable to detect and mitigate an emergency situation involving a non-conventional user. Thus, there is a need for new procedures to be developed in order to handle off-nominal events involving emerging users in the oceanic environment. Additionally, the typically limited CNS capabilities of some of these emerging users, high-altitude balloons, for example, diminish controller situational awareness and could pose a significant risk to the flying public. To address these shortfalls, FOTO35 aims to establish uniform policies, procedures and technologies that allow controllers to monitor, control and manage emerging user operations in oceanic airspace, such as space launches, spacecraft re-entries, and other non-conventional activities. By understanding and incorporating the CNS performance capabilities of these non-conventional airspace users, FOTO35 will increase safety and controller situational awareness, and will contribute to enhancing evolving aviation markets and innovation.

3.10. Similar to previously mentioned program goals, successful integration of emerging users in the oceanic environment relies on the satisfaction of objectives and completion of initiatives. In order to begin preparing for the regular presence of these users, the FAA must identify the user needs to operate in the oceanic environment. This involves continuing industry outreach and conducting more needs analyses of stakeholders both internal and external to the FAA. As aviation adopts new technologies, the FAA must partner with industry and other ANSPs to identify opportunities that allow for data sharing and early system integration of such technologies. Once these opportunities are known, the FAA will begin identifying requirements to increase situational awareness of, and improve services to, emerging users. After socializing these requirements with industry, partners, and other branches of the FAA, FOTO35 will begin incorporating these requirements and data connections into the oceanic automation system, along with the 4DT and separation standards requirements. Following deployment, the FAA will continue to develop and implement ATC procedures so that emerging users in oceanic airspace will be better served and accommodated well beyond 2035.

3.11. *Implementing Improved Oceanic ATM Automation*

Given the various changes the aviation industry is undergoing and will undergo, it is unlikely that the oceanic ATM automation systems of today will be capable of effectively supporting complex global oceanic operations in the coming fifteen years. Many oceanic automation systems are based on monolithic hardware systems that are difficult to reboot and repair. Further, most oceanic automation systems are incompatible with the systems in the domestic radar environment. Oceanic flights managed by oceanic automation systems are not automatically integrated with domestic systems, such as the FAA ERAM system, until they enter airspace with radar coverage. The inability to integrate data between oceanic and domestic systems creates an environment in which the entire operation, both oceanic and domestic, is negatively affected. FOTO35 intends to introduce new measures that enhance the future of oceanic automation, and, if deemed necessary, an entirely new FAA oceanic ATM automation system that will be capable of improving seamless, efficient, and safe oceanic operations.

3.12. The introduction of improved oceanic ATM services and systems supported by a new oceanic automation system serves not only as simply an upgrade to adapt to modern technology, but also as an enabler to the other three goals of the FOTO35 program. This provides a new opportunity to successfully integrate oceanic automation platforms with evolving domestic systems. New oceanic ATM automation services will increase operational efficiencies (by enabling 4DT & on-demand tactical operations), reduce system complexity and controller workload, increase safety with outage detections and improved conflict resolution capabilities, improve access to system data, and improve overall system management and customer service. The integration of improved communications, data exchange, and data processing technologies will enable greater shared situational awareness by all parties involved with the operation of the oceanic flight. Additionally, improved automation will support enhanced aircraft avionics capabilities in oceanic regions, potentially allowing flight crew access to more extensive information concerning weather, airspace status or constraints, and traffic that could impact their desired trajectory. This will result in improved situational awareness beyond the primarily tactical view held today, allowing the flight crew to collaborate with their support personnel as necessary and then negotiate needed trajectory adjustments with ATC for improved efficiency in aircraft operation.

3.13. Automation architecture also plays a major role in future oceanic ATM. Current advances in cloud-based technologies are redefining how the FAA and industry develop and deliver solutions to not only their employees and the global flying public, but also to other countries. Leveraging cloud technologies and agile processes will enable FAA teams to more quickly and effectively innovate in the future as oceanic ATM automation capabilities evolve. This includes the improved exchange of information with the application of cloud-based technologies, which will also enable artificial intelligence (AI) capabilities.

4. NAT2030 Vision Alignment

4.1. Common alignment has been identified between the plans and goals of FOTO35 and those of the NAT2030 vision matrix. This section aims to highlight a few examples of this alignment and convey that the work of FOTO35 will positively impact the work outlined in the NAT2030 vision.

The NAT2030 vision matrix has specified six primary goals:

- Ensure as far as possible that all NAT developments are implemented in the context of seamless boundaries
- See enhanced resilience and predictability of NAT-wide operations
- Continue cooperation with all adjacent regions and industry-wide stakeholders to achieve seamless boundaries
- Take account of both the prevailing and forecast operational and stakeholders' capabilities and implement proportionate performance-based outcomes,
- Align the NAT technology roadmap to the practical capabilities that will exist to 2030.

- Measure safety, service, value and environmental benefits using representative metrics that are part of not only the business case for all developments, but are used to monitor NAT performance.

4.2. The goals, objectives and initiatives of FOTO35 each have an outcome and plan to positively affect each of the six NAT2030 goals, and often overlap with each other when compared side by side. For example, all four FOTO35 program goals intend to ensure that all program outcomes are to be developed and implemented in the context of more seamless airspace transitions and boundaries, which includes clearer cooperation and communication with adjacent ANSPs through means such as oceanic flight-data information sharing.

4.3. *Leveraging Technologies to 2030 and Beyond*

Enhanced automation capabilities, which will enable the implementation of 4DT operations, enhancement of oceanic separation standards and procedures, and the integration of emerging users, will be implemented in a manner that allows systems to more flexibly continue updating themselves as new technologies emerge beyond 2030. They also allow airspace users to leverage to the fullest extent their optimal flight capabilities in order to achieve their optimal performance-based outcomes. While these goals and intentions are presently aligned with each other, it is important to emphasize that both the NAT and FOTO35 are planning for the future. Similar to the NAT2030 vision, FOTO35 intends to ensure that the capabilities and goals outlined in the aligned matrices will also be adaptable and manageable in the foreseeable future. Examples of this include updating automation systems and software that could potentially provide airspace users the ability to leverage UPRs and other flexible planning capabilities, which could result in the decrease of carbon emissions and fuel costs.

4.4. *Enhanced Resiliency and Predictability*

The flexibility of future oceanic automation systems also plays a major role not just in supporting the optimal performance-based outcomes of industry, but also in providing more resilience to the NAT-wide operation. For example, weather and other events that adversely influence system operations will be managed through new procedures, enabled by automation enhancements, with minimum operational impact. However, this is not limited to solely tactical operational events. FOTO35 also plans to leverage its automation capabilities to implement integrated communications across oceanic airspace, directly addressing the NAT2030 potential improvement identified in 2-1 calling for a resilience of communications systems, SATVOICE migration, digital HF developments and space-based ADS-B. In this suite of integrated communication capabilities, multiple modes of communication would be integrated in the enhanced oceanic automation platform. It also would allow controllers to be immediately notified that a message was not received by the flight deck and vice versa (not received, not responded) and reduce time to necessary to receive a response. The resilience of current and future communications systems is essential to safe and efficient air traffic management.

4.5. These are just a few examples of how FOTO35 has taken steps to align itself with the NAT2030 vision. A side-by-side comparison of the NAT2030 matrix and respective

FOTO35 impacts can be found in Attachment 2. It demonstrates precisely which FOTO35 goals, initiatives and objectives align with those in the NAT2030 matrix.

5. Conclusion

5.1. Oceanic airspace is evolving rapidly as advancements in technology reshape air traffic management. The FAA maintains its commitment to industry and its international partners as it continues to leverage new technologies to enhance oceanic ATM capabilities. That commitment extends to ongoing mutual collaboration and communication with its partners in the NAT as the FAA progresses FOTO35 program development and implementation. As reflected explicitly in its FOTO35 program documents, a key agency priority is future collaboration and harmonization with regional partners, specifically with NAT ANSPs and stakeholders,. The FAA also maintains its full commitment to advancing the goals and objectives agreed with its partners in the NAT, other ICAO regional groups, and other international aviation working groups.

5.2. The seamless boundaries, resiliency and predictability, and commitment to leveraging future technological capabilities to enhance oceanic air traffic management are all major NAT2030 initiatives and goals with which FOTO35 is committed to advancing. The FAA is committed to the socialization of its FOTO35 program goals and strategies with the NAT, and will incorporate appropriate feedback into future planning efforts. As significant developments emerge, FOTO35 will provide the NAT IMG with information papers and other updates when necessary.