UberAir Vehicle Requirements and Missions

Uber

Introduction

Uber Elevate aims to enable aerial ridesharing in cities around the world. This multi-modal, on-demand service will reduce riders' commute times and relieve congestion in and around cities. This service will be known to riders as Uber Air, aligning with current product offerings such as UberX and UberPool.

To serve this market, we have defined a set of missions and requirements for Electric Vertical Takeoff and Landing (eVTOL) aircraft operating on the Elevate network. These requirements have been developed by leveraging extensive analyses of current and predicted demand, understanding the capabilities of enabling technologies, and focusing on creating the optimal rider experience.

In order to bring this transformational technology to our riders as quickly as possible, Uber Elevate is conducting demonstration flights in 2020 to measure eVTOL noise, assess community acceptance, and quantify vehicle safety and performance. Flights from 2023 onward will be conducted with certified aircraft as revenue producing operations.

Vehicle Requirements

VTOL: Vehicles must have Vertical Takeoff and Landing capability with short duration hover.

Safety: Certified vehicles must be able to perform a safe vertical landing in the event of a critical failure, including a collision with a bird, in any phase of flight.

Noise: We are developing noise standards for UAM eVTOL aircraft that will use detailed time integrated annoyance metrics to ensure community friendliness. This involves designing the aircraft to achieve specific signatures that can map into background city noise soundscapes. Simplified comparative sound levels experienced by observers should be on the order of 15 dB quieter than existing light helicopters, or about 70 dB SEL at 500 ft vs 85 dB for a typical helicopter of similar weight.

Energy Storage: Vehicles should operate entirely on battery-electric energy storage. Vehicles utilizing liquid hydrocarbon fuels, such as hybrids, have severe logistical and economical challenges for successful integration into the network.

Skyports: Vehicles on our network will operate only from Skyports, which are VTOL hubs with multiple takeoff and landing pads and include charging infrastructure. Vehicles should not require ground equipment that is specific to the vehicle model. Passenger ingress/egress should be optimized in support of high throughput Skyport operations.

Charging: We are working with our partners to develop a rapid charging capability (up to 600 kW); the vehicles should be able to interface with this infrastructure. Vehicles are expected to charge for less than 7 minutes during 3-hour sprint windows and less than 15 minutes otherwise.

Pilots: We expect on day one that vehicles will have the avionics and sensors needed for autonomous flight. However, they will be piloted in our first years while data is collected to prove the safety of autonomous systems. While not required by FAA, Uber will require the pilot to be physically separated from the passengers to achieve maximum safety.

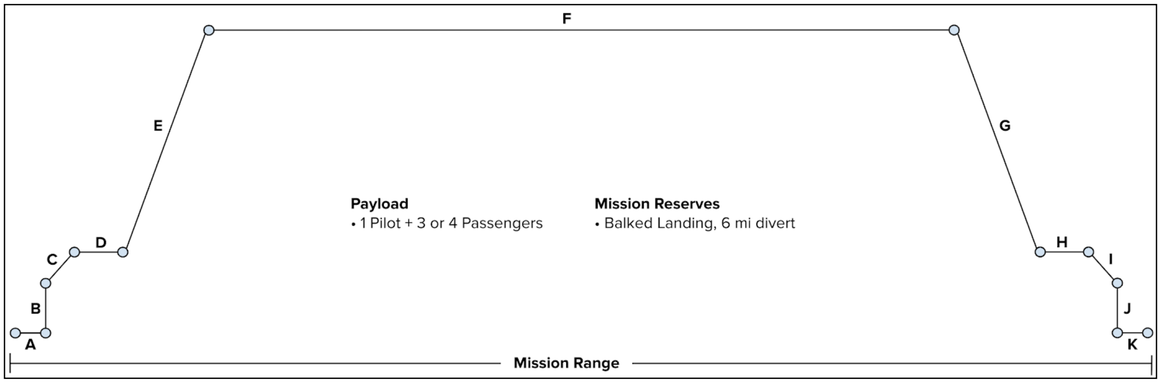
Network Communications: We will work with our partners to develop a secure bi-directional API for network communication. For example, the vehicle must be able to receive precise flight plans and report position and battery state. Vehicles must have the required equipage to fly in Class B airspace.

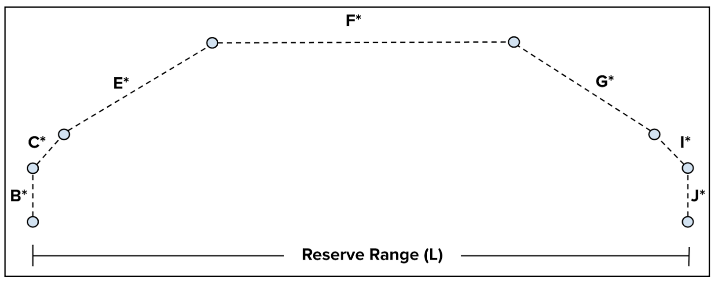
Payload: Vehicles must have space for a pilot and 3 or 4 passenger seats with a max payload weight of at least 980 lb, including luggage.

Ground Taxi: Vehicles must be able to perform a powered, wheeled ground taxi without spinning propellers or rotors. We intend for vehicles to travel on the ground for up to 300' at a ground taxi speed of approximately 5 ft/sec.

Size: Due to the limited size of the Skyports in urban environments, the vehicle footprint must not exceed 50' in its max dimension, including fully extended rotors. Max height should not exceed 20'.

Missions





	Segment	Distance (mi)	Vertical Speed (ft/min)	Horizontal Speed (mph)	AGL Ending Altitude (ft)
A	Ground Taxi	No Distance Credit	0	3	0
B	Hover Climb		0 to 500	0	50
C	Transition + Climb	Sizing | Repeated 60 | 25	500	0 to 1.2*Vstall	300
D	Departure Terminal Procedures		0	1.2*Vstall	300
E	Accel + Climb		500	1.2*Vstall to 150	1500
F	Cruise		0	150	1500
G	Decel + Descend		500	150 to 1.2*Vstall	300
H	Arrival Terminal Procedures		500	1.2*Vstall	300
I	Transition + Descend		500 to 300	1.2*Vstall to 0	50
J	Hover Descend	No Distance Credit	300 to 0	0	0
K	Ground Taxi		0	3	0
L	Reserves	Balked Landing, 6 mi divert at 500 feet AGL			

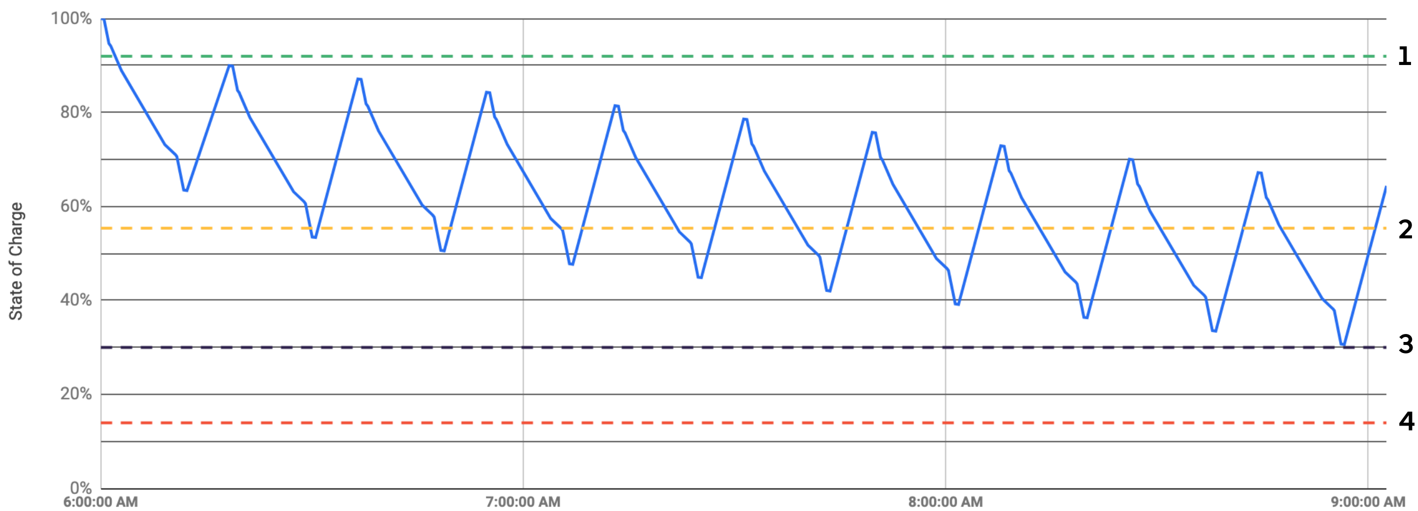
Range: Vehicles shall be able to fly 60 miles while maintaining enough energy to fly the reserve mission. This must be achieved at the battery's end-of-life state, which is determined by the vehicle developer.

Takeoff: Vehicles shall be capable of takeoff and hover climb at 5,000 ft DA. This is sufficient to operate in a majority of cities. Over time, vehicles with increased capability may need to exceed 5,000 ft DA takeoff requirements to generate network productivity in select markets (e.g. Mexico City).

Reserves: The aircraft shall have sufficient energy at the end of the Sizing or Repeated missions to perform a balked landing at the original destination, divert 6 miles to an alternate landing site, and land vertically at the alternate. The actual reserve energy required to execute a flight will be determined operationally and through working with regulators. Note that the effect of battery aging (decreased capacity and increased internal impedance) must be accounted for in evaluation of battery reserves.

Cruise: Network analysis favors faster vehicles capable of cruise speeds of 150 mph, with additional ±15 mph capability required for airspace sequencing and headwinds. Cruise should be performed at 1,500 ft above ground level (AGL). Initially, vehicles will operate only in visual meteorological conditions (VMC), with a path to autonomy enabling near-all-weather operation.

Repeatability: The vehicle must be able to operate continuously for at least 3 hours while flying 25 mile missions at the battery's end-of-life state. We define continuous operations as needing to charge for less than 7 minutes between flights, such that the limit on throughput is only the time to unload and load the passengers. We believe that this repeatability will be key to maximizing throughput.



Note: All state of charge values are nominal values used for sizing. In practice, they will depend on many factors, including power requirements, battery state-of-health, internal resistance, and operational constraints.

1. **Battery Rapid Charge Ceiling:** Above an upper state of charge (SoC), the charge rate will begin to decrease from maximum capability.
2. **Minimum State of Charge for Dispatch:** Battery must be above this SoC to take off. This includes energy to complete the next mission with reserves, without dropping below the battery floor.
3. **Minimum Reserve State of Charge:** Battery SoC should not pass below this line in nominal operations. The battery may operate below this threshold during a reserve mission, but the SoC must remain above the battery floor.
4. **Battery Floor:** At low SoC conditions, the current spikes and voltage drops precipitously. This section of the battery should not be counted as battery reserves.

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