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Low Altitude Authorization and Notification Capability (LAANC)

Concept of Operations

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1 Introduction

Congress directed the FAA to focus on Unmanned Aircraft Systems (UAS) and their integration into the National Airspace System (NAS) in the FAA Modernization and Reform Act of 2012 and the FAA Reauthorization Act of 2018. From these acts, a variety of UAS initiatives, programs, and policies have been implemented. Included among these are 14 C.F.R. Part 107 ("Part 107") and 49 U.S.C. § 44809 ("Section 44809"), which require small UAS (sUAS) to receive authorization prior to commencing any flight operation in controlled airspace.

The backdrop to UAS integration into the NAS is the FAA's statutory mandate to control and maintain a consistently high level of civil aviation safety. The FAA is tasked with the exclusive management of airspace in the United States and must issue regulations and control the use of airspace to ensure the safe and efficient use of airspace.¹

This Concept of Operations will focus on the Low Altitude Authorization and Notification Capability (LAANC), which helps to implement authorization services under Part 107 and Section 44809.

1.1 Problem Statement

The FAA is responsible for processing authorization requests under Part 107 and Section 44809. The Part 107 rule was finalized in June 2016 and took effect on August 29, 2016. Section 44809 was enacted on October 5, 2018.

Part 107 at 14 C.F.R. § 107.41 states:

No person may operate a small unmanned aircraft in Class B, Class C, or Class D airspace or within the lateral boundaries of the surface area of Class E airspace designated for an airport unless that person has **prior authorization** from Air Traffic Control (ATC).

Similarly, Section 44809 states:

In Class B, Class C, or Class D airspace or within the lateral boundaries of the surface area of Class E airspace designated for an airport, the operator obtains **prior authorization** from the Administrator or designee before operating and complies with all airspace restrictions and prohibitions.

In December 2015, the FAA finalized a rule requiring registration of sUAS aircraft. By the end of 2016, soon after Part 107 was finalized, there were over 626,000 recreational registrations and over 44,000 commercial registrations. The FAA Aerospace Forecast for Fiscal Years 2017-2037 forecasted that these UAS numbers would continue to grow

¹ See 49 U.S.C. §§ 40103 and 44701; 49 U.S.C. § 44807

at an accelerated rate and that has occurred. The most current FAA Aerospace Forecast (for Fiscal Years 2019-2039) described UAS growth in the United States as healthy and predicted growth rates of 1.5% for recreational UAS from 2020 to 2021 and 30.5% for commercial UAS from 2020 to 2021. As of January 20, 2020, there were 430,000 commercial UAS registered and 1.1 million recreational registrations.

The FAA must design a way to safely and efficiently process authorization requests from those flying under Part 107 and Section 44809.² This is especially true given that the number of authorization requests is expected to grow over time commensurate with UAS growth.

1.1.1 Airspace Authorization Processing

After the Part 107 rule was published, the FAA had only a manual method to process authorization requests. This manual process was not scalable and while the number of sUAS was much smaller in 2016 than it is in 2020, a backlog of tens of thousands of authorization requests developed. Part 107 operators faced waits that averaged 104 days to receive an authorization to fly.³

Not only was the average wait of 104 days not acceptable to the FAA, but it was clear that as UAS growth continued this wait would only increase. An automated process was necessary to process the airspace authorization requests, clear the backlog, and provide more immediate access to the NAS for the Part 107 operators.

The FAA created LAANC to address this identified problem. As this document will discuss, LAANC is an innovative solution that leverages the regulatory expertise of the FAA with the technical expertise and agility of private industry. Combined, the government and private industry have created a model for UAS integration known throughout the world of aviation.

1.2 Purpose and Scope

This document gives interested parties, including industry stakeholders, government leadership, and the flying public, the necessary contextual information to understand the LAANC design, development, and implementation. A secondary outcome of the demonstration of LAANC will be to validate and inform a data exchange for use in future applications.

² Those flying under Part 107 are referred to as Part 107 operators. Those flying under Section 44809 are referred to as recreational flyers. Throughout this document, "sUAS operators" will be used to collectively refer to Part 107 operators and recreational flyers. The rules governing both groups differ slightly and, when necessary, the two groups will be discussed individually as either Part 107 operators or recreational flyers.

³ At this time, Congress had not yet enacted Section 44809 so Part 107 operators were the only sUAS operators required to make authorization requests to gain access to controlled airspace.

This document will encompass the concept of operations for the issuing of airspace authorizations through LAANC in Class B, Class C, Class D, or within the lateral boundaries of the surface area of Class E airspace designated for an airport.⁴ This document references features and plans for implementation and/or future functionality beyond initial implementation, but such information is subject to change as lessons are learned.

2 Referenced Sources

- Federal Aviation Administration, Advisory Circular: 107-2, "Small Unmanned Aircraft Systems (sUAS)", 21 June 2016
- Federal Aviation Administration, "Integration of Unmanned Aircraft Systems into the National Airspace System, Concept of Operations v2.0", September, 2012
- U.S. Government Publishing Office, Code of Federal Regulations, Title 14, Parts 107 ("Small Unmanned Aircraft Systems")
- FAA Modernization and Reform Act of 2012, Pub. L. 112-95 (Feb. 14, 2012)
- FAA Extension, Safety, and Security Act of 2016, Pub. L. 114-190 (July 15, 2016)
- Federal Aviation Administration, Aeronautical Information Manual (AIM), January 30, 2020
- 49 U.S.C. § 44809 (Sec. 349, FAA Reauthorization Act of 2018 (P.L. 115-254)), "Exception for limited recreational operations of unmanned aircraft."

⁴ For ease of discussion, this document will use the term "controlled airspace" to describe the above described airspace. It is recognized the controlled airspace extends beyond the enumerated classes, but for this document the term "controlled airspace" will mean just these classes.

3 Current Operations

Information needs with respect to sUAS operations depend on a number of factors. Air Traffic may require more information about the proposed sUAS activity as the risk of the operation increases.

As discussed above, both Part 107 and Section 44809 operations require prior authorization before the FAA will allow a person to operate a sUAS in controlled airspace. Prior to the initial launch of LAANC, the FAA received requests and granted approvals only through a manual process involving coordination with air traffic facilities.

Basic information needs should generally be consistent across operations. However, even for relatively straightforward operations, there are numerous regulatory factors that add to the complexity of automating authorizations.

3.1 Operational Shortfalls

Operational shortfalls have included inefficient processes, the timeline required to obtain authorizations from FAA, and a potential backlog associated with manual processes. Failing to address these operational shortfalls could lead to a lack of compliance and lack of air traffic awareness of flights occurring in the NAS.

As previously discussed, the number of sUAS flights is expected to increase dramatically as the new rules are expanded to enable new types of operations and are further clarified regarding where and how sUAS flights can be conducted. As operators are seeking ways comply with the governing rules, automated processes and electronic systems supporting these rules and associated sUAS operations are needed.

3.2 Technology Gap

Technologically, sUAS operators and the FAA need a streamlined, efficient solution to enable airspace authorization requests. Initially, sUAS operators and Air Traffic communicated through the manual process discussed above. The FAA had no system in place that could effectively manage the volume of authorization requests coming through the manual system.

A system needed to be built that would effectively connect sUAS operators and the FAA so that the FAA could effectively and efficiently manage the volume of authorization requests.

3.3 Implementation Alternative

The FAA investigated several alternatives to achieving authorization requirements in 2016 and in 4Q FY16 issued a request for information (RFI) seeking industry's understanding and input toward solving the problem statement discussed in Section 1.1 and the operational shortfalls and technology gap discussed in Sections 3.1 and 3.2 above. Based on the RFI and the responses to it, the FAA pursued a public-private

partnership with private industry companies. Under this partnership, the FAA relies on private companies, known as UAS Service Suppliers (USSs), to provide authorization services to sUAS operators. In this alternative, the FAA provides authenticated map data (UAS Facility Maps – UASFMS, see Section **Error! Reference source not found.** for more detail), and USSs provide authorization data to the FAA via an automated interface.

LAANC involves significantly new approaches to enabling a dynamic UAS flight community:

- System-level collaboration between FAA and USSs
- Provisioning LAANC using web services and cloud infrastructure
- Radically faster authorization approval times (seconds, not months)

LAANC automates the airspace authorization approval process. As opposed to manually checking every request against the UASFMs and any outstanding special airspace restrictions (such as TFRs), USSs develop applications that sUAS operators use to submit authorization requests.

This partnership relieves the FAA of managing hundreds of thousands of sUAS operator accounts and helps create an efficient marketplace for USSs. LAANC is intended for flexible integration with a wide range of USS business models in the evolving UAS services sector.

4 Nature of Changes

4.1 Development and Deployment of LAANC

LAANC major elements include the FAA's provision of authenticated map data for use in determining authorization, the use of USSs to provide services to sUAS operators, and the ability for multiple USSs to provide services.

With LAANC, the FAA provides USSs with UASFMs and performance rules. USSs provide the FAA with authorization requests. LAANC is also a capability that display UAS authorization requests and planned flight operations to Air Traffic. LAANC implementation includes multiple USSs sending and receiving data, all of which can be integrated for display at Air Traffic facilities. LAANC handles automatic authorizations for Part 107 and Section 44809 (using the UASFMs), and requests for further coordination (see Section 4.2.3 for more detail) with Air Traffic (Part 107 only).

In the future, LAANC may incorporate additional functionality, including but not limited to:

- addressing contingency operations for clearing airspace efficiently
- associating waivers and sUAS registrations with operations
- distributing LAANC information to FAA authorities to aid in accident investigation and compliance monitoring activities
- handling authorizations in Department of Defense (DOD) controlled airspace,
- handling multiple associated vehicles (swarms)
- distributing additional flight information (e.g., "FAA Extension, Safety, and Security Act of 2016" Section 2209)
- implementing other advanced features to support small UAS operations.

4.2 Essential Elements

LAANC functions at the operational planning stage, identifying intended operations and managing the associated authorizations. Operators may submit intended operations up to 90 days in advance. At a minimum, sUAS operators are encouraged to submit authorization requests with as much lead time as possible to increase Air Traffic situational awareness. Most LAANC information exchanges occur in real time and provide immediate feedback to operators.

4.3 Expectations

Following are expectations set forth to provide industry and FAA with the common understanding of functionality associated with LAANC. They include key integration assumptions as well as those specifically applicable to the sUAS operations described in this document.

- 1) LAANC services the well informed/well intended operator and will actively encourage participation with the FAA's goal of ensuring safe NAS operations for all aircraft types.
- 2) FAA works with USSs to establish the LAANC service.
- 3) USSs collaborate with each other as well as the FAA, where feasible, through and within workshops, demonstration(s), data exchange partnerships, and in the overall development of the LAANC nationwide solution.
- 4) The use of UASFMs to perform automatic authorization is not a delegation of authority by the FAA to the USS. USSs assist sUAS operators to identify automatically approved authorizations as defined by regulations in collaboration with the FAA.
- 5) The Part 107 remote pilot in command and the Section 44809 operator are ultimately responsible for the operation and safety during flight.
- 6) FAA supplies UASFMs for automatic authorizations via an FAA ArcGIS interface in GeoJSON format. Distribution of map data will be separate from the application programming interface (API) for LAANC data exchange concerning operations.
- 7) USSs enter into a Memorandum of Agreement and complete the LAANC USS Onboarding Process prior to providing LAANC services.
- 8) FAA supplies airspace class designations and airport locations.
- 9) LAANC APIs are limited to the smallest function practicable (e.g., via "micro web services") to ensure scalability and flexibility. APIs are versioned to accommodate additional phased capabilities as they are introduced.
- 10) For the purposes of communication between Air Traffic and operators during flight events, a valid U.S. phone number point of contact that can be used to reach the operator at any time during flight operations is required for all authorizations submitted to the FAA from any USS.
- 11) Normal FAA communication with the sUAS operator (for manual authorizations, contingencies, etc.) is conducted through LAANC via the USSs. By exception, the FAA may circumvent the USS when necessary to conduct direct communication via voice or text to the sUAS operator.

- 12) Any individual authorization applies to one sUAS operator flying one UAS at a time during the operational window.
- 13) USSs are responsible for managing requests from operators in potentially large numbers. Accordingly, there is no maximum number of authorization requests the FAA will accept from a USS per day.
- 14) If applicable, a USS may choose to utilize an operator's registration number(s) when a flight request is entered. However, registration numbers will not be dynamically verified or pulled from FAA records or data sources. There will be no dynamic connection between USS systems and the FAA sUAS registration for the initial implementation of LAANC.
- 15) USSs send the FAA a copy of all authorizations provided from sUAS operators and provide sUAS operators confirmation of FAA receipt. USSs share data with the FAA upon request for records.

5 LAANC Key Concepts

LAANC plays an essential role in the authorization process. Automated transfer of information from the USSs to the FAA allows sUAS operators to quickly receive authorization to fly in controlled airspace. LAANC also provides situation awareness to Air Traffic of all planned sUAS flight operations in their controlled airspace. LAANC also enables Air Traffic to quickly communicate with sUAS operators when required. This section will provide an overview of some key LAANC functionality and stakeholders.

5.1 UAS Facility Maps (UASFMs)

UASFMs are established by local FAA facilities to define the altitude thresholds in the surface area around most airports at and below which sUAS operations can by authorized without explicit coordination with the local facility. UASFMs are published to the public and represent a major step forward in streamlining the authorization of sUAS operations. As long as USSs use current and authoritative UASFMs and operate within agreed LAANC rules and processes, automated authorizations can be provided to sUAS operators. LAANC's use of UASFMs means that the FAA does not need to specifically analyze each authorization request.

5.2 UAS Service Supplier (USS) – FAA Data Exchange

The FAA is provisioning LAANC services by utilizing private USSs to provide services specific to sUAS operations in controlled airspace. Such services are accomplished through an exchange of information between the FAA and the USS, whereby the USS is the primary interface to the sUAS operator. The USS uses the UASFMs and follows performance rules provided by the FAA to convey the authorization of sUAS operations in a given area, at a particular time, under a set of conditions.

LAANC operational requirements call for an automated Air Traffic authorization system or service that would eliminate the need for sUAS operators to make requests via the FAA's webpage and limits overall operator interaction with Air Traffic. This requires the system/service to incorporate the following information:

- Available projected information on airspace status (e.g., Controlled Airspace, Special Activity Airspace)
- UASFMs that indicate automatic approval altitude thresholds
 - Within each grid on the map, the FAA identifies maximum altitudes at which flight is authorized without further coordination.
 - Airspace at or below the maximum altitudes are "auto-approved fly zones" (automatically authorized) and airspace above the maximum altitudes, and at or below 400', requires further Air Traffic coordination.

A notional architecture is shown below in Figure 1.



Figure 1. LAANC Notional Architecture

The sUAS operator may use the USS's system to determine the feasibility of his/her proposed flight operation as a planning function. Based on the sUAS operator's input for proposed operating area, altitude, date, start time, and duration, the USS determines whether each proposed flight operation falls within auto-approved airspace or requires further coordination. The USS may provide information to a sUAS operator for the following:

- (a) Class B, C, D, or Class E surface area;
- (b) Any airport-specific "areas that require further ATC coordination";
- (c) Special Use Airspace (SUA) where operations are prohibited;
- (d) National Security UAS Flight Restricted areas; and
- (e) "No-fly zones" (outside of airport-specific maps, e.g., Temporary Flight Restrictions TFRs).

5.2.1 Automatic Authorization

sUAS operators, whether flying under Part 107 or Section 44809, submit authorization requests through a USS to the FAA to fly in controlled airspace. These authorization requests are automatically checked against UASFMs and any request that falls within the established maximum altitude limits and is otherwise legally able to fly is automatically approved.

Authorization requests contain key data elements that are transmitted through LAANC. Data elements include date, time, location, and duration of the requested operation. The sUAS operator will submit the request through their chosen USS's application and the USS processes the requests, submits to the FAA, and transmits the authorization approval decision to the sUAS operator. Upon receiving authorization approval, the sUAS operator may continue with his or her flight operation.

If the operator (or designee) submits their proposed flight information, and the operation is within a volume in which operations are prohibited, the USS will identify this and automatically deliver a message rejecting the operation. Note: The FAA anticipates continuing the current process of manual direct coordination between operators and the FAA in parallel with LAANC. That process is envisioned to remain in place as LAANC is introduced and after LAANC is fully operational. Future demand on the manual process is expected to decrease as a result of deploying LAANC.

5.2.2 Further Coordination

"Further coordination" is available to Part 107 operators when an automatic authorization is insufficient for a planned operation. Further coordination are those operations where the Part 107 operator requests to fly at an altitude that is above the threshold limit of the UASFM grid cell, but not higher than 400 feet. For example, if an operator wants to fly at 250 feet and the grid cell threshold is 200 feet, a further coordination request can be made and set to Air Traffic for manual approval or denial.

FAA personnel must be involved in approving or denying the request. The USS submits the request for further coordination and LAANC directs it to the appropriate local facility authority. When a response is available, LAANC sends the response back to the Part 107 operator through the USS.

Further coordination requires longer periods of processing time (hours, days, etc.) than other LAANC processes, depending on the availability of Air Traffic personnel to consider and decide on the request. A response to a further coordination request is not guaranteed; unresolved requests will expire 24 hours prior to the operation's proposed start time. Authorization requests that require further coordination should be submitted with this processing time in mind.

Note: LAANC further coordination is not the same as a waiver as defined by Part 107 Subpart D. Waivers are not within the scope of initial LAANC implementation. Furthermore, Part 107 requires a waiver for operations above 400 feet.

5.3 AT Displays for sUAS Operations

Designated Air Traffic personnel have access to an FAA-generated report of approved authorizations under Part 107 and Section 44809, with selectable timeframes and location (e.g., facility or airport). UAS authorizations are displayed showing approved and pending operations.

Each authorization flight record includes date, time, and location information specifying the flight operation. The location information is communicated with the use of a specified point/radius or polygon of the flight operations. Additionally, contact information that Air Traffic can use to contact the sUAS operator is provided as part of the view designed for use by Air Traffic.

The Air Traffic interface is presented as a Geographic Information System (GIS) formatted display. GIS information about authorized flight operations is displayed as a

data overlay to existing UASFM map data. Air Traffic personnel are able to select an area of the map, and zoom in and out, to see all authorizations for operations in and around an affected airport. The display of sUAS data shown includes graphics representing the submitted airspace volume for each UAS in the vicinity with information including time of flight, unique identifier, and phone number associated with the record.

5.4 LAANC Roles

There are three primary roles defined for the LAANC concept: sUAS Operator, USS, and FAA. Intermediary roles may develop over time, but for the purposes of the general concept, these are the primary roles.

5.4.1 sUAS Operator

sUAS Operators are individuals who are flying a sUAS under either Part 107 or Section 44809 and desire to fly in controlled airspace. Under the LAANC model, sUAS Operators use a USS to submit authorization requests to the FAA. sUAS are free to use the USS of their choice. The sUAS Operator will provide data such as their name, telephone number, and flight plan information to the USS through the USS's designated application. sUAS Operators provide information to a USS as shown in Figure 2 below.



Figure 2: Operator Information Flows

5.4.2 UAS Service Supplier

USSs provide authorization communication services between sUAS Operators and the FAA. USSs are private industry partners of the FAA. USSs are responsible for developing applications that sUAS operators can use to make authorization requests. After collecting the information described above in Section 5.4.1, USSs transmit the information to the FAA via an API. The APIs are continuously tested, proven, controlled and securely managed.

USSs are subject to performance rules and go through an onboarding process. Onboarding includes USSs contractually agreeing to provide services under certain requirements, the USS proving that is able meet performance rules, and testing the endto-end system and connections.

Information exchanges between the USS and sUAS Operators and the FAA are shown in Figure 3.



5.4.3 FAA

The FAA provides APIs for processing to and from the USS. The FAA also provides processing services to display information to meet the FAA users' needs (e.g., Air Traffic). Internal to the FAA, APIs serve as routing functions for display and storage. The basic exchange of information is shown in Figure 4.



Figure 4. FAA Information Flows

Air Traffic personnel at a facility may access the information sent to the FAA. The FAA authorizes Air Traffic personnel to access this information through secure means after their identity is established. Air Traffic personnel are able to review all authorizations affecting their respective airspace and to reject, accept, acknowledge, or perform additional review.

While the FAA owns the LAANC system, the FAA does not control or design the USS applications. Other than providing and testing system requirements to ensure compliance with legal standards and LAANC requirements, the FAA does not impose strict design criteria on USSs or established a certain means of design.

6 Operational Scenarios

The scenarios included in this section illustrate key operational concepts for LAANC. As the LAANC implementation effort progresses and through workshops and continued collaboration with industry and other government organizations, including NASA, the FAA will solicit feedback to refine existing scenarios as well as develop additional necessary scenarios.

Note that scenario descriptions are not comprehensive. Details may be included in one scenario and not another for the purposes of brevity and minimal redundancy. Also, these scenarios do not represent every permutation of operations that LAANC must handle. Scenarios may be added and/or modified as LAANC development continues.

Note also that scenario descriptions are not equivalent to requirements. In general, scenario descriptions provide nothing more than a detailed example that is compatible with the LAANC concept. Requirements associated with any part of LAANC (USS, FAA, operator, etc.) are explicitly documented outside of this Concept of Operations.

6.1 Scenario 1: Part 107 Authorization Below Automatically Approved Altitude

6.1.1 Operator & Airspace

14 CFR Part 107 (commercial operator), Class B, below UASFM auto-approved altitude.

6.1.2 Overview

The operator wants to take pictures for real estate purposes. This is a 14 CFR Part 107 operation, 4mi from the San Francisco International Airport (SFO) Airport Reference Point (ARP), in Class B airspace. The operation is compliant with all subparts of 14 CFR Part 107: daylight operations, Visual Line of Sight (VLOS), not over people, below 400' AGL. The applicable AT auto-approved altitude threshold is 100' AGL. Figures 5 and 6 **Error! Reference source not found.**illustrate the scenario.



Figure 5: Scenario 1 – Authorization for 107 Operation: map showing area of operation



Figure 6: Scenario 1 – Authorization for 107 Operation: map showing area of operation relative to SFO

6.1.3 Background: SFO UASFM

The FAA provides UASFM data for airports – in this case, SFO. Note that this operation is near other airports as well: San Carlos (SQL), Palo Alto (PAO), Moffett Federal (NUQ). However, in this scenario the FAA has designated SFO as the UASFM authority for the area in question. The gridded UASFM map indicates where a sUAS may be automatically authorized to fly, based on authorized altitudes within the grid elements.

The gridded map data for SFO showing where authorizations can be processed in LAANC and their corresponding heights in "above ground level" are shown in Figure 7. The area of this operation has an auto-approved authorization threshold of 100' AGL.



6.1.4 Description of Activities

The operator logs in and uses the USS planning interface, which may depict the terrain and accompanying major natural and man-made features of the terrain, classes of airspace, distance from airport, any active temporary flight restriction (TFR), obstacles, and other restricted airspace (e.g., public utilities).

The operator provides the operational details: 14 CFR Part 107, $\leq 100^{\circ}$, starting at 11am for 2hrs the following day. This operator also uses a feature of the USS interface that specifies the operating area using a polygon (in this case, a rectangle). (Polygon definitions of operating regions are submitted to the FAA in GeoJSON format.)

The USS checks against airspace and airports. Noting the airspace classification, the USS provides a message to the operator such as "An FAA airspace authorization is required to fly in this controlled airspace." Noting that the maximum altitude is at or below the applicable UASFM threshold, the USS further provides, "This operation as described is eligible for automatic authorization."

The operator initiates submission of the authorization request, and the USS, based on the UASFM data, responds with acknowledgement of automatic authorization. The USS conveys relevant authorization information similar to that which is included in the manual authorization process in an authorization message to the operator and retains a copy of the necessary information on record to be transmitted to the FAA. An example of an encapsulated authorization may read as follows:

[USS6MIL79MP0 / SFO, 2020-02-17 11:00:00 AM PST - 2020-02-17 01:00:00 PM PST, Max Alt 100ft]: In accordance with Title 14 CFR Part 107.41, your operation is authorized within the designated airspace and timeframe constraints. Altitude limits are absolute values above ground level which shall not be added to the height of any structures. This Authorization is subject to cancellation at any time upon notice by the FAA Administrator or his/her authorized representative. This Authorization does not constitute a waiver of any State law or local ordinance. [Name of operator] is the person designated as responsible for the overall safety of UAS operations under this Authorization. During UAS operations for on-site communication/recall, [name of operator] shall be continuously available for direct contact at [contact phone number] by Air Traffic. Remote pilots are responsible to check the airspace they are operating in and comply with all restrictions that may be present in accordance with 14 CFR 107.45 and 107.49 (a)(2), such as restricted and Prohibited Airspace, Temporary Flight Restrictions, etc. Operations are not authorized in Class E airspace when there is a weather ceiling less than 1,000 feet AGL. If the UAS loses communications or loses its GPS signal, it must return to a predetermined location within the operating area and land. The pilot in command must abort the flight in the event of unpredicted obstacles or emergencies.".

The USS provides a record of the authorization to the FAA via the USS-FAA LAANC API. The FAA stores the record of authorization approval.

The authorization data is retrievable by Air Traffic at the nearest airport(s) to the planned flight. This includes SFO, which is the designated facility for auto-approved authorizations in this area. It may also includes SQL, PAO, and NUQ, which may need situational awareness of the flight to maintain safe manned operations. Since the operation is entirely contained within the SFO airspace, the USS does not need to make multiple submissions although there are multiple facilities in the area. One authorization submission to LAANC is directed to as many operational stakeholders as warranted for safe operations.

6.2 Scenario 2: Authorization with FAA Further Coordination

6.2.1 Operator & Airspace

14 CFR Part 107 (commercial operator), Class D, and above UASFM auto-approved 14 CFR Part 107 altitude for operation at that location.

6.2.2 Overview

Hog Neck Park Golf Course wants to conduct an aerial survey and produce and aerial map of the course. A commercial operator is contracted to conduct a 14 CFR Part 107 flight at Hog Neck Park Gold Course that is about 1mi from the Easton/Newnam Field (ESN) Airport Reference Point (ARP), in Class D airspace. The operation is compliant with all provisions of 14 CFR Part 107: daylight operations, VLOS, not over people, at or below 400' AGL. However, it is not an auto-approved altitude for operation location. The operational scenario is illustrated in Figure 8Figure 8.



Figure 8: Scenario 2 – Part 107 Altitude Not Auto-Approved: map showing area of operation

Background: ESN UASFM 6.2.3

The UASFM gridded map data for ESN showing where authorizations can be processed in LAANC and their corresponding heights in "above ground level" are shown in Figure 9.



Figure 9: ESN gridded map system with altitude restrictions

6.2.4 Description of Activities

The operator logs in, and the USS provides the means for an operator to view areas of planned flight using a latitude/longitudinal reference mapping system, including terrain, airspace classes, airports, National Security UAS Flight Restrictions (NSUFRs), obstacles, etc. In addition, any specific notes concerning the airport that may be helpful in the area of flight may also be portrayed (e.g., special notices of weather or other hazard.)

The operator enters the applicable information: 14 CFR Part 107, in a defined polygon area that approximates the area of the golf course, ≤ 100 ', from 3pm-5pm, in 90 days time.

Based on the proposed operational information (and the ESN UASFM), the USS might provide the operator with a message that states "An authorization is required to fly in this controlled airspace. The operation exceeds the threshold for automatically approved authorizations from ESN. The published threshold is 0', therefore any Part 107 authorizations require manual approval from the FAA."

For proposed operations not below auto-approved authorization altitude thresholds in controlled airspace under Part 107, the operator may use information from the USS to modify the operation to be below the UASFM auto-approved altitude. If so, the process continues with a normal auto-approved authorization LAANC submission. If not - as in this case where the threshold is 0' – the operator would indicate a desire to submit a request for further manual consideration, acknowledging that the process will take substantially longer (days, weeks, etc.) than automatic authorizations. Furthermore, resource constraints may be such that the request cannot be handled prior to the proposed operation or a set expiration duration (e.g., 24 hours prior to the operation start time). The information asking for manual authorization would be forwarded to the proper authorities as determined by the FAA.

Upon submission of the request for manual authorization, as with other authorizations, the USS assigns a unique identification number and operator contact information is included (telephone number). The FAA does require a method to communicate with the operator (i.e. phone number) directly. The USS receives an acknowledgement of the authorization request from the FAA, and the operator receives it from the USS.

In this scenario, it is assumed that a response is provided after 5 days, and that the operation is denied based on the information provided. The denial is final from a process standpoint. There is no explicit negotiation process; each request for authorization is stand-alone.

In the case of this scenario, the operator explores alternatives such as conducting the survey from a UAS closer to the ground ($\leq 10^{\circ}$), which may be more likely to be approved, and the representatives of the golf course explore alternative ground-based methods such as the use of a cherry picker.

6.3 Scenario 3: Authorization for 14 CFR Part 107 Subdivided Operation

6.3.1 Operator & Airspace

14 CFR Part 107 (commercial operator), Class C & D, below UASFM auto-approved altitude.

6.3.2 Overview

The sUAS operator wants to film for commercial purposes over an area that crosses FAA authorization boundaries. This is a 14 CFR Part 107 operation, 5mi from Will Rogers World Airport (OKC) and 4mi from the Wiley Post Airport (PWA), in Class C and D airspace. The operation is compliant with all subparts of 14 CFR Part 107: daylight operations, VLOS, not over people, below 400' AGL. The applicable AT auto-approved altitude threshold is 300' AGL.

6.3.3 Background:

FAA authorization boundaries for the purposes of LAANC are expressed by the airspace boundaries. The UASFM grids identify the authorizing facility associated with each maximum auto-approval altitude. As the grids are geodetically rectangular, some grids cross boundaries and list two (or more) authorities. For the area in question (highlighted below in Figure 10), the FAA has designated OKC and PWA as the UASFM authorities. The area of this operation has an auto-approved authorization threshold of 300'.



Figure 10: Scenario 3 – Authorization for 107 Subdivided Operation: map showing area of operation

6.3.4 Description of Activities

The operator logs in and uses the USS planning interface, which may depict the terrain and accompanying major natural and man-made features of the terrain, classes of airspace, distance from airport, any active temporary flight restriction (TFR), obstacles, and other restricted airspace (e.g., public utilities).

The operator provides the operational details: 14 CFR Part 107, \leq 300', starting at 1pm for 2hrs the following day. This operator also uses a feature of the USS interface that specifies the operating area using a polygon (in this case, a rectangle). (Polygon definitions of operating regions are submitted to the FAA in GeoJSON format.)

The USS checks against airspace and airports. The USS determines that subdividing the operation is necessary so that each authorization has a single authority. Since the proposed operation crosses the airspace boundary between OKC and PWA, the USS subdivides the operation along the airspace boundary and make separate LAANC submissions, to each authority. Noting the airspace classifications for each subdivision, the operator provides a message to the USS such as "*An FAA airspace authorization is required to fly in this controlled airspace.*" Noting that the maximum altitude is at or

below the applicable UASFM thresholds, the USS further provides, "*This operation as described is eligible for automatic 14 CFR Part 107 authorization.*"

Is it important to note that the operator should receive 2 authorizations: one for OKC and one for PWA. The operator initiates submission of the authorization requests, and the USS, based on the UASFM data, responds with acknowledgement of automatic authorizations. The USS conveys relevant authorization information similar to that which is included in the manual authorization process in an authorization message to the operator and retain a copy of the necessary information on record to be transmitted to the FAA. As an example, an encapsulated authorization from OKC may read as follows:

[USS6RIL8AOP0 / OKC, 2020-02-17 01:00:00 PM CST - 2020-02-17 03:00:00 PM CST, Max Alt 300ft]: In accordance with Title 14 CFR Part 107.41, your operation is authorized within the designated airspace and timeframe constraints. Altitude limits are absolute values above ground level which shall not be added to the height of any structures. This Authorization is subject to cancellation at any time upon notice by the FAA Administrator or his/her authorized representative. This Authorization does not constitute a waiver of any State law or local ordinance. [Name of operator] is the person designated as responsible for the overall safety of UAS operations under this Authorization. During UAS operations for on-site communication/recall, [name of operator] shall be continuously available for direct contact at [contact phone number] by Air Traffic. Remote pilots are responsible to check the airspace they are operating in and comply with all restrictions that may be present in accordance with 14 CFR 107.45 and 107.49 (a)(2), such as restricted and Prohibited Airspace, Temporary Flight Restrictions, etc. Operations are not authorized in Class E airspace when there is a weather ceiling less than 1,000 feet AGL. If the UAS loses communications or loses its GPS signal, it must return to a predetermined location within the operating area and land. The pilot in command must abort the flight in the event of unpredicted obstacles or emergencies.".

The USS provides a record of the authorization to the FAA via the USS-FAA LAANC API. The FAA stores the record of authorization approval. The authorization data is retrievable by Air Traffic at OKC and PWA, which are the designated facilities for authorizations in this area.

6.4 Scenario 4: Recreational authorization in accordance with 49 U.S.C. § 44809

6.4.1 Operator & Airspace

49 U.S.C. § 44809 (recreational flyer), Class E, below UASFM auto-approved altitude.

6.4.2 Overview

A recreational flyer wants to fly his drone in South Park in Lawrence, KS. This is a 49 U.S.C. § 44809 operation, 3mi from Lawrence Municipal Airport (LWC), in Class E airspace. The operation is compliant with all subparts of 49 U.S.C. § 44809: strictly recreational, VLOS, not over people, below 400' AGL. The applicable AT auto-approved altitude threshold is 200' AGL. Figure 11 below illustrates the scenario.



Figure 11: Scenario 4 – Recreational authorization in accordance with 49 U.S.C. § 44809: map showing area of operation

6.4.3 Background: LWC UASFM

The FAA provides UASFM data for airports – in this case, LWC. The FAA has designated LWC as the UASFM authority for the area in question. The gridded UASFM map indicates where a sUAS may be automatically authorized to fly, based on authorized altitudes within the grid elements.

The gridded map data for LWC showing where authorizations can be processed in LAANC and their corresponding heights in "above ground level" are shown in Figure 12 below. The area of this operation has an auto-approved authorization threshold of 200' AGL.



6.4.4 Description of Activities

The operator logs in and uses the USS planning interface, which may depict the terrain and accompanying major natural and man-made features of the terrain, classes of airspace, distance from airport, any active temporary flight restriction (TFR), obstacles, and other restricted airspace (e.g., public utilities).

The operator provides the operational details: 49 U.S.C. § 44809, \leq 200', starting at noon for 2hrs the following day. This operator also uses a feature of the USS interface that specifies the operating area using a polygon. (Polygon definitions of operating regions are submitted to the FAA in GeoJSON format.)

The USS checks against airspace and airports. Noting the airspace classification, the operator provides a message to the USS such as "An FAA airspace authorization is required to fly in this controlled airspace." Noting that the maximum altitude is at or below the applicable UASFM threshold, the USS further provides, "This operation as described is eligible for automatic 49 U.S.C. § 44809 authorization."

The operator initiates submission of the authorization request, and the USS, based on the UASFM data, responds with acknowledgement of automatic authorization. The USS conveys relevant authorization information similar to that which is included in the manual authorization process in an authorization message to the operator and retain a copy of the necessary information on record to be transmitted to the FAA. An example of an encapsulated authorization may read as follows:

[USSHUDKZTL00 / LCW, 2020-02-17 12:00:00 PM CST - 2020-02-17 02:00:00 PM CST, Max Alt numft]: In accordance with 49 U.S.C. 44809(a)(5), your operation is authorized within the designated airspace and timeframe constraints. Altitude limits are absolute values above ground level which shall not be added to the height of any structures. This Authorization is subject to cancellation at any time upon notice by the FAA Administrator or his/her authorized representative. This Authorization does not constitute a waiver of any State law or local ordinance. [Name of operator] is the person designated as responsible for the overall safety of UAS operations under this Authorization. During UAS operations for on-site communication/recall, [name of operator] shall be continuously available for direct contact at [contact phone number] by Air Traffic. [Name of operator] is responsible to check the airspace in which the UAS will be operated and comply with all restrictions that may be present in accordance with 44809(a)(5), such as restricted and prohibited airspace, temporary flight restrictions, etc. This authorization is subject to the following conditions: (1) operations are not authorized in Class E surface area airspace when there is a weather ceiling less than 1,000 feet AGL; (2) if the UAS loses communications or loses its GPS signal, it must return to a predetermined location within the operating area and land; and (3) the person manipulating the controls of the UAS must abort the flight in the event of unpredicted obstacles or emergencies.

The USS provides a record of the authorization to the FAA via the USS-FAA LAANC API. The FAA stores the record of authorization approval. The authorization data is retrievable by Air Traffic at the nearest airport to the planned flight, LWC, which is the designated facility for auto-approved authorizations in this area.

Appendix A: U.S. Airspace Classification Descriptions



U.S. Airspace Classifications

Note: See Federal Aviation Administration, *Aeronautical Information Manual*, Chapter 3 - Airspace

Controlled Airspace

Controlled airspace is a generic term that covers the different classifications of airspace and defined dimensions within which air traffic control (ATC) service is provided in accordance with the airspace classification. Controlled airspace that is of concern to the sUAS remote pilot is:

- Class B
- Class C
- Class D
- Class E

Class A

(While not applicable for sUAS UTM operations described in this document, included for clarity.)

Airspace Class A airspace is generally the airspace from 18,000 feet mean sea level (MSL) up to and including flight level (FL) 600, including the airspace overlying the waters within 12 nautical miles (NM) of the coast of the 48 contiguous states and Alaska. Unless otherwise authorized, all operation in Class A airspace is conducted under instrument flight rules (IFR).

Class B Airspace

Class B airspace is generally airspace from the surface to 10,000 feet MSL surrounding the nation's busiest airports in terms of airport operations or passenger enplanements. The configuration of each Class B airspace area is individually tailored, consists of a surface area and two or more layers (some Class B airspace areas resemble upside-down wedding cakes), and is designed to contain all published instrument procedures once an aircraft

enters the airspace. An ATC clearance is required for all aircraft to operate in the area, and all aircraft that are so cleared receive separation services within the airspace.

Class C Airspace

Class C airspace is generally airspace from the surface to 4,000 feet above the airport elevation (charted in MSL) surrounding those airports that have an operational control tower, are serviced by a radar approach control, and have a certain number of IFR operations or passenger enplanements. Although the configuration of each Class C area is individually tailored, the airspace usually consists of a surface area with a five NM radius, an outer circle with a ten NM radius that extends from 1,200 feet to 4,000 feet above the airport elevation, and an outer area. Each aircraft must establish two-way radio communications with the ATC facility providing air traffic services prior to entering the airspace and thereafter maintain those communications while within the airspace.

Class D Airspace

Class D airspace is generally airspace from the surface to 2,500 feet above the airport elevation (charted in MSL) surrounding those airports that have an operational control tower. The configuration of each Class D airspace area is individually tailored and when instrument procedures are published, the airspace is normally designed to contain the procedures. Arrival extensions for instrument approach procedures (IAPs) may be Class D or Class E airspace. Unless otherwise authorized, each aircraft must establish two-way radio communications with the ATC facility providing air traffic services prior to entering the airspace and thereafter maintain those communications while in the airspace.

Class E Airspace

If the airspace is not Class A, B, C, or D, and is controlled airspace, then it is Class E airspace. Class E airspace extends upward from either the surface or a designated altitude to the overlying or adjacent controlled airspace. When designated as a surface area, the airspace is configured to contain all instrument procedures. Also, in this class are federal airways, airspace beginning at either 700 or 1,200 feet above ground level (AGL) used to transition to and from the terminal or en-route environment, and en-route domestic and offshore airspace areas designated below 18,000 feet MSL. Unless designated at a lower altitude, Class E airspace begins at 14,500 MSL over the United States, including that airspace overlying the waters within 12 NM of the coast of the 48 contiguous states and Alaska, up to but not including 18,000 feet MSL, and the airspace above FL 600.

Uncontrolled Airspace

Class G Airspace

Uncontrolled airspace or Class G airspace is the portion of the airspace that has not been designated as Class A, B, C, D, or E. It is therefore designated uncontrolled airspace. Class G airspace extends from the surface to the base of the overlying Class E airspace. Although ATC has no authority or responsibility to control air traffic, operators should remember there are visual flight rules (VFR) minimums which apply to Class G airspace. A remote pilot will not need ATC authorization to operate in Class G airspace.

Appendix B: Acronyms

Acronym or Term	Description
AGL	Above Ground Level
API	Application Programming Interface
ARP	Airport Reference Point
AT	Air Traffic
ATC	Air Traffic Control
ATM	Air Traffic Management
АТО	Air Traffic Organization (FAA)
CFR	Code of Federal Regulations
DOD	Department of Defense
FAA	Federal Aviation Administration
FL	Flight Level
GA	General Aviation
GeoJSON	Geographic JavaScript Object Notation
GIS	Geographic Information System
IAP	Instrument Approach Procedures
IFR	Instrument Flight Rules
LAANC	Low Altitude Authorization and Notification Capability
MSL	Mean Sea Level
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NM	Nautical Miles
NSUFR	National Security UAS Flight Restriction
PIC	Pilot in Command
PII	Personally Identifiable Information
RFI	Request for Information
SORN	Systems of Records Notices
SUA	Special Use Airspace
sUAS	Small UAS
TFR	Temporary Flight Restriction
UASFM	UAS Facility Map
USS	UAS Service Supplier
UTM	UAS Traffic Management
UAS	Unmanned Aircraft System

Acronym or Term	Description
VFR	Visual Flight Rules
VLOS	Visual Line of Sight