Assessment for Utilizing Upper Class E Airspace in the United States

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1. Airspace Classification in the United States and Background Related to Ultra-high Altitude Airspace Usage

As shown in Figure 1, U.S. airspace is divided into controlled airspace (Class A, B, C, D, and E) and uncontrolled airspace (Class G). Among controlled airspaces, Classes B, C, and D are situated around airports. Moreover, Class A airspace is determined to be at or above an altitude of 18,000 feet (about 5,500 meters) and at or below 60,000 feet (about 18,000 meters), while Class E controlled airspace is at an altitude less than 18,000 feet, except around airports, and all airspace above 60,000 feet.

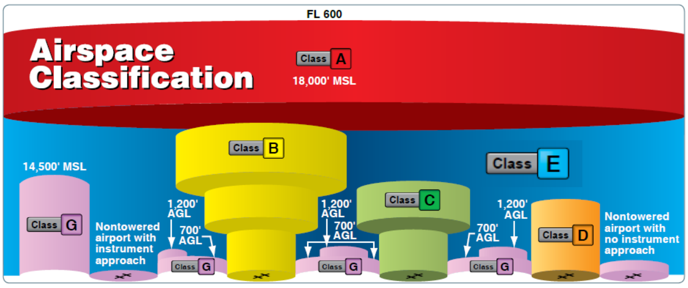

Figure 1: U.S. Airspace Classification [created by referencing the Federal Aviation Administration's (FAA) Pilot's Handbook of Aerocnautical Knowledge[1)]]

The altitude at which typical jet airplanes (including business jets) can presently operate is limited to 51,000 feet (about 16,000 meters), corresponding to Class A airspace. Up to now, there were restrictions on the use of ultra-high altitude airspace above 60,000 feet, that is, airspace above Class A's altitude limit and within Upper Class E airspace, due to low air density causing performance challenges among conventional aircraft.

However, recent advances in propulsion technology, aircraft construction, flight automation, and aerodynamics have increased the number of aircraft capable of flying in such ultra-high altitude airspace. Specific examples include high altitude long endurance (HALE) unmanned aerial vehicles, unmanned free balloons, and supersonic and hypersonic aircraft. These aircraft are expected to enable efficient and economical implementation of research objectives, wide-ranging services such as Earth observation and communications, and supersonic passenger flights.

2. Assessment in Response to the Expansion of Ultra-High Altitude Airspace Use

2.1 The Need for New Traffic Management

In the United States, there are no provisions specific to civil aircraft operations in airspace above 60,000 feet, which up till now have been limited to mostly military operations.

Additionally, existing air traffic management (ATM) systems are undesirable as they cannot cost-effectively meet the needs of flying in ultra-high altitude airspace.

As described above, the expected rise in future operations, along with differences in performance characteristics and operational needs of new aircraft as compared to conventional vehicles, present novel challenges to existing airspace infrastructure and require totally new solutions.

For this reason, the FAA and NASA are working with the industry to advance considerations of the Upper Class E Traffic Management (ETM) concept to support future operations and expanded use.

2.2 Future Vision of ETM

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As mentioned above, new technologies have made it possible to design and develop aircraft that can operate at altitudes never seen before. As demand increases because of new technologies and emerging markets, the future of operation in Upper Class E airspace becomes an opportunity for alternative traffic management approaches that ensure the provision of safe and efficient services.

The ETM concept extends beyond the infrastructure and human resources of existing airspace systems to meet market needs, supports the management of operations where air traffic control services do not have access to separation services, and promotes the sharing of situational awareness among operators.

In addition, it is important to develop ETM regulatory frameworks, flight rules, performance-based standards and procedures, and operator roles and responsibilities. Through these, as the authority that controls and oversees operations in all airspaces as well as regulating and monitoring commercial activities, the FAA will ensure that the future of ETM meets the requirements for safe and efficient operations.

3. ETM Concept of Operations

3.1 Overview

In collaboration with NASA and industry partners, the FAA compiled the ETM Concept of Operations, publishing the first edition in May 2020.[2)]

The released ETM Concept of Operations includes how operators are to plan flying in Upper Class E airspace, interact with ATM systems and air traffic control during the transition phase of flight, and deal with emergencies.

Furthermore, the ETM Concept of Operations defines the roles and responsibilities of the operator and air traffic control, and describes high-level case studies that demonstrate flight operations.

The first edition presents the basic operating principles of ETMs at altitudes above 60,000 feet, and a more comprehensive approach to cooperative traffic management between operators in this airspace will be covered in future revisions.

The following sections will detail the aforementioned Concept of Operations.

3.2 Pre-flight Planning

In Upper Class E airspace, operators cooperating on separation is essential. Therefore, operators obtain information within the vicinity of their intended flight path during pre-flight planning, including the flight intent of other operators, airspace restrictions, weather, and so on.

By using this information and coordinating with others as necessary, operators create a flight path that does not conflict with the trajectory of predetermined flights. Once flight intent is determined, operators share it with other operators.

In addition, the operator must report necessary flight plans, request issuance of aviation notification (notam), and receive authorization from the air traffic control. Specific requirements vary depending on the type of aircraft. For example, manned supersonic aircraft must declare their flight plan up to 24 hours in advance and receive Air Traffic Control (ATC) approval for all routes in order to fly. Likewise, in the case of HALE unmanned aerial vehicles, it is necessary to report flight plans and request the issuance of aviation notifications up to 24 hours in advance, as well as to receive the required ATC approval in accordance with individual agreements.

3.3 Transition to / from Upper Class E Airspace

From an aircraft's takeoff to it's transition into Upper Class E airspace, the operator will maintain communication with air traffic control in accordance with their existing rules. In addition, by considering aircraft performance, maneuverability, and resistance to wake turbulence, the air traffic control will secure separation between aircraft, issue necessary control instructions, and approve entry into Upper Class E airspace.

The ascent pattern into Upper Class E airspace varies greatly depending on the aircraft. Manned supersonic aircraft are expected to operate through Class A airspace similar to current subsonic aircraft, but are anticipated to climb at higher rates to reduce fuel consumption, and also require greater separation distances from other aircraft. Furthermore, HALE unmanned aerial vehicles ascend in a spiral pattern, but due to their low maneuverability, air traffic control segregrates them from other aircraft until their transition to Upper Class E airspace.

Air traffic control also approves descent from Upper Class E to Class A airspace. Once opertors enter Class A airspace, air traffic control establishes separation between aircraft and issues control instructions in accordance with existing ATC regulations.

Like ascent patterns, descent patterns vary greatly depending on the aircraft. In the case of manned supersonic aircraft, clearance to descend as reported in the flight plan must be recieved from air traffic control before lowering from operating altitude. In the case of HALE type unmanned aerial vehicles, operators provide notification to air traffic control with an intended descent time and estimated exit point from upper Class E to Class A airspace before descending. Air traffic control approves descent into Class A airspace and segregates aircraft from each other, and in some cases may provide a stepped clearance on descent to allow for other aircraft to operate efficiently.

3.4 Emergency Management

Operators flying in Upper Class E airspace have to establish procedures for emergencies that can impact their ability to fly or land safely, such as uncontrolled descent and loss of links to command and control.

While responses to emergencies can vary based on the nature of the event, vehicle capabilities, operational characteristics, phase of flight (take-off, transit, operating altitude, etc.), location (over populated areas, over the ocean, etc.), the airspace management system, and other factors, operators must establish protocols to discern emergency conditions and to correct or mitigate them.

In addition, if the state of emergency cannot be corrected or poses a danger to other aircraft, the potentially impacted entities must be notified as soon as possible and provided operational information for them to take action. Furthermore, if the emergency requires FAA attention and intervention, or could affect flights managed by air traffic control, they must also be notified.

Relevant and known information (last identified location, projected flight path, etc.) is provided to impacted parties (air traffic control, other cooperating operators, etc.) and used to directly implement the necessary measures for response or mitigation. If necessary, emergency response personnel (such as fire departments), public/private entities (such as alternate landing sites), and/or other impacted parties (such as citizens on the ground) are also notified.

Moreover, operators are responsible for collecting and retaining FAA specified data about accidents and incidents over a period of time.

3.5 Flexible Operations of Upper Class E's Lower Altitude

As mentioned in Section 1, the lowermost altitude limit for Upper Class E is 60,000 feet. On the other hand, HALE unmanned aerial vehicles fly over 60,000 feet during the day to charge their batteries and descend below 60,000 feet at night to minimize battery drain, and thus can be expected to operate across this lowermost altitude limit.

Because the number of cases of existing conventional aircraft flying close to an altitude of 60,000 feet is extremely limited, in areas where air traffic control deems appropriate, it may be possible for Upper Class E operators to conduct coordinated traffic management amongst themselves in altitutudes below 60,00 feet (at 55,000 feet, for example) without coordinating with air traffic control.

4. Conclusion

Some aircraft flying at ultra-high altitudes will continue to operate for several months. In addition, during this period they may fly over vast areas spanning multiple countries.

For this reason, the FAA will continue to consider international interoperability when deliberating the ETM operational concept.

Therefore, following the progress of studies on the ETM operational concept in the United States, as well as simulataneously examining those in Japan, is imperative.

References

1) FAA, Pilot's Handbook of Aeronautical Knowledge
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2) FAA, Upper Class E Traffic Management (ETM) Concept of Operations v1.0
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