NASA Advanced Air Mobility (AAM) Project

National Campaign Mobile Vertipad System Statement of Work

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AAM National Campaign

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1.0 BACKGROUND

The NASA Aeronautics Research Mission Directorate plans to host a series of Advanced Air Mobility (AAM) National Campaign (NC) events to help determine the readiness level of Industry Partners with regards to experimental vehicle stability, control and performance, safety assurance, airspace interoperability, and social acceptance. The NC series, which includes both simulations and flight tests, is designed to promote public confidence in Urban Air Mobility (UAM) safety, facilitate community-wide learning, and inform new regulatory policies while capturing the public's imagination. Towards helping Industry Partners with their development of first generation of UAM vehicles, the NC has undertaken an AAM NC UAM Helicopter Dry Run, using currently-in-use helicopter passenger aircraft to capture foundational vehicle and operational data to support evolutions in vehicle, infrastructure, and airspace requirements that will enable the advent of UAM in the National Airspace System (NAS).

Currently, there are three areas of focus within the NASA UAM portfolio; however, a during recent flight check operations, and in planning for future live flight events, a fourth focus area has come to light:

* Vehicle standards development and operations – focus on capabilities that are critical enablers for UAM such as electric aircraft propulsion, stability, control and performance, materials and structures, and autonomy.

* Airspace design and operations – develop and validate operational concepts for how to manage UAM traffic safely and efficiently.

* Community integration – understanding and addressing the most critical barriers to community integration, such as public acceptance (noise, security, privacy, etc.), supporting infrastructure, and local regulations.

* Terminal Operations Infrastructure—the physical infrastructure needed to conduct UAM operations. This is the new area identified in recent test events and mentioned above.

As the National Campaign series progressed through recent flight test scenarios that increased in complexity, and as its team is planning for UAM flight events around the United States, at locations advantageous to NASA and Industry Partners, and through lessons learned about the time and economic constraints in designing and installing conventional surface based helipads/vertipads at pre-existing airports and/or future planned vertiports/vertistops it has come to light that what is needed is a Mobile Vertipad System (MVS) which can serve as a launch and recovery platform for helicopter dry run and experimental UAM vehicles which can be deployed and re-deployed based upon the needs of NC and its Industry Partners participating in the flight events.

1.1 OVERVIEW DESCRIPTION OF SERVICES

The Contractor shall provide all research, development, prototyping and delivering of a Mobile Vertipad System (MVS), which can be moved using the existing transportation infrastructure, and then deployed for the purpose of providing a safe launch and landing surface for helicopter dry run and experimental UAM test vehicles with minimal impact to environment. The delivery of the first system will progress through the following stages:

* Presentation of design and schematics to NASA for approval,
* Building and delivery of a prototype system,
* Operation of the prototype system at a future helicopter dry-run event,
* Solicitation of adjustments requested by NASA,
* Implementation of requested changes into the finished product
* Delivery of the completed Vertipad for use by NASA at future NC flight events.
* Training for NASA NC personnel on the deployment and use of the system

2.0 OBJECTIVES

The objectives of the Mobile Vertipad System are to:

* Provide a mobile, safe and stable launch and recovery surface for UAM aircraft
* Provide terminal weather information
* Provide high precision latitude/ longitude
* Provide high precision field elevation
* Provide lighting information
* Provided cost and energy efficient platform for UAM operations

3.0 SCOPE

The Contractor will provide to NASA a Mobile Vertipad System that meets the requirements specified in paragraph 4.0. To that end, the Contractor will design, prototype, field test, adjust and deliver the system, based upon the NASA directed timetables, as well as provide NASA NC personal with training for the installation and use of the system upon delivery. There is no page limit to the proposal, but it should include details on how the contractor will satisfy the requirements in this SOW.

4.0 VERTIPAD OPERATIONS

The contractor shall provide a design of a Mobile Vertipad System (MVS) to include the method of transportation and specification outlined in this statement of work. The design of the MVS shall include on instrumentation packages outline in this statement of work and where applicable the performance parameters of the MVS and subcomponents. The MVS shall be defined as one Vertipad and transportation chassis that can hold more than one Vertipad. The MVS must be able to be transported via roadway without any restrictions. Restrictions are defined as but not limited to requiring a Commercial Driver's License (CDL), wide load exemption, extended trailer lengths, or excessive gross weights.

As part of the testing process the MVS shall be designed that it can be quickly deployed in less than 30 minutes from arrival on site location. The contractor will provide transportation and set up services as directed by the project. The MVS should be easily set-up and taken down (field expedient) urban use case that can be man-powered or one "heavy" unit. Take down of the MVS should take no more than 30 minutes. The locations may require prior security clearance and/or coordination with entities managing access. The contractor shall coordinate prior to MVS transportation access to government, municipal, or partner testing sites.

The contractor shall provide set up and any adjust services required for the MVS deployment. As part of testing multiple set up and tear downs will be required per site. The contractor shall provide NASA personnel with any training or SOP's required or that will be used in the MVS deployment and redeployment.

The contractor shall provide any maintenance services to the MVS required during the duration of testing on site at each location. Maintenance services to the MVS will include the transportation chassis.

The Contractor shall review and provide critical feedback to the MVS design, production and testing process to include any flight test plans, scenarios, or flight operations documents. The contractor will also be expected to support the test readiness review (TRR) and may be asked to provide detailed engineering data to the TRR board prior to the first flight under this contract. The Contractor shall participate in all pre-mission and post-mission debrief.

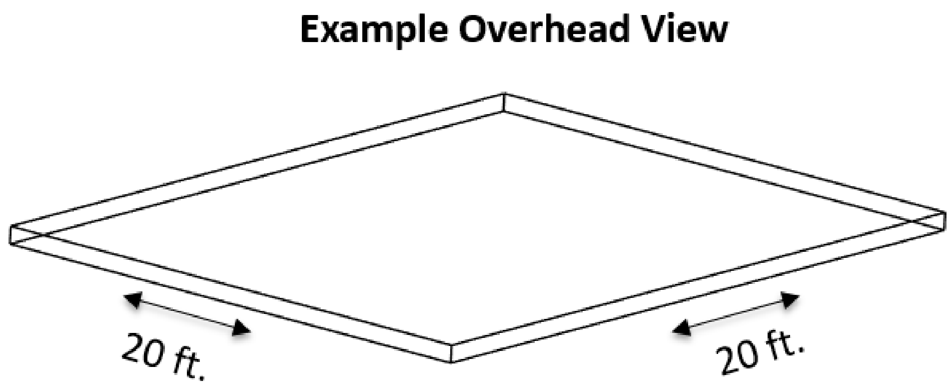
The contractor will deliver the completed MVS to the NASA Armstrong Flight Research Center (AFRC) located on Edwards Air Force Base (EAFB). NASA will provide a Ford F-350 Super Duty pick-up truck (or similar alternate vehicle with approximate weight of 7,000 lbs.) to transport the MVS to the test site.

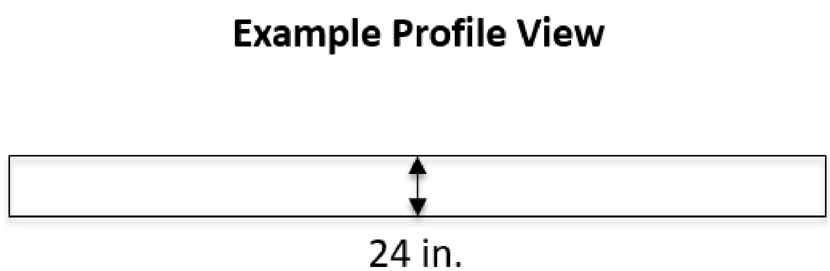
4.1 Vertipad Requirements

1. Maximum gross weight of MVS shall not exceed 4,000 lbs.
2. MVS transportation apparatus (e.g., trailer) shall be delivered with the MVS.
3. A method of easily securing/deploying/stowing up to three MVS from/to the transportation apparatus shall be delivered with the MVS.

4. MVS transportation apparatus shall be integrated into a vehicle, or towable by a Class 3 (1 ton) truck such that the combination does not require a Class A Commercial Driver's License (CDL) to transport up to three MVS. Maximum gross combined weight of up to three MVS and transportation apparatus, along with tow vehicle – if required - shall not exceed US DOT limitation not requiring Class A CDL (Gross Combination Weight Rating (GCWR) of 26,000 lbs.)
5. Maximum load bearing capacity of landing platform shall be 14,000 lbs. verified by Finite Element Analysis (FEA) , the results of the analysis delivered at the MVS system design review. The load can be expected to no more than 75% of the controlling dimension (CD) but the pad should be able to take load to the edges.
6. Minimum controlling dimension no less than 20 x 20 ft.
7. Maximum height off of ground 24 in.
8. Maximum length of MVS with transportation apparatus 40 ft
9. Maximum width of MVS with transportation apparatus 102 in.
10. Maximum adjustable-leveling design shall accommodate up to 7° slope at deployment site. The 7° leveling is for the slope of the ground underneath the MVS and is does not include the pad dimensions.
11. Self-contained energy source shall be included to powering any onboard equipment (i.e. hydraulics, lights, anemometer etc.) for up to 10 hours with no recharge required. The MVS should use renewable power sources to the maximum extent possible. A power diagram shall be included in the proposal to validate system consumption requirements relative to power pack being used.
12. The MVS shall include a minimum high precision latitude/longitude transceiver reporting in 0.1 ft.
13. The MVS shall include a minimum high precision field elevation transceiver reporting in 0.1 ft in accordance with Datum WGS-84 ITRF (2014).
14. The GNSS augmentation system must be capable of being used by representative aircraft that will be arriving to the vertipad. Since there is not an industry standard, the contractor may suggest the standard to be used and implement for this solution. The system is expected to have 4 major components: GNSS receiver, GNSS antenna, data radio transmitter, data radio antenna. The data radio should utilize the uncontrolled frequency band. Suggested frequencies are 433 MGHz and 5.8 GHz.
15. The MVS shall include a minimum surface weather reporting 2 min intervals, 10 degree all azimuths.
16. The MVS shall be deployable and operable in all-weather climates and environments within the Industrial temperature range of -20 degrees C to +85 degrees C
17. The MVS shall be accompanied by an operation and maintenance manual that covers all aspects of MVS deployment, operation, stowage and maintenance.
18. The following are not requirements but are highly desired:
    a. A minimum 4 lights that illuminate the landing surface for night operation testing
    b. A renewable energy source (i.e. solar, chemical, steam) to power the systems
    c. Construction that maximizes the use of recycled composite materials
    d. Transportation chassis that can hold more than one, up to three, MVS without exceeding the US DOT limitation not requiring an Class A CDL (GCWR of 26,000 lbs.)
    e. Provide Real Time Kinematics for PBN operations

4.2 Vertipad Dimensions



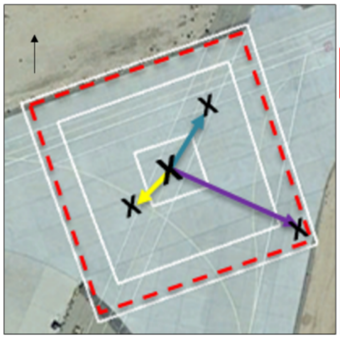


4.2.1 UAM Task Elements

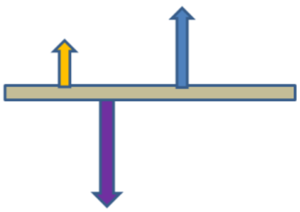
Perform discrete "building block" tasks that make up the Urban Air Mobility Mission in accordance with the Helicopter Dry Run Flight Test Plan. In some cases, tests will be flown with varying environmental or geometric parameters to measure foundational vehicle characteristics during the conduct of the tests. Tests will include, but are not limited to: Taxiing; Hover; Hover translation; Heading changes over a point; UAM Heliport Approaches/Departures; UAM Vertiport Approaches/Departures; Maneuvering flight; Missed Approach; Balked Landing; and simulated airspace tasks. Spatial data integrity and avionics interoperability will also be tested as part of the foundational UAM mission.

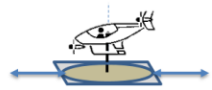
Spatial Data Integrity

Spatial Data Position Errors



Instrument	Location	Elevation	Vertical Error (from Garmin)	Lateral Error (from Garmin)
Garmin Handheld Survey	(34 57 32.88 N, 117 52 54.07 W)	2274 ft.	Most Accurate	Most Accurate
Google Earth	(34 57 32.84 N, 117 52 54.20 W)	2276 ft.	+2 ft.	(-0.04 degrees, .+0.13 degrees) 11.55 ft. 249.50 True Bearing
TARGETS	(34 57 32.69 N, 117 52 53.29 W)	2241 ft.	-33 ft.	(-0.19 degrees, - 0.78 degrees) 67.71 ft. 106.48 degrees True Bearing
Surveillance Broadcast Services Monitor	(34 57 33.01 N, 117 52 53.97 W)	2280 ft.	+6 ft.	(+0.13 degrees, -0.10 degrees) 15.56 ft. 32.34 True Bearing
FIAPA	Pending Flight Data			





4.2.2 Mission Overview of MVS Scenario 1

Perform nominal MVS loading and transportation via single roadway and interstate. MVS security and conformance to DOT noncommercial standards will be measured. Scenario one will assume an urban environment such a concrete, asphalt or hardened level load bearing surface already prepared for the MVS unload. MVS will be set up and adjusted for any uneven elevations and time will be kept to measure the expediency of the MVS. Chalk, spray paint, or other marking agent will be outlined around the pad to measure physical displacements to and from each landing and take-off.

4.2.3 Mission Overview of MVS Scenario 2

Perform nominal MVS operations once unloaded and leveled. Testing will include multiple checks on MVS spatial data reported against survey data already supplied at test site. Wind monitoring will also be cross referenced with NASA provided wind temperature and barometric data at same site. VMC flights via helicopter will be made to and from the Vertipad. Spatial data will be measured (elevation, lat/long) in the vertical and lateral axis before and after takeoff. Physical measurements will be taken in the later axis identifying any deviation from the chalk/spray paint outlined in scenario 1. Energy required to power internal components such as hydraulics, lights, avionics will be measured against what was planned given the time, intensity and duration and the actual energy consumed during the test. Scenarios one and two will be repeated at three different sites of similar environmental condition

4.2.4 Mission Overview of MVS Scenario 3

Perform nominal MVS operations outlined in scenario two at an unimproved landing site. The landing site will have no concrete or asphalt and will not have a slope that exceeds 7 degrees. The only additional test that will be included from scenario two will be a physical measurement in the vertical axis (elevation) after multiple takeoff and landings are made to measure dirt or earth displacement from the weight of the MVS, helicopter gross weight, and loading applied from different feet per minute descent rates within landing gear limitation of surrogate helicopter.

5.0 SECURITY

Access to EAFB and AFRC is limited to US Nationals. AFRC will arrange for unescorted access of Contractor personnel to the center. The Contractor will provide a list of personnel who will require access to EAFB and AFRC no later than 30 days prior to the arrival date.

6.0 PERIOD OF PERFORMANCE

September 1, 2021 – June 1, 2022

7.0 DELIVERABLES/TASKS

The following are the tasks and or deliverables for the Mobile Vertipad System:

* Project integrated schedule, including deliverables schedule, 1 month after contract award

* System Concept/Requirements Review prior to commencing design of the MVS to ensure the concept envisioned by NASA and the system architecture will meet the intent of NASA's National Campaign

* System Design Review, including results of the FEA, with the MVS design at least 90% complete and prior to commencing prototype build to ensure the design will meet the intent prior to expending resources to build the prototype

* Design drawings (Both CAD .step files and 2D), electrical schematics, operational and maintenance manual(s), and parts list

* Building and deliver one prototype system

* Build and deliver one MVS transportation apparatus to the NASA Armstrong Flight Research Center located at Edwards Air Force Base, CA

* Operation of the prototype system at a future helicopter dry-run event

* Delivery of the completed MVS/transportation systems (including updated operation/maintenance manuals and parts list) post implementation of design adjustments following the systems first test event; if any are required

* Delivery of the completed Vertipad for use by NASA at future NC flight events

* Training for the NASA NC operators at an NC flight event

8.0 OTHER REQUIREMENTS

NA