**THE FORTY-THIRD MEETING OF THE
INFORMAL PACIFIC ATC CO-ORDINATING GROUP
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Agenda Item 5: Communications/Navigation/Surveillance (CNS) Issues

ATC Services Above FL600

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Presented by Federal Aviation Administration

SUMMARY

The expansion of aerial activity to altitude stratums above what is considered the "conventional" National Airspace System (NAS) is among the priorities of the Federal Aviation Administration (FAA). Historic development of the current NAS provides the FAA with the fundamentals to expand our capacity as an Air Navigation Service Provider (ANSP) for the next generation of manned and unmanned activities. In research for this paper, numerous shortfalls and challenges were explored and summarized. Several complications have been identified and initial solutions brought forward through NextGen research. Other challenges include the fundamental issues of Communications, Navigation and Surveillance, all of which can be overcome by technological advancements and their implementation in the upper stratums of the NAS.

Opportunities are not limited by technology, and perhaps technology will afford us various approaches to solutions. The ambition of entities outside the United States Government opens the door to dialogue with some of the most creative minds in the world. With the FAA as the administrator of safety, service and regulatory responsibilities in the United States, the advent of new participants in the NAS affords the FAA the opportunity to collaboratively develop new solutions that reach beyond the limits of the current NAS architecture.

1. INTRODUCTION

1.1 The FAA has recognized that the operations forecast for extremely high altitude flight will challenge our conventional application of Air Traffic Control (ATC) services. The purpose of this information paper is to identify challenges and provide possible recommendations to facilitate better services in the upper altitude stratum. While numerous operations occur in the NAS above 45,000 feet (FL450), they are generally below FL600. However, industry's desire to operate at higher altitudes is increasingly becoming the norm. As the need for additional services above FL600 increases, so does the need to reevaluate standards to ensure the safety of users at these higher altitudes. The reconsiderations include, but are not limited to altitude stratum, surveillance, communications, procedural applications, navigation, mission requirements, Class

E structure, resources and New Entrants. For the purpose of this paper, “extremely high altitude” refers to any altitude above FL600.

2. DISCUSSION

2.1 **Stratum**: Per 14 CFR (Code of Federal Regulations) Part 71, the airspace above FL600 is designated as Class E airspace, and as such, the FAA has authority for providing ATC services in this stratum. The first step should be to determine the maximum altitude to which the FAA should provide service, and whether this airspace should be further stratified for different requirements regarding Communication, Navigation and Surveillance (CNS). Airspace parameters should be established to ensure equipment and procedural requirements for separation and safety services at these higher altitudes can be identified, scoped, budgeted and implemented.

2.1.1 There are several options to consider when deciding the altitude parameters for the establishment of services at extremely high altitudes. One option is to establish the notional ceiling as 500,000 feet, since CFRs allow amateur rockets to operate up to +/- 487,344 feet. Another suggestion is to use 330,000 feet, also known as the Kármán Line, which is considered by many to be the unofficial boundary between the Earth’s atmosphere and outer space. A third option is to establish the initial ceiling at 100,000 feet on a short-term basis, since the En Route Automation Modernization (ERAM) is currently configured to FL999. This would allow future incremental increases of altitudes to the upper stratum as technology, increased aviation activity, and FAA resources allow. It is reasonable to expect multiple different strata with different CNS requirements.

2.2 **Surveillance**: There are several technological challenges associated with aircraft surveillance above FL600. Air Route Surveillance Radar Model 4 (ARSR-4) radars have vertical limitations and areas of non-surveillance (cones of silence) which can inhibit detection. In most Air Route Traffic Control Centers, multi-sensor adaptation mitigates these limitations. Research concerning ARSR-3 and ARSR-4 radars concluded that 100,000 feet Above Ground Level (AGL) is generally the accepted radar coverage limitation. However, external interferences, such as those caused by large windmills, result in widespread degredation of ARSR-4 coverage above 50,000 AGL. Upgrades will be necessary to return the radar coverage capability to the 100,000 foot level.

2.2.1 Further enhancement of existing data, such as Mode S data, (e.g. actual heading, actual indicated speed, altitudes set in Vertical Navigation (VNAV), and other information from the Flight Management System), which is filtered at the radar sites and not processed for use by ATC, may yield useful information to enhance the usage of current systems above FL600. Research and testing for the inclusion and use of this discarded information should transpire to determine if this data could be utilized to enhance the future system.

2.2.2 A more promising alternative surveillance source is the use of Automatic Dependent Surveillance-Broadcast (ADS-B). Some testing has been accomplished with positive results at altitudes over 300,000 feet. However, additional security and reliability measures need to be adopted prior to utilization.

2.3 **Altitude Determination**: Today our vertical separation standards are based on barometric altitude reporting in conjunction with Mode C. At higher altitudes, with less dense atmospheric conditions, the barometric altitude readout becomes less reliable. It seems unlikely that separation above FL600 could be dependent upon barometric altitude reporting.

2.3.1 Geometric (GEO) altitude, determined using the Global Positioning System (GPS), may be the future alternative. Research and testing would be required to determine how GEO altitude reporting could be integrated into the NAS. It is also important to explore the cutoff altitude for reliance on barometric equipment and where geometric equipment dependence should begin.

2.4 **Communications**: Vertical limitations of FAA transmitters and receivers, and the impact of frequency overlap, are of concern. The ability to utilize other equipment such as High Frequency third party communication and Controller-Pilot Data Link Communications (CPDLC; also known as DataComm) would have to be reviewed to establish definitive performance standards. Latency is a potential hazard for consideration due to the high speeds associated with some high altitude flights. Line of sight, curvature of the earth and spectrum overlap will limit Very High and Ultra High Frequency radio usage. While conventional communication equipment in the NAS has limitations in these higher altitude arenas, the opportunities available with Voice over Internet Protocol (VoIP) offered by the NAS Voice System (NVS) hold a promising outlook.

2.5 **Procedural Applications**: Current procedures in FAA Order JO 7110.65, Air Traffic Control, establish a vertical separation standard of 2,000 feet between aircraft above FL410. In oceanic airspace, the separation standard between a supersonic and any other aircraft is 4,000 feet above FL450. The vertical separation requirement between military aircraft operating above FL600 is 5,000 feet. Lateral radar separation for all aircraft increases from five to ten miles above FL600. These standards, which are now outdated, were established when the only operator above FL600 was the United States Air Force. Additional evaluation and research must be accomplished to validate operational vertical separation standards for all users of the airspace above FL600.

2.5.1 There are also many non-radar procedures for use when surveillance is not available. These procedures must be reviewed for applicability at extremely high altitudes to ensure the safety of operations in this stratum.

2.6 **Aerodynamics and Speed**: Using current ATC procedures and techniques, the erosion of aircraft performance in the diminishing atmosphere will require that control actions be taken well in advance of the timeframes established in the ATC system today. Aircraft type and speed capabilities throughout the NAS will be much more exaggerated at extremely high altitudes than at lower altitudes. Some aircraft will maintain the capability to maneuver in the high strata, while other aircraft may have restrictions that limit their performance capabilities. Due to the limitations on ATC services and vehicle maneuverability, the timeframe to recognize potential threats must be extended well beyond that which exists in the current ATC system.

2.7 **Navigation**: There is currently no conventional or Area Navigation (RNAV) route structure above FL450, so a determination will have to be made as to whether a route structure should be designed and implemented. Also, since GPS coordinates are associated with the surface of the Earth, a determination must be made regarding a fix displacement factor for higher altitudes that could have an impact on navigability.

2.8 **Mission Requirements**: Our current ATC procedures are based primarily on subsonic, fixed-wing aircraft traversing the airspace while flying from point to point. By contrast, future users of airspace above FL600 will travel at much more diversified speeds and have varying missions (e.g., loitering to provide Internet access versus transitioning to and from space). Also, during different phases of flight, mission requirements for these users may not allow adjustments in speed, heading, climb rate and/or altitude. The conventional methods of establishing separation in the NAS such as speed, altitude, and routing assignments would then become ineffective. We will have to rethink separation standards in their entirity, while trying to determine the best way to separate a hypersonic, suborbital rocket traveling from New York to Paris from a loitering, unmanned free balloon.

2.9 **Class E Structure**: Based on known and predicted intent of missions in Class E airspace above FL600, the current allowance of Visual Flight Rules (VFR) operations does not provide qualitative positive separation service. For example, for VFR operations, there is no minimum separation requirement other than for an aircraft to see and avoid other aircraft. Until this is modified, a positively controlled environment, such as that which exists in Class A airspace, is not possible. The envelope of aerodynamic performance is so limited that the mix of operational profiles and speeds reduces the effectiveness to conduct see-and-avoid operations. This may be enhanced by a Detect and Avoid (DAA) system, using an Airborne Collision Avoidance System (ACAS) or onboard radar. Furthermore, due to the sensitive and classified parameters of military operations above FL600, restricted altitude reporting is the norm. In the future, this may have to change so that all affected aircraft will be informed of possible traffic alert conflictions. Even though Class E airspace above FL600 does not currently provide for a positive controlled environment, analysis may determine that ATC services are sufficient for future operations in this airspace without changes to airspace classification. Likewise, it may be necessary to convert all or part of Class E airspace above FL600 to Class A airspace.

2.10 **Resources**: An increase in traffic above FL600 may necessitate additional resources to create new extremely high altitude sectors at en route centers. Each of these sectors will require the resource burden of normal sector logistics, as well as any newly required equipment which aids ATC specialists in providing service to the users of the airspace. Additionally, the use of the Advanced Technologies and Oceanic Procedures (ATOP) system should be explored for integrating flights at extremely high altitudes crossing the ocean. The integration of space launch and recovery operations in areas previously void of such activity challenges the equal use of airspace while segregating areas for vehicles and possible debris areas, should an off-nominal event occur.

2.11 **New Entrants**: Until recently, most operations above FL600 were conducted by the military, the National Weather Service and NASA. However, technological advancements have dramatically lowered costs, making this airspace increasingly accessible to the private sector. Today, many new entrants to the NAS routinely operate at altitudes above FL600. Some of the classifications of new entrants are:

2.11.1 Unmanned and manned aircraft

2.11.2 Orbital and suborbital spacecraft

2.11.3 Unmanned free balloons

2.11.4 Hybrids (e.g., Captive Carry)

2.11.5 As new entrants are introduced into the NAS, new requirements may need to be enacted via rulemaking or policy changes, in the near future.

3. CONCLUSION

3.1 The ability of the FAA to integrate Extreme High Altitude ATC Services into the current ATC system, while preserving the safety of the NAS, is dependent largely upon a detailed and effective collaboration of all stakeholders. Based on research for this paper, the issues of stratification, proceduralization and CNS in the airspace above FL600 must be undertaken soon to allow the emerging Commercial Space industry to flourish without placing an unacceptable risk on the NAS.

4. ACTION BY THE MEETING

4.1 The meeting is invited to:

4.1.1 Note the content of the paper