July 16, 2019

VIA FDMS

Ms. Cheryl Collins
Program Manager, Docket Operations
Docket Management Facility
U.S. Department of Transportation
1200 New Jersey Avenue, SE
West Building Ground Floor, Room W12-140
Attn: FAA Dockets
Washington, DC 20590

RE: *Amazon Prime Air – Petition for Exemption Under 49 U.S.C. § 44807 and 14 C.F.R. Parts 61, 91, and 135*

Dear Ms. Collins,

Amazon[1] respectfully submits this petition for exemption to facilitate the operations of our Prime Air delivery service using unmanned aircraft systems (UAS) in the United States. Specifically, Amazon seeks an exemption: (1) pursuant to 49 U.S.C. § 44807 to fulfill the requirements in 14 C.F.R. § 135.25 that a civil aircraft operated in air commerce have an airworthiness certificate (Section 44807 Exemption); and (2) from various provisions of 14 C.F.R. Parts 61, 91, and 135 to permit operations under a Part 135 air carrier operating certificate (Part 135 AOC) to be conducted using UAS (Operating Exemption).[2]

I. Background

At Amazon, our energy comes from inventing on behalf of customers. Amazon Prime Air, a delivery system that will get packages to customers in 30 minutes or less using UAS, is one invention that we are incredibly passionate about. Amazon and our over 600,000 employees are guided by four principles: customer obsession rather than competitor focus, passion for invention, commitment to operational excellence, and long-term thinking. We will continue to invest in technology—like Prime Air—that provides additional choice and convenience for our customers. When Amazon launched the Prime program in 2005, two-day delivery was the

[1] Amazon.com Services, Inc. submits this petition on behalf of itself and its related affiliates under common ownership and control.

[2] While Amazon has consolidated these exemption requests into a single petition for administrative efficiency given the overlap in supporting information, we recognize that the Federal Aviation Administration (FAA) may choose to assign the Section 44807 Exemption and the Operating Exemption to separate dockets.

exception. This year we demonstrated our commitment to our customers by announcing our expansion of one-day delivery with Amazon Prime. We anticipate Prime Air will be the same type of game-changing service for our customers.

Prime Air is *driven* by innovation, yet *inspired* by aviation tradition. We will always optimize for safety ahead of productivity, scale, or economics. We are deeply committed to working in lock-step with regulators, and will only proceed and scale when, together, we are fully satisfied that it is safe to do so. Granting this petition will serve the public interest, helping the FAA gather data that will advance the future of UAS cargo delivery operations and the safe and efficient integration of UAS into the National Airspace System (NAS) more generally.[3]

Since 2013, Amazon has invested extensively in research and development, worked closely with the FAA and other regulators to secure testing permissions, collaborated with industry partners to establish global safety standards and trial new operations and technologies, and taken a long-term view focused on safely bringing Prime Air deliveries to our customers. We continue to build our world-class team of professionals that includes pilots, research scientists, roboticists, and hardware and software developers, as well as aerospace, manufacturing, reliability, aero-acoustic and safety engineers, who share a vision of safely driving this innovation forward. Amazon Prime Air employees design, prototype, and manufacture our UAS, including ground control stations (GCS), command links, and propulsion systems, and are committed to continuously improving the technology. We have conducted extensive testing at ranges in the U.S. and other international locations, and have launched development centers in the U.S., United Kingdom, France, Austria, and Israel.

In addition to extensive operations conducted under 14 C.F.R. Part 107 in the United States, the FAA has certificated four different models of Prime Air UAS under the Experimental Category provisions (Experimental Certificate)[4] defined in 14 C.F.R. Part 21 during this time, and Prime Air has also received a variety of exemptions from Federal Aviation Regulations based on

[3] *See, e.g., In the Matter of the Petition of Wing Aviation, LLC*, Grant of Exemption No. 18163, Corrected Copy (Apr. 2, 2019), Docket FAA-2018-0835, at 68 (noting that "FAA's first step toward authorizing the carriage of property by UAS operators is gathering data through the issuance of exemptions from current regulations.").

[4] Applicants must submit a safety assessment of the aircraft and operations, a flight test plan, maintenance and inspection procedures, and "any pertinent information found necessary by the FAA to safeguard the general public" after which FAA will conduct a safety evaluation and on-site inspection of the aircraft, and, if deemed safe for flight, will issue an Experimental Certificate containing specific operating limitations. 14 C.F.R. § 21.191; *see also* FAA Order 8130.34D, *Airworthiness Certification of Unmanned Aircraft Systems and Optionally Piloted Aircraft* (Sept. 8, 2017) (process for obtaining an Experimental Certificate for UAS).

our operations having provided for an equivalent level of safety,[5] including under Section 333 of the FAA Modernization and Reform Act of 2012,[6] to support Prime Air's crawl, walk, run approach. These Experimental Certificates and exemptions have afforded us the opportunity to iterate on different aircraft designs, from traditional vertical takeoff and landing (VTOL) to hybrid UA embodying VTOL characteristics combined with lifting surfaces capable of wing-borne flight. We began with a performance and autonomy-based focus that worked backwards from three concurrent goals: (1) develop a system that safely and efficiently meets our customers' needs; (2) design our UA to be highly autonomous and independently safe; and (3) enable automated integration into the current airspace system. With our co-designed, co-optimized, formal-engineering approach, Amazon controls every aspect of the design, manufacturing, hardware and software development, engineering, testing, integration, operations, and maintenance for all of our systems. Everything is purpose-built and co-optimized, in-house. This multi-year project yielded our current UA that will be used for initial Prime Air operations, the MK27.

Prime Air's program development to date has incorporated the following elements:

- Multi-disciplinary optimization (MDO) approach to design and engineering that includes:
  - Custom aero-performance codes down-selected from millions of possible configurations
  - Vehicle design down-selected from approximately 50,000 candidate configurations
- Structural finite element analysis
- Computational fluid dynamics (CFD)
- Scalable safe-autonomy algorithms tested on simulated, synthetic, and real-world data
- Software-in-the-loop simulation (SILSIM)
- Hardware-in-the-loop simulation (HILSIM)
- Accelerated life testing of hardware components
- Fleet leader testing program for propulsion systems
- Structural load testing
- Wind tunnel testing
- Multi-phased vehicle verification and validation through component testing, ground testing, flight cage testing, and outdoor flight testing
- Qualification curriculum and monthly currency for flight operations and support crews
- Flight crew line checks and trend-based auditing

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[5] *See* Grant of Exemption No. 11290 (Apr. 8, 2015), Docket FAA-2014-0474 (exemption from various provisions of 14 C.F.R. Parts 61 and 91 to allow aerial data collection in support of research and development operations); Grant of Exemption No. 11290A (Oct.28, 2015), Docket FAA 2014-0474 (amending Exemption No. 11290 to cover testing with additional unmanned aircraft (UA) under the same operational limitations); Grant of Exemption No. 11210 (Mar. 13, 2015), Docket FAA-2015-0318 (exemption from various provisions of 14 C.F.R. Parts 61 and 91 to support testing with UAS that have received an Experimental Certificate); Grant of Exemption No. 11210A (Mar. 30, 2017), Docket FAA-2015-0318 (extending Exemption No. 11210); Grant of Exemption No. 11210B (Sept. 29, 2017), Docket FAA-2015-0318 (amending Exemption No. 11210 to allow operations above 400 feet AGL if permitted under a certificate of authorization or waiver (COA)).

[6] P.L. 112-95, 126 Stat. 11 (Feb. 12, 2012).

- Safety management system (SMS)/safety reporting system (SRS) based on airline best principles
- Incident response program, including formal safety investigation and correction of error processes
- Concept of Operations (CONOPS) validation testing
- Continued airworthiness and maintenance program (CAMP)

Our MDO approach integrates aircraft design and development functions defined by members of our system safety, engineering, system integration, propulsion, structures, aerodynamics, software, aeroacoustics, controls, and avionics teams that optimize the UA for safety, autonomy and performance—using a formal requirements and traceability approach. The MK27 design effort has thus far involved more than 250,000 SILSIM and 15,000 HILSIM evaluations to validate components and design parameters. As part of the engineering development process, prior to outdoor flight, every UA is subjected to a bench test and indoor flight cage validation defined by a series of flight test cards that establish mission parameters, and operational readiness pass/fail flight release criteria. Once airworthiness requirements are satisfied, the UA is subjected to another round of systems checks on an outdoor tether system. Upon completion of the successful tether evaluation it is released for full-range flights through a structured validation sequence. Throughout each phase of this process, logs of system parameters are generated and recorded for every flight which can be retrieved for immediate and future analysis.

II. Supporting Documentation

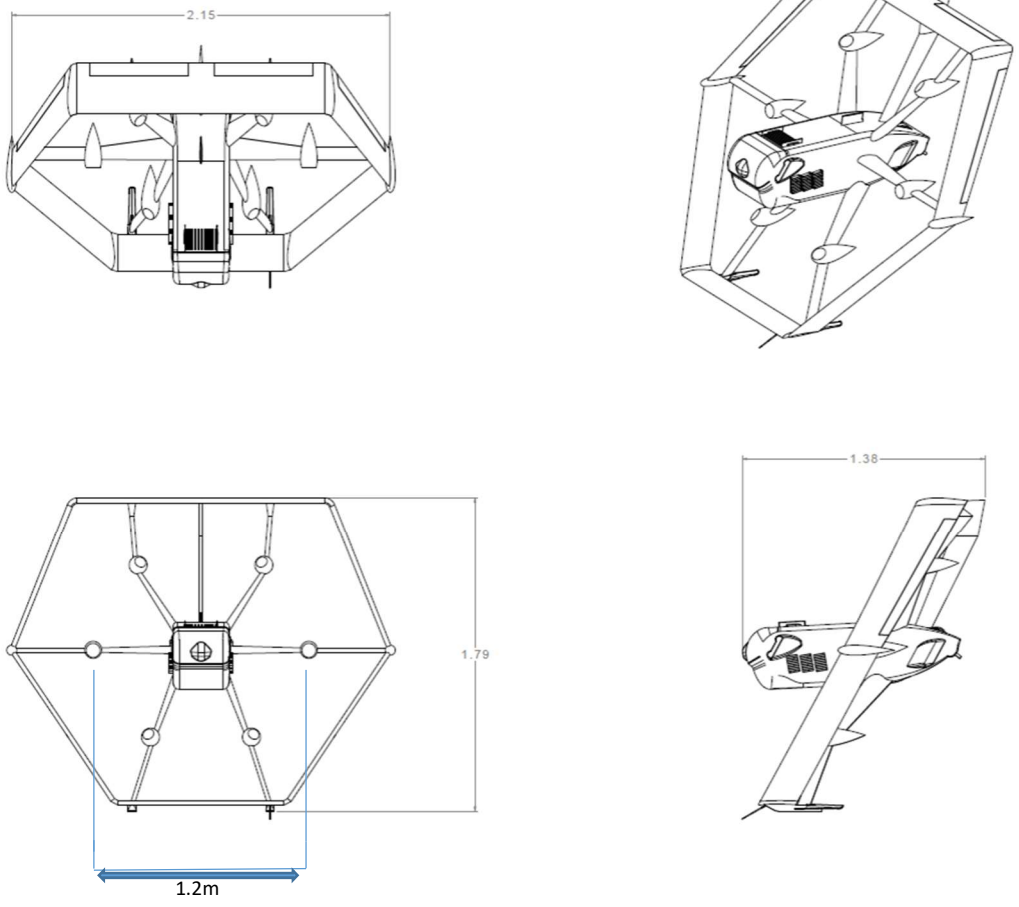
Amazon is also submitting the following documents in support of this petition on a confidential basis[7] under separate cover (Supporting Documents):

- Prime Air General Operations Manual (GOM) version 1.1, dated July 16, 2019
- Prime Air General Maintenance Manual (GMM) version 1.5, dated July 16, 2019
- Prime Air Flight Operations Training Manual (FOTM) version 1.1, dated July 16, 2019
- Prime Air MK27 Aircraft Flight Manual (AFM) version 1.1, dated July 16, 2019
- Prime Air MK27 Aircraft Maintenance Manual (AMM) version 1.3, dated July 16, 2019
- Hazard Risk Assessment (HRA) dated July 16, 2019

[7] The Supporting Documents are being submitted on a confidential basis pursuant to 14 C.F.R. § 11.35(b), as they contain confidential commercial and proprietary information what would materially harm Amazon's competitive position if they were publically disclosed. The information contained in this material is not generally available to the public, is commercially sensitive, confidential, and proprietary, and is protected from release under the Freedom of Information Act, 5 U.S.C. § 552, *et seq*.

III. Amazon MK27 Model UAS

The MK27 is an Amazon-designed fixed-wing aircraft capable of VTOL and wing-borne flight. Amazon formally entered aircraft type certificate program status for the MK27 in 2017 and has been engaged on a weekly basis with the FAA on that effort since its initial filing. The MK27 is able to carry internal payloads of up to five pounds,[8] with a roundtrip range of up to 15 nautical miles. The MK27's general specifications and performance characteristics, as well as its subsystems, are described below. Additional details are available in the AFM.



[8] The maximum payload is calculated based on the MK27's planned performance envelope.

A. General Specifications & Performance Characteristics

UA Type	*VTOL hybrid*
Dimensions – Motor to Motor (VTOL)	*1.2 m. (between motor pylons)*
Dimensions – Wing-Span	*2.15 m.*
Max gross takeoff weight	*88 lbs. (including payload)*
Max payload weight at planned range	*5 lbs.*
Nominal cruise speed	*60 kts. IAS*
Max planned operating altitude	*400 ft. AGL*
Max operating altitude	*1,200 ft. AGL*
Planned Range	*15 NM. round trip (with reserve)*
Temperature	*-10 to 40 degrees C*

B. Subsystems

Airframe Structure	*Combination of carbon fiber composite materials and metal*
Engine (Propulsive Unit)	*Electric motors, brushless DC, with electronic controllers*
Fuel	*Not applicable*
Batteries	*Lithium rechargeable batteries*
Avionics	*Distributed modular avionics*
Communications	*Dual cellular connectivity; redundant*
Navigation	*INS/GNSS navigation system*
Perception/Environment Sensing Systems	*Use of onboard sensors for obstacle detection during transit and delivery phases of flight*

IV. Prime Air CONOPS

A. Overview

Prime Air will deliver packages using UAS to customers within 30 minutes of placing their order. The MK27 is capable of delivering parcels of up to 5 pounds (at maximum planned range) to a variety of customer locations and designated drop-off points, which represents 80-85% of the products we sell. Operations beyond visual line-of-sight (BVLOS) are supported through a combination of foundational elements of a UAS Traffic Management (UTM) system (*e.g.*, remote identification and automated deconfliction), onboard sense and avoid (SAA) capabilities, communications with local air traffic control (ATC) facilities, and careful screening of the flight area. This multi-layered approach helps ensure safe separation between our UA and other aircraft (both manned and unmanned) and obstacles, and is consistent with fulfilling the analogous responsibilities that are embodied in the FAA's right-of-way rules for manned aviation.[9]

[9] *See* 14 C.F.R. § 91.113.

Our operations will begin over areas with low population density that have been thoroughly vetted for proximate airborne operations, obstructions, communications coverage, and sensitive overflight areas, and will be subject to FAA approval in the form of a certificate of authorization (COA).[10] We will seek to expand our areas of operation based on the submission of the appropriate operational plan and risk mitigations necessary to support the issuance of subsequent COAs.

Before a customer is able to place an order for delivery via Prime Air, we will have satisfied the following conditions to ensure safety: (1) determined that a UA is airworthy; (2) reviewed weather conditions to ensure the UA will remain within operational limits; (3) identified all known airspace constraints; and (4) established a high level of confidence that we will be able to meet our 30-minute delivery commitment. If we cannot satisfy all preconditions necessary to ensure a safe operation (*e.g.*, weather out of limits), we will not offer the Prime Air service as a delivery option to the customer. Rather, we will provide an alternate ground delivery option, or offer the airborne delivery at a later time.

Once we establish that the order can be fulfilled safely, and the UA has passed pre-flight airworthiness checks, the package will be loaded into the inside of the UA at our facility, and the flight will be dispatched. It will then takeoff and fly an optimized route that conforms to all known constraints. Our UA will rely on a Global Navigation Satellite System (GNSS) (*e.g.*, GPS) for the primary means of navigation, with a non-GNSS (*e.g.*, diverse onboard sensors) backup means of navigation to enable a safe landing in the event of a degraded GNSS environment.[11] Upon reaching the delivery location, the UA will hover at a safe distance, the package will be released from the internal holding compartment to complete the delivery, and after the UA departs the customer will be notified. If, for any reason, the UA is unable to complete the delivery phase of the mission (*e.g.*, if a person or pet approaches the delivery location as the UA prepares to deliver the package), it will return-to-base, respecting all safety and performance constraints on the return leg.

The MK27 has onboard health monitoring systems that support maintenance and diagnostic functions. In the event there is an in-flight malfunction that impacts mission capability, the UA will either return to base or land at a safe alternate location, depending on the specific fault condition. Any malfunctions will be formally documented and trigger appropriate maintenance action under Prime Air's Part 135 AOC, similar to the way maintenance issues are addressed with manned operations.

Prime Air is confident our autonomous systems will achieve demonstrable levels of safety and reliability equivalent to operations that currently rely on certificated airmen with manned flight experience. At the same time, given the newness of emergent unmanned business cases,

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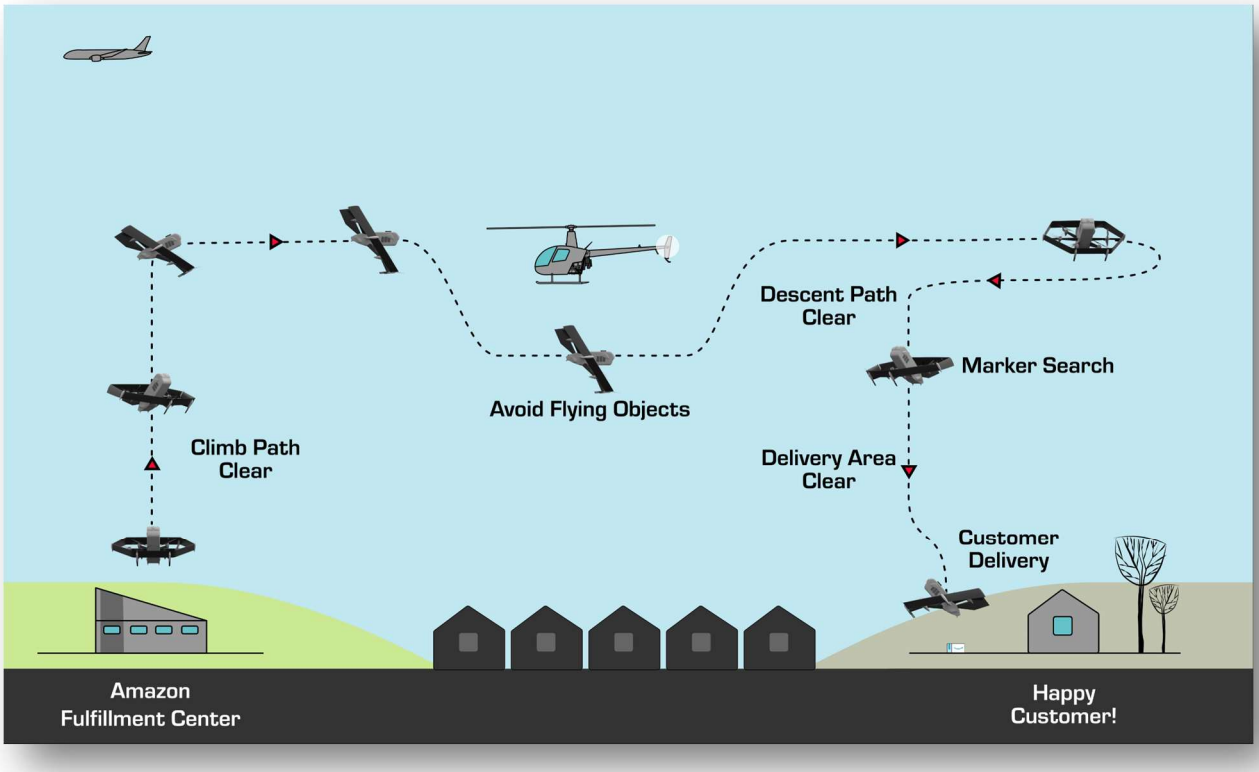
[10] *See* FAA, *Certificates of Waiver or Authorization*, https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/systemops/aaim/organizations/uas/coa/ (last visited July 16, 2019).

[11] *See* AFM, Sections 2.4.2 (Navigation Sensors/IMU) and 6.4 (Navigation System).

we believe in a stepwise approach to introducing operations into the NAS that builds public trust in our systems and confidence with regulatory partners. Accordingly, our initial operations will be overseen by operators in command (OICs) who possess, at minimum, a current Part 61 airman certificate, a Class III medical certificate, and who will have participated in a training and qualification program approved under our Part 135 AOC. The OIC will be assisted by a Safety Officer (SO) who will undergo a general core curriculum and role specific training syllabus that defines roles and responsibilities.

Prime Air's planned future CONOPS is described below. Additional details are available in the relevant Supporting Documents.



B. Pre-Flight

Prime Air's UTM system will compute an optimized flight profile based on: (1) customer delivery location; (2) package weight; (3) current environmental conditions; (4) air traffic and airspace constraints; and (5) takeoff and landing location constraints. The flight trajectory will avoid all known overflight areas such as sensitive government installations, hospitals, open air assemblies (e.g. sporting events), etc. Our UTM system will generate 4D trajectories (3D plus time) based on multiple data sources that incorporate all terrain elevations, known obstacles, and obstructions. Transit flight will be planned to occur at or below 400 feet AGL, although there may be occasional transitory moments where cruise level may briefly exceed 400 feet AGL for

operational safety reasons (*e.g.*, transit over a small land depression between ridgelines). These are the same well-established principles that are applied to safely manage manned aviation.

Operations will be planned within the following parameters for the duration of the flight:

- Weather minimums: Basic Visual Flight Rules (daytime)[12]
- Icing: No flights in known icing conditions
- Wind: Max 24 knots (total including gusts)
- Areas of significant meteorological activity: No operations

Once an order is placed, a flight assistant will be responsible for ensuring a pre-flight inspection is complete to ensure that the UA is prepared for flight and is in an airworthy state. The assistant will then be responsible for preparing the package for delivery, including confirming that an accurate package weight and UA center of gravity is reflected in the mission data. An OIC will then be assigned to the UA. Operations will be flown concurrently, with each UA having a dedicated OIC for the duration of a specific mission. Before OICs can upload mission data to the UA and authorize launch, they must first confirm that: (1) the UA is airworthy and ready for delivery; (2) the mission has been validated (including conformance to weight and balance limits and operational/airspace restrictions); and (3) an SO has been assigned to the flight. Operations will begin under a 1:1 UA to OIC ratio. We plan to increase the UA to OIC ratio subject to FAA approval based on flights and simulations that demonstrate required levels of safety.[13]

C. En Route

From the point of launch, flights will be conducted autonomously. Our flight planning system incorporates a fail-safe design architecture whereby any proposed modifications to the mission profile that violate operating limits or airspace restrictions will be automatically rejected. The UA will depart an Amazon facility to its preprogramed cruise altitude and transition to horizontal flight, after which it will transit to the delivery location. Flights will be conducted BVLOS, with the OIC remotely monitoring vehicle telemetry and system state. We will maintain separation assurance from other aircraft through multiple layers of technical and operational safety mitigations to include the optional use of visual observers (VOs) as an added safety mitigation. Technical mitigations will include an on-board Sense and Avoid system, a UTM system that incorporates ADS-B in traffic data, local ATC feeds, and full duplex communications between OICs and local ATC facilities.[14] The flight path will be planned to avoid any known obstacles, and active onboard sensors will provide separation assurance from any uncharted obstacles and

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[12] *See* 14 C.F.R. § 91.155.

[13] *See* Grant of Exemption No. 18163, at 79.

[14] *See In the Matter of the Petition of Avitas Systems, Inc.*, Grant of Exemption No. 17992 (Sept. 25, 2018), Docket FAA-2018-0263, at 18 (permitting BVLOS operations with multiple layers of technical and operational safety mitigations).

airborne objects. Real-time UA identification and tracking capabilities will also be available to the FAA ATC facility that oversees local flight operations.

The OIC will have final responsibility and authority for the safe operation of the flight, and will oversee the mission, monitor UA telemetry, airspace, weather, and, to the extent necessary, issue commands to the UA through the GCS. If an off-nominal event occurs, the OIC will have the ability to command the UA to return home or command a landing (with the benefit of onboard sensors to ensure safety), as dictated by the specific circumstances.

D. Command & Control

Command links will be secure and redundant. We will operate beyond radio line of sight using land mobile infrastructure and networks such as LTE cellular networks for primary command functions with redundant communications links. Control links are unnecessary due to the UA's automated fail-safe capability in the event of degraded communications. Due to the nature of our CONOPS and use of automation, there are no circumstances in which the OIC would need to remotely intervene to directly control the UA's flight control system (*i.e*., to alter heading, airspeed, or altitude). In this management by exception model, real-time situational awareness features are incorporated in our automated systems. The OIC will maintain real-time awareness of off-nominal events through system warning indications, and can direct system outcomes (*e.g*., return-to-base if the delivery area is not clear, or land-safely-now if there is an airborne conflict or directive to vacate the airspace).

Although our communication systems are designed to be highly reliable and redundant, as an added safety mitigation the MK27 is designed to perform an automated response maneuver to ensure separation from other aircraft and objects and that a safe landing will occur without the need for any operator intervention in the highly unlikely event of a complete lost link situation. The MK27 is independently safe in that regard.[15]

E. Delivery

Once the UA arrives close to the delivery location, it will transition to vertical flight, identify the specific delivery area through a unique marker, and then perform a delivery area clear assessment using onboard sensors. If that condition is met, it will descend to a safe delivery height, hold in a hover position and, barring any other obstructions or hazards being sensed, release the package.[16] Even though our system is designed with default fail-safe logic to abort the delivery if an obstruction is detected, the OIC will have the ability to discontinue the delivery

[15] This design ensures that the MK27 has a "fail-safe solution to avoid traffic and obstacles" including those that are non-cooperative. *Comments of Air Line Pilots Ass'n International (ALPA) on the Petition of Wing Aviation*, LLC, Docket FAA-2018-0835 (Oct. 18, 2018), at 4.

[16] Prime Air will take all reasonable precautions pursuant to its CONOPS to avoid injury or damage to persons or property. *See* 14 C.F.R. § 91.15.

phase for any reason. Conversely, the OIC cannot force the UA to proceed with a delivery if the UA decides to abort the delivery and return-to-base. Once the delivery has been completed, the UA will return to the Amazon facility along a route that incorporates all operational limits and airspace constraints.

Our delivery-phase autonomy test program, backed up by over 10,000 real-world datasets (and counting) accomplished via flights in representative backyard locations, has already demonstrated the ability of the UA's diverse sensors and algorithms to ensure that the approach path and delivery area are clear of obstructions. SOs monitoring the delivery-area will remain in communication with the OIC throughout the relevant phases of the operation.

F. Continued Airworthiness & Maintenance

Prime Air has a continuous airworthiness and maintenance department (CAM) that is responsible for all actions necessary to maintain, modify, and repair our UA and associated equipment to an airworthy condition. CAM will utilize a formal maintenance tracking system, indexed to individual UA and components, for all maintenance functions, including repair and inspection. This is accomplished through a systematic maintenance program and the collection and analysis of data that Prime Air will use to continuously enhance the overall safety of the operation.

Our UA will have onboard health monitoring systems that perform real-time diagnostics and reporting while airborne as well as during ground turn-around maintenance. Upon return to the Amazon facility, a flight assistant will be responsible for the post-flight inspection checklist. If a maintenance action is required, the UA will be taken out of service and sent to CAM. The UA will not be dispatched again until CAM has provided airworthiness release, which will then be subject to the OIC's review prior to flight.

In the event there is a condition that impacts a UA's airworthiness, it will be taken out of service and the issue will be rectified and recorded in a service difficulty report (SDR) in accordance with the requirements of Prime Air's Part 135 AOC before the UA is returned to service. Further details regarding our CAMP are outlined in the GOM and GMM.[17]

G. Emergency Response

We have a comprehensive UA emergency response plan backed up by Amazon's global operations center that is staffed 24 hours a day, 365 days a year to provide appropriate personnel and logistics support. The plan provides clear guidelines and immediate action items that are indexed to the severity of the incident/accident and any applicable regulatory reporting requirements. In the event of a UA incident/accident, we will launch a formal event review process involving representatives from Prime Air's Safety & Regulatory, Engineering,

[17] *See* GOM, Section 1.7 (Flight Operations Organization) and GMM, Section 2.4 (Maintenance Programs).

Operations, and Leadership teams that will review report findings and assign further action and investigative steps as needed.

V. Enhancing Safety Through Technology

Since Prime Air's inception, Amazon has prioritized innovation and become a technological leader in the UAS sector. One of the biggest challenges to integration of UAS into the NAS is how to maintain safe separation between UA and other aircraft (manned and unmanned) and objects. Prime Air has adopted a multi-layered approach to meeting this challenge through the development of: (1) a UTM system that provides for trajectory management, accommodates dynamic airspace restrictions, and shares safety critical data with fellow operators and regulatory authorities; and (2) onboard SAA systems that ensure the UA acts safely and predictably as a fail-safe measure against system degradation or other malfunctions- even those involving a total loss of system communications.

A. UTM; Remote ID & Tracking

A standardized registration, tracking, and remote ID system is a foundational element of safe and secure operations. It is the combination of network and broadcast solutions that provides the necessary coverage and redundancy through:

- Identifying what individual or entity is operating a UAS in a given area of interest;
- Determining whether operations are authorized for a given volume of airspace, and
- Facilitating the means to share safety critical information.

While we have long advocated for the formal regulatory adoption of such a remote ID system to facilitate the integration of UAS into the airspace more broadly, Prime Air's UTM system—which offers these safeguards—is ready to be deployed in support of our initial commercial delivery operations. We are also prepared to conform to a rules-based governance structure for UAS operations in the NAS managed cooperatively by multiple UTM service suppliers (USS), including Prime Air, in each area of operations.

Multiple USS-supported operations are already underway. For example, we have collaborated with industry partners via NASA-facilitated UTM technical capabilities level (TCL) demonstration projects.[18] Later this year, we also plan to further demonstrate these technical

[18] The goal of these TCL demonstration projects is the "development and demonstration of a possible future UTM system that could safely enable low-altitude airspace and UAS operations." *See* NASA, *UTM,* https://utm.arc.nasa.gov/index.shtml (last visited July 16, 2019). To date, NASA has completed three TCL demonstration projects. TCL 4 is ongoing, with the first of two flight tests completed in Reno, Nevada in May 2019.

capabilities as part of FAA's UTM Pilot Program,[19] as well as through the European Council's Single European Sky ATM Research (SESAR) Joint Undertaking's "U-Space" Demonstrator project involving five concurrent flight operations and multiple USS.[20] These events continue to demonstrate how Prime Air's technology, as well as that of UTM more generally, will support safe UAS flight operations.[21]

Prime Air has developed a remote ID and tracking system that includes the following elements: (1) a globally unique identifier (GUID) for each unique mission, which can then be tied to a unique vehicle ID; (2) the capability to leverage the transmission of this GUID from registered UAs and/or associated GCSs; and (3) public and private application programming interfaces (APIs) for accessing the system. This system will be incorporated into our flight operations, in compliance with standards being developed through ASTM International,[22] an industry standards development organization. Prime Air will also be prepared to comply with all requirements that may be defined through future FAA rules.

B. Sense & Avoid

Beyond the need to demonstrate a sufficient degree of hardware and communication/navigation reliability to protect against in-flight failures and maintain assigned flight path trajectory volumes, BVLOS UA operations must provide for an equivalent level of safety to a manned aircraft operation in which the pilot satisfies the general operating requirement to be able to "see and avoid" other aircraft.[23] This presents critical challenges regarding how to mitigate for network communication failures (analogous to lost communication procedures in manned aircraft) and potential encounters with non-collaborative objects in the absence of a pilot onboard the aircraft. Accordingly, the waivers and exemptions that the FAA has granted in support of BVLOS UAS operations to date have typically required the use of VOs

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[19] *See* FAA, *UTM Pilot Program*, https://www.faa.gov/uas/research_development/traffic_management/utm_pilot_program/ (last visited July 16, 2019). The UTM Pilot Program is designed to identify industry and FAA capabilities to support UTM operations, through the collection and analysis of test data.

[20] *See* SESAR, *Safe and Flexible Integration of Initial U-Space Services in a Real Environment – SAFIR*, https://www.sesarju.eu/projects/safir (last visited July 16, 2019). The SAFIR demonstrations will include multiple use cases to assess telecommunication network technologies and UTM services in support of the deployment of UAS services and operations across Europe.

[21] Having a consistent structure for broadcast and networked remote ID implementation will help facilitate flexible, dynamic, secure, and scalable development of a UTM construct that can safely accommodate the many existing and potential combinations of operators and service providers. For this reason, we believe it is critical for the industry to continue validating this governance structure and technical implementations by participating in remote ID proof of concepts events with multi-USS environments.

[22] *See* ASTM International, *New Specifications for Service Provided under UAS Traffic Management*, https://www.astm.org/DATABASE.CART/WORKITEMS/WK63418.htm (last visited July 16, 2019).

[23] *See* 14 C.F.R. § 91.113.

along the entire flight path "to identify any non-participating aircraft prior to their entry into the planned operational area"[24]—essentially making them extended visual line of sight (EVLOS) operations by default. This is not a scalable solution for true BVLOS operations.

In anticipation of this requirement, Prime Air made the early program decision to prioritize creating the technological means by which our UA can remain independently safe and demonstrate the equivalent means of performing the SAA functions that would otherwise be the responsibility of an onboard pilot. This meant developing a highly reliable capability for the UA to independently detect and avoid another aircraft—both unmanned and manned, as well as obstructions and other objects, as opposed to a "blind autonomous" solution where the UA would be incapable of operating safely in an environment where emergent, unidentified obstacles may be present. The MK27 includes an onboard solution that uses custom-built sensors and algorithms that have been tested and qualified against real world, synthetic and simulated datasets, at scale. These algorithms are used for sensing purposes to yield outputs that are deterministically mapped to a predefined safe action.[25]

Translated to our CONOPS, the MK27's SAA capabilities consist of the following onboard sensor-based safety mitigations:

SAA Autonomous Feature	Independent System Function
Climb Path Clear (*e.g.*, trees, powerlines, phone lines, static & dynamic objects, etc.)	Sensor based clearance of VTOL ascent area (when departing after the delivery)
Unidentified Flying Object – Mid Air Collision Alert	Avoidance of airborne objects (collaborative and non-collaborative)
Descent Path Clear (*e.g.*, trees, powerlines, phone lines, static and dynamic objects, etc.)	Sensor based clearance of VTOL descent area (when approaching landing or delivery)
Delivery Area Clear (*e.g.*, structures, static & dynamic objects, terrain geometry, etc.)	Survey of delivery area
Humans & Animals	Detection (but not recognition) of humans and animals around the delivery area. Differentiation between objects and humans and animals.
Find Marker Position (*e.g.*, delivery location)	Locate the exact position of delivery or landing location identified by locally-unique ID marker
Find Safe Landing (for emergency safe landing)	Ability to pick a safe emergency landing spot, away from humans, animals, or objects.
GNSS Backup	Sensor based navigation backup for degraded GNSS environment

VI. Safety Management System

Prime Air's SMS, which was implemented in 2015, provides the structure and tools necessary to establish safety policies, identify and mitigate risks, audit those risk mitigations, and promote safety and drive continuous improvement throughout the organization. We adhere to

[24] *Certificate of Waiver issued to Wing Aviation*, *LLC*, No. 107W0-2019-02631 (May 22, 2019). *See also, Certificate of Waiver Issued to State Farm Mutual Automobile Insurance Company & affiliated entities (State Farm),* No. 107W-2019-01808A (Apr. 17, 2019) and Grant of Exemption No. 18163, Corrected Copy (Apr. 2, 2019), at 73.

[25] The training and validation of algorithms is done offline, before their deployment on the UA.

aviation industry best practices with three primary safety goals: (1) no injuries; (2) no regulatory violations; and (3) no third-party property damage. Our independent Safety & Regulatory team conducts monthly system wide safety meetings and quarterly safety briefs with senior leadership. Our automated online safety reporting system (SRS), which is derivative of the Aviation Safety Action Program (ASAP) used by Part 121 airlines, encourages all team members to file safety reports on a confidential, non-retribution basis, and all reports are tracked and followed to conclusion. Prime Air has consistently delivered on these goals throughout the course of tens of thousands of cumulative flight operations.

Through customer feedback, flight data, consultation with subject matter experts, design reviews, and multidisciplinary workgroups, our Safety Managers drive the safety risk management (SRM) process. This process initiates a safety risk assessment whenever the following triggers occur:

- Introduction of a new UA
- Substantial change to a UA that warrants a new risk analysis
- Changes to our procedures or CONOPS (to include new phases of operations)
- Identification of a new hazard

As part of the SRM process, Prime Air's Safety & Regulatory team enters the following risk management cycle:

- Identify and classify hazards
- Analyze and assess the risk based on probability and severity
- Create an actionable plan to mitigate the risk
- Monitor those actions
- Measure and control those actions

Hazard mitigation is anchored by our SMS, along with other operating limitations. Vehicle reliability, redundancy when necessary, site location, aircrew training, onboard sensing, and off-vehicle systems all aggregate into a safety-mitigated CONOPS.

VII. Targeted Level of Safety

Prime Air has established a targeted level of safety (TLS) that reduces the risk posed by our operations to persons and property on the ground to acceptable levels. We will demonstrate to the FAA that our operations will meet or exceed that TLS based on the equations and supporting data from proprietary testing, which have been shared confidentially with the FAA.[26]

As part of the MK27 type certification process, Prime Air submitted an operational risk assessment (ORA) to the FAA that deconstructs each phase of our CONOPS, identifies potential

[26] *See, e.g.*, HRA, Sections HR-100 (Fire), HR-200 (Struck by Detached/Falling Object), and HR-300 (Collision).

failure modes, defines the mitigations required to bring operations to an acceptable level of safety, and associates those mitigations with relevant airworthiness categories. The certification process, which was initiated in 2017, defines the design and performance requirements that are reflected in the MK27's system architecture as needed to meet our TLS.

The ORA was specifically developed to incorporate the various risks that would be present in commercial cargo flight operations. First, our operations were reviewed through an assessment of the regulations applicable to our operations, including 14 C.F.R. Parts 43, 61, 91, and 135. Our aircraft design process is baselined against mitigations that would be appropriate to meet the regulatory intent of current manned aviation and required to support our TLS. Many of the mitigations and technologies that allow us to meet safety equivalence are documented in this petition and our supplementary materials. These mitigations and our technology development are indexed to our longer-term goal of type certification and derived from airworthiness criteria. While we are pursuing a standard type certificate for the MK27, this petition and our TLS are indexed to the criteria for the type certification of special class aircraft.[27]

TLS is a quantifiable metric that guides engineering and operational decisions. It is also a risk-based approach that is widely accepted and applied across the transportation sector (including by FAA and other regulatory agencies) to assess the costs and benefits associated with any proposed course of action. This approach does not require the complete absence of risk. Instead, it ensures that a risk will be mitigated to acceptable levels.[28] From a global industry standards perspective, the International Civil Aviation Organization's (ICAO) guidance for establishing a TLS provides that an organization "should take into consideration factors such as the applicable level of safety risk, the costs and benefits related to improvements in the aviation system, as well as expectations regarding the safety of the State's aviation industry."[29] Thus, the large-scale purpose of a TLS is to balance the risk the system causes against the public benefit it provides.

Through the use of a fault tree analysis tool, we can identify and allocate the reliability "budget" that is required at the system, component, and subcomponent levels to ensure our

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[27] *See* 14 C.F.R. § 21.17(b).

[28] TLS is simply a target threshold to allow operations. It does not mean that a system performs to this level, but rather that a system cannot be used until it is analyzed to have a risk equal to or lower than the TLS. The analysis of the system's current risk profile is a completely different exercise than setting the TLS. *See, e.g.*, FAA Advisory Circular 23.1309-1E (Nov. 17, 2011), at ¶ 14(b) ("The safety assessment objective is to ensure an acceptable safety level for equipment and systems installed on the airplane."); FAA Advisory Circular 120-92B (Jan. 8, 2015), at ¶ 2.2(c) (describing safety risk management as "the organization's way of fulfilling its commitment to consider risk in their operations and to reduce it to an acceptable level."); 14 C.F.R. § 5.55 (a certificate holder's SMS must (1) "define a process for conducting risk assessment that allows for the determination of acceptable safety risk," and then (2) develop risk controls based on that risk assessment); and FAA Advisory Circular 120-92B, at ¶ 3.4(c)(2)(f)-(c)(3)(f) (once the risk is analyzed, you must assess whether the risk is acceptable" and then "risk controls must be designed for risks that the carrier deems unacceptable").

[29] ICAO document 8959 AN/474, Safety Management Manual (3d. Ed. 2013), at ¶ 4.3.5.7, *available at* https://www.icao.int/safety/SafetyManagement/Documents/Doc.9859.3rd%20Edition.alltext.en.pdf (last visited July 16, 2019).

system meets a minimum level of safety, including from a regulatory approval perspective, for a given area of operations. The two elements that Prime Air controls most directly are the loss of control (LoC) rate and the population density. The LoC rate is a reflection of the performance/reliability of the system and how much evidence there is to support it. Under Prime Air's safety and reliability model, TLS is derived from the following algorithm:

Risk of Catastrophic Event per Mission = System loss of control rate × Lethality × Population Density × Area of Impact × Non-Shelter Factor

Our standards-based approach to reliability draws heavily on component failure figures obtained directly from equipment providers and is derived through testing using standards based prediction models. System level reliability must be validated through operations conducted with suitable safety margins that will provide essential empirical data. In enabling flight operations within safe margins, we will be able to better correlate estimates for maintenance and manufacturing defects, operational errors, and projections for system performance and component reliability—especially those that may be related to new sensor-based onboard systems. Having a fixed TLS that can be maintained throughout the course of all operations, whether they are sterile test range flights, operations involving only participating individuals, or actual commercial delivery flights, is a powerful tool because it provides for a common taxonomy and simplifies our overall approach to system safety.

VIII. Additional Information Supporting this Petition as Specified in 14 C.F.R. § 11.81

A. Mailing address and other contact information such as fax number, telephone number, or e-mail address

Amazon.com
Legal Department
Attn: Associate General Counsel, Aviation
440 Terry Avenue N
Seattle, WA 98109
Fax: (206) 266-7010
Email: prime-air-exemption@amazon.com

B. The specific section or sections of 14 C.F.R. from which Amazon seeks an exemption

1. Section 44807 Exemption

- 14 C.F.R. § 135.25(a)(1)-(2)

2. Operating Exemption

- 14 C.F.R. § 61.23

- 14 C.F.R. § 61.133
- 14 C.F.R. § 91.113(b)-(f)
- 14 C.F.R. § 91.119(b)-(c)
- 14 C.F.R. § 91.121
- 14 C.F.R. § 91.151(a)
- 14 C.F.R. § 135.63(c)-(d)
- 14 C.F.R. § 135.65(d)
- 14 C.F.R. § 135.93(g)
- 14 C.F.R. § 135.149(a)
- 14 C.F.R. § 135.161(a)(1)-(3)
- 14 C.F.R. § 135.203(a)
- 14 C.F.R. § 135.209(a)
- 14 C.F.R. § 135.243(b)(1)-(3)
- 14 C.F.R. § 135.415(b)
- 14 C.F.R. § 135.501(a)

C. The extent of relief Amazon seeks

1. Section 44807 Exemption

Section 44807 provides the Secretary of Transportation with authority to determine whether a certificate of waiver, certificate or authorization, or a certificate under 49 U.S.C. §§ 44703 or 44704, is required for the operation of certain UAS, and instructs the Secretary to base this determination on which types of UAS do not create a hazard to users of the NAS or the public.[30] Although Amazon has already applied for a type certificate for the MK27, it does not currently have the necessary airworthiness certificate to support its operation under a Part 135 AOC, and Amazon does not expect to have completed the type certification process before initial Prime Air operations are ready to begin. Accordingly, Amazon is requesting relief under Section 44807 from the requirement that it have an airworthiness certificate to conduct commercial package delivery operations.

As described above and in the Supplemental Documents, Prime Air, through its operational limitations and aircraft reliability, will achieve a level of safety equivalent to the level that complies with the requirements described below would otherwise achieve, and granting the

[30] *See* 49 U.S.C. § 44807.

petition is in the public interest. Specifically, Amazon seeks relief from the following provisions in accordance with Section 44807.[31]

- **14 C.F.R. § 135.25(a) (1)-(2) – Aircraft Requirements.** Amazon seeks relief from § 135.25(a) (1)-(2), which provides "no certificate holder may operate an aircraft under this part unless that aircraft—(1) Is registered as a civil aircraft of the United States and carries an appropriate and current airworthiness certificate issued under this chapter; and (2) Is in an airworthy condition and meets the applicable airworthiness requirements of this chapter, including those relating to identification and equipment." FAA has issued Amazon multiple Experimental Certificates specifically for the MK27 platform since 2017 and more than 30 Experimental Certificates for Prime Air UAS since 2015 that included the component, systems, and other technology innovations that have been incorporated into our current design. Prime Air's CONOPS is supported by multiple layers of technical and operational safety mitigations, including a robust crew training and currency system, detailed operational and maintenance procedures, comprehensive hazard risk analysis targeted to each step of our operation, and an SMS that implements a data based approach to identifying and mitigating risks, to ensure safe operations during the pendency of our type certificate application. To support operations under a Part 135 AOC, we require relief from this requirement under Section 44807 until Amazon completes the type certification process for the MK27.

2. Operating Exemption

a. 14 C.F.R Part 91, Subpart B—Flight Rules

Prime Air will implement operational rules that conform to airspace access requirements and provide for the exchange of safety critical flight information with ATC and with other airspace users. Our operations will be conducted in both controlled and uncontrolled airspace and below 400 feet AGL, unless temporary deviations are necessary for safety.

Prime Air will comply with the majority of general flight rules contained in Part 91, and seeks limited relief only to the extent that we cannot comply with the provisions due to operational or aircraft design constraints. In order to operate according to its CONOPS as described in this petition and in the Supplemental Documents, Amazon is seeking relief from the following regulations.

[31] To the extent FAA determines that Prime Air's Section 44807 Exemption must include relief from 14 C.F.R. §§ 91.119(b)-(c) and 91.151(a), Amazon incorporates its requests for relief from those regulations that is described in Section VIII(C)(2)(i) of this Petition. Additionally, while Prime Air does not plan to utilize a minimum equipment list (MEL) to operate with any inoperative equipment at this time and, therefore, is not currently seeking relief under 14 C.F.R. § 91.213(a)-(c), Amazon requests that a provision be added to its exemption grant that would allow it to submit a draft Master MEL to FAA for approval. *See In the Matter of the Petition of Wing Aviation, LLC*, Grant of Exemption No. 18162, Corrected Copy (Apr. 2, 2019), Docket FAA-2015-3344, at 6.

- **14 C.F.R. § 91.113(b)-(f) – Right-of-way**. Amazon requests relief to these requirements to the extent necessary to allow BVLOS operations in which the person operating the aircraft will not have the ability to maintain sight of the UA, other aircraft, or obstructions. Safe separation margins will be accomplished through multiple layers of technical and operational safety mitigations.[32] The probability of an airborne encounter with other flight operations occurring below 400 feet AGL, in an operating area away from airport operations and other known flight operations (*e.g.*, a published Academy of Model Aeronautics flying field), is extremely low.[33] The addition of aircraft-based SAA capabilities, UTM implementations, and interfaces with local ATC facilities makes it extremely improbable that Prime Air would have any loss of separation events—especially with manned aircraft. Although our combined separation assurance systems do not technically satisfy the right-of-way rules in 14 C.F.R. § 91.113(c)-(f) as written (*i.e.*, they cannot "see" objects), the aggregate of onboard sensor-based and off-board communication solutions, along with carefully screened operating areas, is an alternate means of meeting the intent of the rule. Accordingly, Amazon requests relief from these requirements.[34] Additional information regarding Prime Air's 14 C.F.R. § 91.113 safety mitigations is contained in the Supporting Documents.[35]

- **14 C.F.R. § 91.119(b)-(c) – Minimum Safe Altitudes.** Amazon requests relief to the minimum altitude requirements over congested and non-congested areas. The maximum planned operating altitude of the MK27 is 400 feet AGL, except when necessary for safety. In accordance with 14 C.F.R. § 91.119, manned aircraft are commonly flown at en route altitudes of at least 500 feet AGL (and at least 1000 feet AGL over congested areas). As our UA are required to operate below a ceiling of 400 feet AGL, an altitude below which manned operations will be extremely infrequent (other than takeoff and landing corridors at airports that we will avoid), relief is warranted.[36]

- **14 C.F.R. § 91.121 – Altimeter Settings**. Amazon requests relief from the requirement to have a typical adjustable barometric altimeter aboard the MK27. Prime Air will be operating below 400 feet AGL and our UAS will incorporate a combination of several altitude reporting systems, including a barometric altimeter, a laser altimeter, and GPS-

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[32] *See* Grant of Exemption No. 17992, at 5 (granting BVLOS operations and noting that "petitioner proposes a combination of risk mitigation measures" that "limit the risk of collision with other aircraft.").

[33] *See id.* at 12 (approving BVLOS operations in part due to the "low risk of exposure to manned aviation within the proposed area of operation").

[34] As of July 15, 2019, FAA has granted 38 waivers to the visual line of sight requirement in 14 C.F.R. § 107.31. *See* https://www.faa.gov/uas/commercial_operators/part_107_waivers/waivers_issued/ (last visited July 15, 2019).

[35] *See, e.g.,* GOM, Appendix C, BVLOS Concept of Operations (CONOPS).

[36] *See* Grant of Exemption No. 18163, at 8; *see also* Grant of Exemption No. 17992, at 14 ("FAA typically limits operating altitudes of unmanned aircraft to 400 feet AGL and below."). Amazon has previously received exemptions from 14 C.F.R. § 91.119(c). *See* Grant of Exemption No. 11290 (extended to all Prime Air vehicles under 55 pounds through Grant of Exemption No. 11290A); Grant of Exemption No. 11210A, (extending exemption No. 11210 for an additional 2 years to the extent necessary to test UAS that have received an Experimental Certificate).

derived altitude capabilities. The UA's altitude above ground is displayed to the OIC.[37] Consistent with prior FAA treatment of this regulation, relief is warranted.[38]

- **14 C.F.R. § 91.151(a) – Fuel Requirements for flight in VFR conditions.** Amazon requests relief from the prescribed fuel reserve minimums due to the UA capabilities and duration of flights. Prime Air will plan flights and mission profiles to allow the UA to return to the Amazon facility with sufficient energy reserve to conduct a safe landing.[39] Consistent with prior FAA treatment of this regulation, relief is warranted.[40]

b. 14 C.F.R. Part 135, Subpart C—Aircraft and Equipment

- **14 C.F.R. § 135.63(d) – Recordkeeping Requirements and 14 C.F.R. 135.65(d) – Reporting Mechanical Irregularities.** Amazon seeks relief from the requirements related to the carriage of a load manifest and to establish a procedure to carry an aircraft maintenance log because the size and characteristics of the MK27 make it impractical to comply. FAA has previously held that similar rules that require carriage of manuals and logs aboard aircraft are not applicable to UAS (*e.g.*, 14 C.F.R. § 91.9(b)) provided the operator makes the manuals readily available for ground personnel and the operator in charge and available at the operator's duty station.[41] Amazon has developed procedures to ensure that load manifests will be stored in accordance with the GOM and the aircraft maintenance log is available to the OIC and ground personnel, and we do not exceed critical loading factors.[42] To the extent this rule is applicable, Prime Air has provided for an equivalent level of safety and requests relief.

- **14 C.F.R. § 135.93 – Minimum altitudes for use of autopilot.** Amazon requests relief to the autopilot use and activation requirements of this rule. Prime Air's MK27 is unmanned, and conducts all navigation and flight through the use of an autopilot, and accordingly cannot comply with this rule. As with other UA hybrid designs that incorporate fixed wing and vertical flight and have been permitted to exercise the rotorcraft exception found in 14 C.F.R. § 135.93(g),[43] the MK27 is a hybrid design that operates, and has been designed

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[37] *See* AFM, Sections 6.4 (Navigation System) and 6.5 (Ground Station).

[38] Amazon has received exemptions from this regulation previously. *See* Grant of Exemption No. 11290 (extended to all Prime Air vehicles under 55 pounds through Grant of Exemption No. 11290A; and Grant of Exemption No. 11210A (extending exemption No. 11210 for an additional 2 years to the extent necessary to test UAS that have received an Experimental Certificate).

[39] *See* GOM, Section 3.8 (Fuel Planning) and Appendix C, BVLOS Concept of Operations (CONOPS).

[40] *See* Grant of Exemption No. 18163 at 10; *see also* note 38, *supra*.

[41] *See* Grant of Exemption No. 18163, at 7, 17.

[42] *See* GOM, Sections 2.12 (Flight Records) and 3.11.2 (Daily Preparation). These procedures will ensure that "packages are not being flown beyond the limitations of the UAS." *Comments of ALPA on the Petition of Wing Aviation, LLC*, Docket FAA-2018-0835 (Oct. 18, 2018), at 6.

[43] *See* Grant of Exemption No. 18163, at 21.

to operate, in the low-altitude, near-earth environment. Accordingly, it should be granted relief from this section and have the rotorcraft exclusion apply.

- **14 C.F.R. § 135.149(a) – Equipment requirements**. Amazon requests relief from the requirement to have a sensitive altimeter that is adjustable by the pilot for barometric pressure. As with previous UAS that have been granted an exemption from this rule, the MK27 will operate below 400 feet AGL, and employs several systems to calculate altitude, including GPS-derived capabilities, a laser altimeter, and a barometric altimeter.[44] Prime Air will deliver packages up to 7.5 nautical miles from an Amazon facility with short mission timelines, making changes in barometric pressure—and the need to adjust the altimeter accordingly—"negligible."[45]

- **14 C.F.R. § 135.161(a) (1)-(3) – Communication and navigation equipment for aircraft operations under VFR over routes navigated by pilotage.** Amazon requests relief from the requirements that its aircraft be equipped with two-way radio communication sufficient to fulfill the requirements outlined in 14 C.F.R. § 136.161(a) (1)-(3). Prime Air's MK27 will not have a pilot onboard, and does not have any procedures that require it to relay two-way radio communication or meteorological information through equipment installed on the aircraft.[46] Prime Air's GCSs will be equipped with reliable and redundant communications interfaces to communicate with ATC facilities when applicable.[47]

c. 14 C.F.R. Part 135, Subpart D—VFR/IFR Operating Limitations and Weather Requirements

- **14 C.F.R. § 135.203(a) – VFR: Minimum altitudes.** Amazon requests relief from both the vertical and horizontal minimum altitudes. The maximum operating altitude of the MK27 is 400 feet AGL, except when necessary for safety. Prime Air's pre-flight mission planning takes into account published obstacles, digital terrain elevation data, and the MK27 incorporates multiple layers of technical and operational safety mitigations, including autonomy and onboard sensing that ensure a non-zero or negative clearance from obstacles and that a collision is extremely unlikely.[48] As a result, the MK27 UAS and Prime Air's operational rule structure provide an equivalent level of safety.

- **14 C.F.R. § 135.209(a). VFR: Fuel supply.** Amazon requests relief from the prescribed fuel reserve minimums due to the UA capabilities and duration of flights. Prime Air will plan flights and mission profiles to allow the UA to return to the Amazon facility launch point with sufficient energy reserve. In the case of an off-nominal mission, we will operate

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[44] *See id.* at 22.

[45] *Id*.

[46] *See id*. at 23-24.

[47] *See* GOM, Section 2.1.2 (Radios).

[48] *See* GOM, Sections 3.2.2 (Airspace Use) and 3.2.3 (Route Planning); *see also* Grant of Exemption No. 18163, at 26.

with sufficient reserves to allow controlled, slow descent to hover and land in a safe location.[49]

d. 14 C.F.R. Part 135, Subpart E—Flight Crewmember Requirements

As part of the "onboarding" process, all crew members involved in flight operations attend a general curriculum syllabus including company policy training, general ground safety, and OSHA/internal safety compliance instruction. As discussed above, flight operations will be overseen by OICs that possess, at minimum, a private pilot license issued pursuant to 14 C.F.R. Part 61, including a current Biennial Flight Review and Class III Medical Certificate issued pursuant to 14 C.F.R. Part 67.

Following the general curriculum, aircrew are given additional specialized "pipeline" training for their roles. OICs attend a ground school that includes understanding and application of SMS principles, crew resource management (CRM), risk assessment, airspace design and operations, nominal and off-nominal flight procedures, meteorology and impact to flight operations, and regulatory compliance responsibilities. Following successful completion of ground school, OICs next observe, then demonstrate, flight operations in an indoor flight cage, and then at an outdoor facility. A check ride/flight, which consists of a multi-part evaluation that includes general knowledge and actual demonstration of flight operations, is administered to the prospective OIC by an evaluator pilot. Only after a successful check ride will the individual be considered qualified to operate the UA as an OIC.[50] Monthly currency consists of multiple action items, including safety meetings, operational exams, flight events, and other items.[51]

- **14 C.F.R. § 135.243(b) (1)-(3). Pilot in command qualifications**. Amazon seeks relief from the requirements for pilots to hold a commercial pilot certificate, category, class, and type ratings, instrument and airline transport pilot certificate, and flight time requirements. Prime Air OICs will have, at minimum, a current Part 61 Private Pilot Certificate and Class III Medical Certificate issued pursuant to Part 67, and they will also receive internal training and qualification prior to conducting UAS operations.[52] This approach ensures that required levels of safety are met that are proportionate to the risk profile of the operation. The integration of fail-safe automation mechanisms and the presence of an SO also provide for additional safety mitigations.

[49] *See* GOM, Sections 2.7.1 New/Proposed Flight Areas (Airport Suitability) and 3.9 (Fuel Planning) and Appendix C, BVLOS Concept of Operations (CONOPS).

[50] See FOTM Section 4.6 (Internal Qualification).

[51] *See* GOM Section 2.6.2 (Currency).

[52] *See* FOTM, Section 3 (Training Requirements) and GOM, Section 1.8 (Flight Crew).

e. 14 C.F.R. Part 135, Subpart J—Maintenance, Preventive Maintenance, and Alterations

- **14 C.F.R. § 135.415(b). Definition of "during flight" in connection with Service Difficulty Reports (SDR).** For purposes of SDRs, 14 C.F.R. § 415(b) provides that "*during flight* means the period from the moment the aircraft leaves the surface of the earth on takeoff until it touches down."[53] Amazon seeks relief to limit SDR reporting requirements to the period defined as the time between the moment the MK27 UA transitions to horizontal flight from Amazon's access controlled takeoff/landing area (AOA) to the moment it transitions to vertical descent upon return to the AOA. As FAA has previously explained, vertical takeoff and landing operations conducted over an AOA are akin to preflight inspection or taxiing in manned aviation and present "no risk to the public or personnel on the ground should a malfunction occur."[54] As a result, any defects discovered during vertical operations over Amazon's AOA should not be reportable and relief is warranted.

f. 14 C.F.R. Part 135, Subpart K—Hazardous Materials Training Program

- **14 C.F.R. § 135.501(a). Training requirements applicable to individual involved handling items for transport on board an aircraft.** Amazon seeks relief from the requirement that "each crewmember and person performing or directly supervising any of the following job functions involving any item for transport on board an aircraft: (1) Acceptance; (2) Rejection; (3) Handling; (4) Storage incidental to transport; (5) Packaging of company material; or (6) Loading." Unlike other potential delivery use cases which involve picking up a package from a vendor at an offsite location and delivering it to a customer, under Prime Air's CONOPS we will be the shipper with flights originating from our own facilities. While Amazon offers a wide selection of products for sale, we have technical and physical safeguards that restrict hazardous materials from being offered for delivery via Prime Air. Further, as described above, only flight assistants will be involved in the acceptance/rejection, handling, storage incidental to transport, packaging, and loading of items during the pre-flight phase of the operation. Accordingly, Amazon requests that the hazardous materials training requirement under 14 C.F.R. § 135.501(a) be limited to flight assistants.

g. 14 C.F.R. Part 61, Subpart A—General

- **14 C.F.R. § 61.23. Medical certificates: requirement and duration.** Amazon seeks relief from the requirement that pilots exercising the privileges of a commercial pilot certificate hold a Class II medical certificate. Amazon requires each of its OIC to hold at least a Class III medical certificate. The fundamental differences between a pilot in command of a

[53] *Emphasis in original*.

[54] Grant of Exemption No. 18163, at 40.

manned aircraft and the OIC of a UAS is that the OIC is not onboard the aircraft, and will have immediate access to ground and support personnel in the event of an incident. Access to additional personnel, along with the fact that the OIC will be monitoring a highly-automated system capable of executing its mission safely without human intervention, obviates the need for a Class II medical certificate.

h. 14 C.F.R Part 61, Subpart F—Commercial Pilots

- **14 C.F.R. § 61.133. Commercial pilot privileges and limitations**. Amazon seeks relief from the requirement that a commercial pilot certificate is required for a person to serve as pilot in command of an aircraft carrying property for compensation or hire. As noted above, Prime Air will use pilots who hold a Part 61 private pilot certificate issued by the Administrator and trained in accordance with the Prime Air FOTM, including operation-specific training under Part 135.[55]

i. 14 C.F.R. Part 43– Maintenance, Preventative Maintenance, and Alteration

Prime Air has primary responsibility for the continued airworthiness of all aircraft it operates, as well as primary responsibility for performance of all maintenance or alterations on its aircraft. Prime Air retains all work done on its aircraft, and all persons completing such work must follow the maintenance program outlined in the GMM.

Prime Air incorporates a CAMP that defines all actions necessary to maintain, modify and repair our UAS to an airworthy condition, and mechanisms for those actions. Our CAMP will incorporate a formal maintenance tracking system, indexed to individual UA and components, for all maintenance functions, including repair and inspection.[56] This is accomplished through application of a systematic maintenance program and the collection, analysis, and use of data in order to continuously improve safety and operations.[57] Given the mechanisms provided in Prime Air's CAMP, Amazon is not seeking relief from any provisions of Part 43.

D. The reasons why granting Amazon's request would be in the public interest; that is, how it would benefit the public as a whole

The FAA has long recognized that the "enhanced safety achieved using an unmanned aircraft . . . is in the public interest."[58] This vital public interest—enhanced safety—has been served through grants of exemption for various UAS, both small and large, and for operations

[55] *See* FOTM, Section 3 (Training Requirements) and Annex 1, Training Curriculum.

[56] *See* GMM, Sections 2.4.9 (Recording Maintenance), 5.4 (Maintenance Recordkeeping Processes), and 5.6 (Service Tags).

[57] *See* GMM Section 8 (Continuous Analysis and Surveillance System (CASS)).

[58] Grant of Exemption No. 11290, at 4.

across myriad use cases, including research and development for package delivery,[59] infrastructure inspection,[60] and agricultural aircraft operations.[61] Prime Air's package delivery operations will similarly bring enhanced safety to the national airspace. As with other UAs over 55 pounds that have been granted exemptions from certain regulations in the public interest, Amazon's MK27 has reduced weight and proportions when compared to traditional aircraft, will eliminate the risk to passengers and crew, and will reduce the risk to persons and property on the ground by carrying no flammable fuel.[62]

Moreover, the FAA has recognized that it is in the public interest to grant an exemption that "promotes safe progression of UAS integration into the National Airspace System."[63] Package delivery is a vital step in this progression. UAS package delivery reduces stress on surface transportation infrastructure, and has less environmental impact than traditional surface or airborne transportation methods. Echoing the importance of package delivery by UAS to the public interest, Section 348 of the 2018 FAA Reauthorization Act, requires the FAA to "update existing regulations to authorize the carriage of property by operators of small unmanned aircraft systems for compensation or hire within the United States" within a year of the date of enactment. [64]

As the FAA has previously noted in granting an exemption for package delivery by UAS, "FAA's first step toward authorizing the carriage of property by UAS operators is gathering data through the issuance of exemptions from current regulations."[65] Granting Amazon's petition for exemption would continue to foster the FAA's safe and reliable collection of the data it will need to authorize carriage of property by UAS operators. More importantly, the requested exemptions will allow Prime Air, as an air carrier operating under a Part 135 AOC, to "provide service with the highest possible degree of safety in the public interest."[66]

E. The reasons why granting the exemption would not adversely affect safety, or how the exemption would provide a level of safety at least equal to that provided by the rule from which Amazon seeks the exemption

With respect to the Operating Exemption, Prime Air will operate under the same regulations, with the same level of FAA oversight and safety requirements, as every Part 135 air carrier operating manned aircraft currently. We will also demonstrate to the FAA that Prime Air

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[59] *Id.*

[60] *See* Grant of Exemption No. 11538 (May 11, 2015) Docket FAA-2015-0394, at 2.

[61] *See In the Matter of the Petition of Droneseed Co*., Grant of Exemption No. 17936 (Aug. 13, 2018) Docket FAA-2017-1157, at 17-18.

[62] *Id.*

[63] Grant of Exemption No. 17992, at 15.

[64] P.L. 114-254, Stat. 130-1005 (Dec. 10, 2016) (codified at 49 U.S.C. § 44808).

[65] *See* Grant of Exemption No. 18163, at 68.

[66] 49 U.S.C. § 44701(d) (1) (a); *see also* Grant of Exemption No. 18163, at 6.

will meet the TLS necessary to support grant of the requested Section 44807 Exemption needed to operate the MK27 subject to the requirements of a Part 135 AOC while we continue to pursue full type certification for that UAS. Amazon previously described the reasons why granting the exemptions from individual rules would not adversely affect safety.[67] Indeed, viewed as a whole, this petition is far from "an attempt to bypass the normal rulemaking process." [68] Congress recently created Section 44807 for the express purpose of empowering the Secretary of Transportation to enable new types of UAS operations under existing FAA rules subject to a safety risk assessment.[69] The process of air carriers seeking targeted relief from certain regulations to facilitate their specific operations is also well established and appropriate.[70] Amazon has long begun the respective processes to obtain type certificate for the MK27 and a Part 135 AOC to conduct commercial package delivery operations with UAS. This petition is also carefully crafted to seek relief from only a limited number of regulations—that were drafted with manned aircraft generally in mind—that would be impractical to apply as written to Prime Air's UAS and CONOPS. While the Prime Air operation may be new and novel, our approach to aviation safety is not.

Nor is Amazon is seeking relief under this petition as a first step in its program development. Instead, this petition is the next step in an iterative process that we have undertaken with the FAA and regulators worldwide to ensure Prime Air's operations will achieve the levels of safety needed to meet our commitment to our customers and general public, and required by regulation. Here in the U.S., Amazon's technical capabilities have been tested through more than 30 Experimental Certificate safety evaluations, including several for the MK27. During each of these evaluations, the FAA considered Amazon's "risk mitigation strategies" and the MK27's "safety features" and determined that Amazon's "system is safe to operate in the national airspace system."[71] Additionally, Amazon has conducted thousands of flight hours of rigorous testing and evaluation in the U.S. and abroad. This testing furthers the same goal of the UAS Integration Pilot Program (IPP)—to facilitate the safe integration of UAS into the NAS.[72]

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[67] *See* Sections VIII(C) (1) and (2), *supra*.

[68] *See* Grant of Exemption No. 18163, at 58 (discussing ALPA's comments to the petition).

[69] *See* 49 U.S.C. § 44807.

[70] *See, e.g., In the Matter of the Petition of the Regional Airline Ass'n,* Grant of Exemption No. 17347A, Docket FAA-2017-0229 (May 17, 2019) (providing relief to member airlines from certain regulations under 14 C.F.R. Part 121); *In the Matter of the Petition of Alaska Airlines, Inc.,* Grant of Exemption No. 18215, Docket FAA-2019-0278 (May 3, 2019) (granting exemption from 14 C.F.R. § 121.135(a)(3)); *In the Matter of the Petition of the Regional Airline Ass'n*, Grant of Exemption No. 11498B, Docket FAA-2001-8762 (Mar. 29, 2019) (providing relief to member airlines from certain regulations under 14 C.F.R. Parts 91 and 121); *In the Matter of the Petition of Flexjet, LLC,* Grant of Exemption No. 12476A, Docket FAA-2015-1818 (Aug. 9, 2017) (extending exemption from certain regulations under Parts 91, 135, and 47); *In the Matter of the Petition of Ameriflight, Inc.,* Grant of Exemption No. 7143E, Docket FAA-2001-9032 (May 2, 2007) (granting exemption from certain regulations under Parts 61, 91, and 121).

[71] FAA Order 8130.34D, *Airworthiness Certification of Unmanned Aircraft Systems and Optionally Piloted Aircraft* (Sept. 8, 2017), at ¶ 16(d).

[72] *See* FAA, *UAS Integration Pilot Program*, https://www.faa.gov/uas/programs_partnerships/integration_pilot_program/ (last visited July 16, 2019).

Significantly, Amazon intends to continue this building-block approach under its Part 135 AOC. Prime Air will field its operations in a measured and iterative way, starting initially with flights over select sparsely populated areas and expanding as our proficiency develops. We will initially deploy SOs as an additional mitigation, and will expand beyond a 1:1 UA to OIC ratio only once the FAA has satisfied itself, through validation testing, that such operations are safe. As described in this petition and in the Supplemental Documents, through the combination of sophisticated SAA systems, UTM, ATC coordination, and careful selection of operating areas, Amazon's MK27 will operate safely under targeted exemptions from current regulations. Moreover, the MK27 fits perfectly within the risk-based contours of 49 U.S.C. § 44807, and can operate without an airworthiness certificate for the limited period before one can be obtained.

F. A summary FAA can publish in the FEDERAL REGISTER, stating: (1) The rule from which Amazon seeks the exemption; and (2) A brief description of the nature of the exemption that Amazon seeks

Petitioner seeks an exemption: (1) from 14 C.F.R. § 135.25(a)(1)-(2) pursuant to 49 U.S.C. § 44807 to operate a civil aircraft in air commerce without an airworthiness certificate; and (2) from 14 C.F.R. §§ 61.23, 61.133, 91.113(b)-(f), 91.119(b)-(c), 91.121, 91.151(a), 135.63(c)-(d), 135.65(d), 135.93(g), 135.149(a), 135.161(a)(1)-(3), 135.203(a), 135.209(a), 135.243(b)(1)-(3), 135.415(b) and 135.501(a) to permit operations under a Part 135 air carrier operating certificate with an unmanned aircraft system (UAS), to enable petitioner's commercial delivery operations using UAS.

G. Any additional information, views or arguments available to support Amazon's request

Please see the Background and CONOPS sections of this petition for additional supporting information,[73] along with the confidential and proprietary information contained in the Supporting Documents that are being submitted under separate cover.

H. If Amazon wants to exercise the privileges of its exemption outside of the United States, the reason why it needs to do so

Amazon does not seek to exercise the privileges of the requested exemption outside of the United States.

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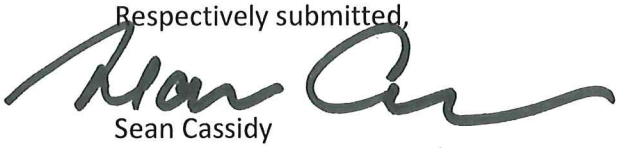
[73] *See* Sections I and IV, *supra*.

Amazon urges the FAA to expeditiously grant this petition for exemption so that we can take the first steps towards bringing Prime Air to customers in the United States.

Please do not hesitate to contact me via email at: prime-air-exemption@amazon.com if you have any questions or concerns.

Respectively submitted,



Sean Cassidy
Director, Safety & Regulatory
Amazon Prime Air