

## AERIAL EVOLUTION ASSOCIATION CANADA

### 2023 STUDENT COMPETITION CONCEPT OF OPERATION (CONOPS) DOCUMENT

To enhance realism in the 2023 competition scenario, this Conops document is in the format of a 'Request for Proposal (RFP)' from a mythical Big City who wishes to assess concepts for an Urban Air Mobility (UAM) capability. Student teams will act as industry Bidders to create concepts, design a UAM System, and compete in a sub-scale assessment of their designs. Their Phase 1 'design papers' will be in the form of Proposals in response to the Big City RFP.

Note that references to 'BVLOS' in the document refer to the inability of the flight line crew to see the UAS; competition staff will act as on-site spotters such that actual BVLOS will not be performed.

Refer any comments on this document to the Competition Chief Judge, Mark Espenant, at [mark.espenant@gmail.com](mailto:mark.espenant@gmail.com).

### RECORD OF AMENDMENTS

Amendments are highlighted.

Version #	Date	Comments/Changes
1.0	7 Sep 22	Initial issue
2.0	17 Oct 22	Responding to Team questions
2.1	30 Nov 22	Response to Team questions, definition of Barbie type, specification of tracking method for Task 1

## AEAC 2023 Student Competition

Version 2.1, 30 November 2022

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## CALL FOR PROPOSALS

### BIG CITY URBAN AIR MOBILITY SYSTEM (UAMS)

### PROTOTYPE DEVELOPMENT AND EVALUATION

*Conducted as the 2023 Aerial Evolution Association Canada Student Competition*

#### This Document

1. This is a competitive Call for Proposals for design, development, and assessment of a drone-based Urban Air Mobility System (UAMS) for Big City. This version of the document contains highlighted changes from the previous version. **Bidders' questions are answered in Annex D, and appropriate changes made to the document text as required.**

#### Background

2. Big City would like to improve the efficiency and effectiveness of downtown passenger transit, and requests bids to develop and demonstrate a UAMS sub-scale prototype. Bidders are invited to propose their design for a system to meet the criteria specified below, construct a subscale prototype, and participate in head-to-head flight assessments.

#### Assessment Format

3. This solicitation will result in two activities:
  - a. Phase 1 Proposal, in which proposals for the design and execution of the UAMS are presented based on the requirements below, due 15 January 2023 at 1700 EST; and
  - b. Phase 2 Flight Assessment, in which competing sub-scale prototype systems will conduct 'operational' flights according to the requirements detailed below. Phase 2 will take place 5-7 May 2023 in Alma QC; the assessment schedule is in Para 15.
4. All Bidders must complete Phase 1 by submission of a Proposal to be eligible to participate in Phase 2. There will be separate awards for each Phase.

#### Eligibility and Administrative Requirements

5. Due to Big City procurement regulations, the eligibility and administrative requirement for Bidders are unusual. Bidders are cautioned to pay attention to Annex A, which contains relevant details.

#### Key Dates

6. The following are the key deadlines for the response:
  - a. 28 November 2022 at 1700 EST – Submit expression of interest to [competition@aerialevolution.ca](mailto:competition@aerialevolution.ca) and complete online registration, which includes paying the \$600+tax team registration fee.
  - b. 15 January 2023 at 1700 EST – Submit Phase 1 Proposal.
  - c. 31 March 2023 – Submit team list and pay \$300+tax fee for each onsite participant.
  - d. 11 April 2023 – Submit video proof of successful flight, as described in Annex B Para 11.
  - e. 5-7 May 2023 – Attend Phase 2 Flight Assessment.

## Scenario

7. The UAMS will cover all the Big City Urban Area (BCUA), delivering up to six passengers per flight on waypoint-based routes not longer than 30 km. The Phase 2 Flight Assessment of sub-scale prototypes will use various routes, number of passengers, and situations to evaluate the capability of the proposed UAMS.

## Mission Requirements

8. The Phase 2 Flight Assessment will include two Tasks:
  - a. **Task 1 – Long-Range Passenger Transport.** Physical transport of at least two, and up to six, passengers (represented by dolls) over a long-range route, responding to a routing change in real-time, selecting an appropriate landing pad, and safely delivering the passengers.
  - b. **Task 2 – On-Demand Passenger Transport.** Optimization of provided transport requirements, to deliver nominal passengers between routes of different lengths, and with different pad configurations, to maximize revenue.
9. Both Tasks will be conducted within 5 km of the centre of the Alma airfield. The Phase 2 Flight Assessment will be conducted within the area shown on the map in Figure 1; eligible waypoints are provided on this map<sup>1</sup>. A digital version of the map can be found at [https://www.google.com/maps/d/u/0/edit?mid=1oOUCTVP\\_N2zcsJVg9x6hNHBcJyK1S\\_I&usp=sharing](https://www.google.com/maps/d/u/0/edit?mid=1oOUCTVP_N2zcsJVg9x6hNHBcJyK1S_I&usp=sharing), and a list of waypoints and their positions are found in Annex C or can be exported from Google Maps. The waypoints to be used for each Task will be provided in Task instructions at the Assessment, as later detailed in this document.
10. There will be one flight window for each Bidder on each day of Phase 2, with Task 1 on Saturday and Task 2 on Sunday. Within each flight window, the UAMS may operate as many times as Bidders wish to achieve the requirements of the relevant Tasks. However, Bidders may not attempt Task 2 on Saturday, or redo Task 1 on Sunday.
11. There can be only a single UAMS vehicle used for each Task; however, the UAMS design may include any desired combination of aircraft capabilities (eg, rotary wing, fixed wing, hybrid, or other). Different vehicle(s) or vehicle type(s) may be used for the two Tasks, but the passenger cabin for Task 2 must be the same or a duplicate cabin as used in Task 1.
12. UAMS vehicles must be no heavier than 15 kg for safety, and there is no size restriction. However, the landing gear must be completely on the landing pads to score. Some of the landing pads in both Tasks will have obstacles not closer than 2 m from the pad edge, and some will have a 5 kg weight restriction.
13. A GPS tracking device will be provided by the judges for Task 1. The UAMS must provide a flat location 2 inches square on the top of the bodywork. The weight of the device will not exceed 50g. An affixing method will be provided by the judges, likely stick-on Velcro. The actual device to be used will be specified when confirmed.
14. The vehicles must look like real air taxis. This includes such aspects as:
  - a. Appropriate aerodynamic bodywork with windows for the passengers
  - b. Exterior labelling, ie, company name, vehicle icon badges, etc
  - c. Realistic-looking cabin with seats and such
  - d. No loose visible wires

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<sup>1</sup> NOTE: The coordinates of some of the the waypoints in this list will almost certainly be amended as the Assessment methodology is further developed. The total number of waypoints and the waypoint names will not change.

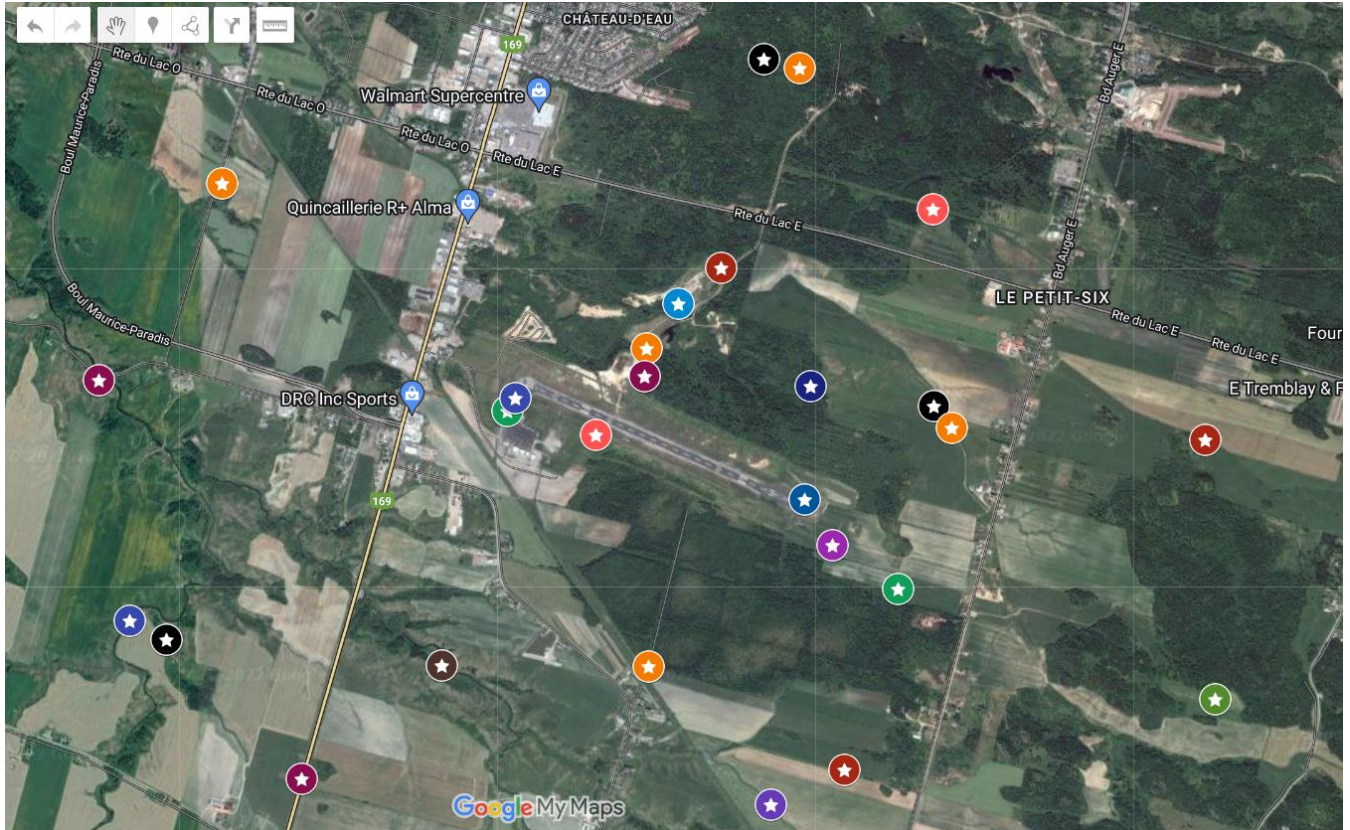


Figure 1 – Waypoints for Tasks 1 and 2, Listed in Annex C

## Phase 2 Assessment Schedule

15. The schedule for Phase 2 in Alma is shown below; detailed timings and order of the teams will be provided by email on the Thursday evening prior to the Assessment weekend.
  - a. Thursday evening – Bidders upload their presentation to the designated on-line cloud location by 2400. **Receive email with the order of Bidders for the presentation and the two Tasks.**
  - b. Friday morning – Starting at 0800, Bidders conduct an 8-minute scored oral presentation to present their team and their plan for conducting the Tasks. **All bidders must attend all presentations;**
  - c. Friday following the presentations – Bidders conduct Flight Readiness Review (FRR) to demonstrate compliance with aircraft safety requirements per the FRR Checklist in Annex B Para 4;
  - d. Friday afternoon at 1500 hrs – Bidders will be provided with a QR code giving a list of the routes for Task 2 in the format shown in Para 19, and will have 60 minutes to return their Flight Plan of route orders. Bidders may then ask questions to clarify Task requirements;
  - e. Saturday – Bidders conduct Task 1;
  - f. Sunday – Bidders conduct Task 2; and
  - g. Sunday evening – Bidders' Conference and dinner, and awarding of prizes.

## Task 1 – Long-Range Passenger Transport

16. Bidders have been provided in this document (see Para 9) with the overall map showing possible waypoints. At the start of the flight window, Bidders will be provided with a QR code specifying the route

as a series of waypoint names (QR Code: “Follow route: Waypoint 1; Waypoint 2;...Waypoint n”, see example below). Note that the actual format of the QR code output will be as read from the QR code below, with the waypoint names per Annex C.



Figure 2 - QR Code Defining Task 1 Route

17. Bidders must meet the following Task 1 requirements:
- a. Load passengers into the UAMS vehicle on the takeoff pad. Passengers will be male and female 11.5 inch ‘Made to Move’ Barbie dolls, having 11 or 22 joints (they come in the two types). At least two passengers must be carried; additional points will be earned for each additional passenger, to a maximum of six. The following considerations apply:
    - i. The UAMS cannot be picked up or moved during loading.
    - ii. The passenger cabin must be enclosed, and realistic entry means (doors? Or method of Bidder’s choice) must be provided. There must be appropriate ‘loading’ ramp/stairs/etc, simulating the ability of a real passenger to enter the cabin.
    - iii. Only one team member may load and secure the passengers.
    - iv. The actual layout of the cabin, seating arrangements, type of seats, degree of recline, seat pitch, etc, are up to the Bidders and will not be evaluated, provided that realistic entry/exit is possible.
    - v. Passengers should be restrained in seats to avoid movement during the flight. Velcro or other fastening materials (glue, tape, etc) may not be used.
    - vi. Once the passengers are loaded and all doors are secured, there must be a Flight Readiness Button to activate flight mode. The operation of this button will be verified in the FRR.
  - b. Take off and fly the specified route, staying within 50 m of the route centre line. The route will be no less than 10 (ten) km long, and no more than 30 km.
  - c. During the flight, a message will be received at the ground station by voice and QR code (Voice and QR code: “Avoid the area bounded by: Waypoint 1; Waypoint 2; ...Waypoint n<sup>2</sup>. Rejoin the route at Waypoint X”, see example below) advising of a geographical area which must be avoided, and indicating the waypoint at which the route must be regained. UAMS response may be manual or autonomous. See Figure 4.

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<sup>2</sup> The region (restricted area) bounded by the given waypoints is defined by straight lines between the perimeter waypoints. The diversion route may follow any path to ‘Waypoint X’ to resume the route, see Figure.





Figure 3 - QR Code Defining Restricted Area and Rejoin Waypoint

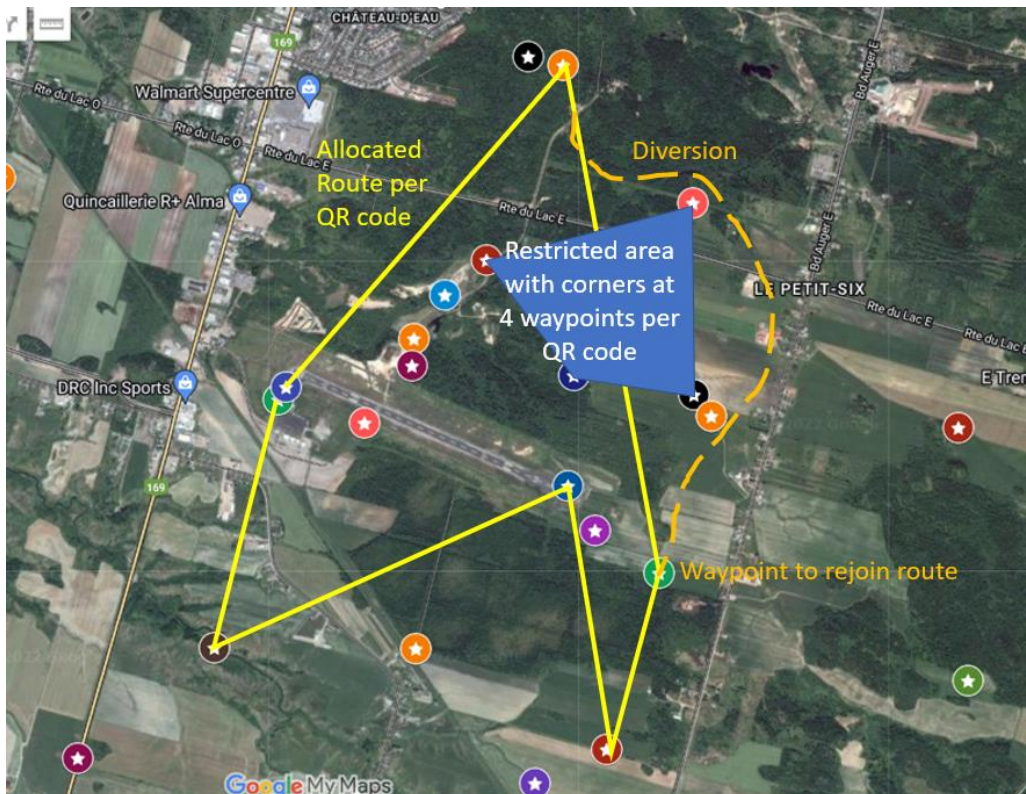


Figure 4 - Example of Task 1 Diversion

- d. Select available landing pad at the final Waypoint and land safely. Pads will be VLOS. Pads will be 32-inch blue/orange drone landing pads sourced on Amazon (like [https://www.amazon.ca/Labs-Quadcopter-imperm%C3%A9able-respectueux-lenvironnement/dp/B06XQP7MHQ/ref=sr\\_1\\_6](https://www.amazon.ca/Labs-Quadcopter-imperm%C3%A9able-respectueux-lenvironnement/dp/B06XQP7MHQ/ref=sr_1_6)). Pads in blue are operational, those in orange are not operational, and you must be able to identify any obstacles or issues with the pads to ensure selection of a safe landing pad.
  - e. Any portion or the entire Task may be done manually or autonomously; there will be additional points for portions of the Task done autonomously.
18. Bidders will be scored on:
- a. Realism – Realistic vehicle 'look' per Para 14.

- b. Passengers – Bonus points for each passenger over two, up to six. All passengers must be ‘seated’ in the vehicle.
- c. Route – Cross each waypoint within 50 m radius, straight line between waypoints within 50 m of airway. **The route will be tracked by a judge-provided GPS tracker, per Para 13.**
- d. Diversion – Does not enter the restricted area, rejoins route at correct waypoint.
- e. Autonomy – Points for things done without human input after activation of flight mode.
- f. Landing – Selects correct landing site, lands safely on pad.
- g. Security – Passengers in place in their seats after flight.
- h. Time – Start of flight window to landing.

## Task 2 – On-Demand Passenger Transport

19. Bidders will be provided with a QR code with a list of transport routes on Friday at 1500 (QR Code: “Route number 1 to n; # of passengers to transport; start waypoint; end waypoint; max vehicle weight; remarks (constricted pad, etc); \$ earned for completing route; carriage return n-1 times”, see example below), and must create a list of routes in the order they will be attempted within 60 minutes, ie, by 1600 (Flight Plan email to [mark.espenant@gmail.com](mailto:mark.espenant@gmail.com): Subject “<Bidder Name> Flight Plan; Body “Bidder Name; series of route numbers separated by semi-colons”).



Figure 5 - QR Code Giving List of Available Routes for Task 2

20. The Flight Plan must include at least 50% of the transport routes provided. Optimization algorithms may be used; use of an automated algorithm will earn additional points. This Bidder-provided Flight Plan must be followed in Task 2, although complete routes may be skipped – once skipped, a route may not be re-attempted.
21. If a route requires moving more passengers than a Bidder’s UAMS has capacity, multiple flights must be done – all required passengers for a route must be transported to earn the available revenue for that route. Routes may not be combined – they must be flown as individual flights. **If the start of the next route is not at the finish of the last route, a non-revenue ferry flight must be done.** There is no requirement to go back to the starting point to finish Task 2.
22. Reminder that the cabin must be the same or a duplicate of that used for Task 1.
23. Most landing pads will be (simulated) BVLOS; some will be VLOS. The pads are the same as for Task 1; **however, the landing sites will have only one pad; obstacles may be present as described in the QR code.**
24. Dolls will not be loaded nor carried. When passengers are ‘on board’, a green ‘Passengers aboard’ light must be illuminated, visible from 360 degrees around the UAMS; otherwise, no credit will be granted for carrying passengers.
25. At each pad, the UAMS must fully land on the pad (all landing gear on the pad) and stay with rotors stopped for 15 seconds.



26. Batteries may be swapped at the launch point at any time during the flight window, provided no passengers are on board.
27. Bidders will be scored on:
  - a. Total earnings for all completed routes done in the order of the Team's Flight Plan, pro-rated to the team with the highest earnings.
  - b. Bonus for each completion of the FULL Flight Plan (ie, all Flight Plan routes, done in order, all passengers). Reminder that a Bidder's Flight Plan must include at least 50% of the provided transport routes.
  - c. Bonus if the Flight Plan was created using an optimization algorithm, with no manual input from reading the QR code to sending the Flight Plan email.

### UAMS Design Constraints

28. The following design restrictions will be verified at the FRR:
  - a. Max weight 15 kg; the weight at the FRR will determine eligibility for some pads in Task 2 which are subject to a 5 kg limit.
  - b. Only electric propulsion (including solar cells, batteries or fuel cell).
  - c. UAMS must have a flight termination system as defined in Annex B Para 3.
  - d. Data links can be by radio, infrared, acoustic or other means so long as no tethers are employed. Unmanned Systems may operate autonomously, semi-autonomously, or under manual control at the discretion of the Bidders.
  - e. Radio frequency usage in Canada is defined by ISED. If a licensed band is used, the license must be obtained and provided to the judges before being allowed to fly.
  - f. **For Task 1** there must be a Flight Readiness Button to allow the UAMS to operate once passengers are loaded.
  - g. **For Task 2** there must be a green 'passengers aboard' light.

### Flight Schedule

29. Bidders will have one flight window for each of the two Tasks, each of which will be approximately 30-45 minutes. The actual amount of time allotted will be announced prior to the start of the assessment flights; the allocated time is subject to the number of registered Bidders and uncontrollable factors such as weather.
30. The schedule for Bidder presentations and two flight windows will be determined by random lottery. The schedule will be provided to the teams by email on Thursday evening.
31. After their last flight of the competition, Bidders have 90 minutes to upload their report to the provided URL.

### Flight Crew

32. Bidders will designate a 'flight crew' consisting of maximum five members. Only the flight crew may be present on the flight line during the flight window.
33. Pilots must remain at the launch point for the complete Task. Pilots must hold an Advanced Pilot certificate.

## Evaluation Criteria

34. All Bidders must complete Phase 1 to be eligible to participate in Phase 2. Phase 1 and 2 are scored and awarded prizes separately. You will not be evaluated on what you put in the Phase 1 Proposal versus what you demonstrate in the Phase 2 Flight Assessment.
35. Phase 2 has a total possible score of 320 points plus bonuses. The individual criteria are detailed in the following paragraphs, and a summary of the Phase 2 scoring is shown in Table 9.

## Phase 1 Proposal

36. The Phase 1 Proposal will describe the technical and programmatic details of a Bidder’s UAMS development and demonstration. Proposals may be submitted in English or French.
37. The Proposal will be evaluated according to the criteria in Table 2. Each criterion is awarded either 0, 4, 7 or 10 points, and each category of criteria are weighted as shown, for a maximum score of 100 points.

**Table 2: Phase 1 Proposal Scoring Criteria**

<b>PROPOSAL</b>	<b>Score</b>
Days Late	
<b>Proposal Quality</b>	15
Grammar/Spelling Structure/Organization Use of Figures/Charts/Tables	
<b>System Capabilities</b>	50
Analysis of Alternate Solutions Passenger Safety and Acceptance Automation Path Optimization Model/Process Computer Vision/Landing Methodology	
<b>Technical Innovation and Novelty</b>	20
Novel Approach to Mission Requirements Novel Elements	
<b>Project Management</b>	15
Risk Management Plan Schedule for Prototype Design/Construction Proposed Budget	

38. The following clarifies content for each evaluation criteria:
  - a. Days Late – Score reduced by 10% for each day late, starting at 1701 EST on 15 Jan 23.
  - b. Grammar/Spelling – Self-explanatory.
  - c. Structure/Organization – Minimize searching for responses to criteria. Include common elements of a ‘proposal’, see the internet for examples.
  - d. Uses of Figures/Charts/Tables – Size, appropriate titles and labels, referenced from the text, etc.
  - e. Analysis of Alternate Solutions – How did you choose the vehicle, the algorithms, the methodologies, etc?
  - f. Passenger Safety and Acceptance – How does your design ensure the safety of the passengers, and make them feel good about the safety of their flight?
  - g. Automation – What portions of the Tasks are automated, and how will this be done?

- h. Path Optimization Model/Process – Details of how path optimization will be done for Task 2 – may be manual or automated. Note this doesn’t assess whether or not you’re using automation...just how you’ve described how you’re going to do it.
  - i. Computer Vision/Landing Methodology – Details of landing methodology including any automation or computer vision.
  - j. Novel Approach to Mission Requirements – Explain how your overall strategy for accomplishment of the Tasks, and the individual strategy for each Task, are novel.
  - k. Novel Elements – Novel technology solutions in the overall System. What does your UAMS have that makes it novel in the execution of the Tasks?
  - l. Risk Management Plan – During design and development of your UAMS, what risks may affect your ability to compete in Alma, and how are you addressing the risks? Risk categories should include technical, programmatic, budget, and/or others. Risk planning must include:
    - a. Identification of the risk.
    - b. Likelihood that the risk will happen.
    - c. Impact on the project if the risk occurs.
    - d. Measures you will take to reduce the likelihood of the risk and to mitigate its effects if it does happen.
  - m. Schedule – Including Gantt chart of all significant activities in UAMS development and planning for the Phase 2 Assessment.
  - n. Budget – Funding Including travel.
39. Proposals are due 15 January 2023 at 1700 EST to [competition@aerialevolution.ca](mailto:competition@aerialevolution.ca) and [mark.espenant@gmail.com](mailto:mark.espenant@gmail.com) in PDF format. 10% will be deducted from the score for each day late.
40. Proposals are limited to 15 pages total, including any appendices, title page, table of contents, list of figures, etc. Pages above the 15-page limit will be ignored in the scoring.

### Phase 2 Bidder’s Presentation

- 41. Bidders make a sales pitch to all other Bidders and the Assessment Judges. Presentations should include:
  - a. Composition of Bidder Team;
  - b. Expertise of each Team member;
  - c. UAMS design;
  - d. Execution of each Task; and
  - e. Why your UAMS solution should be chosen.
- 42. The length of this presentation should not exceed 8 minutes. You may give your presentation in English or French; whichever language is chosen, there must be at least one slide presented in the other language.
- 43. Presentations in Microsoft PowerPoint are to be uploaded to the provided storage site by 2400 on 4 May 2023 (Thursday).
- 44. Presentations will be scored on the criteria in Table 4.

**Table 4: Bidder’s Presentation Scoring**

Criteria	Score
Presentation is well organized; most team members participate; other language is used.	4
Presentation includes all elements in Para 41.	4
Slides are well-prepared, easy to read, contain appropriate media, are not overly technical.	4

The presentation is clear and understandable, with limited jargon or technical terms; good speaking quality.	4
Big City would be convinced this is the right UAMS.	4
<b>Total Possible Score</b>	<b>20</b>

### Task 1 – Long Range Passenger Transport

45. An overview of Task requirements is in Para 17, and the waypoints for the designated route will be provided using a QR code at the start of the flight window. Bidders will be scored on the criteria shown in Table 5:

**Table 5: Long Range Passenger Transport (Task 1) Scoring**

Criteria	Score
Prototype Realism: <ul style="list-style-type: none"> <li>Realistic vehicle 'look', streamlining, labelling (company logo, etc), realistic door and entry, seating area, mannequins can be loaded and secured easily = 10 pts</li> </ul>	10
Passengers: <ul style="list-style-type: none"> <li>Each additional passenger over minimum of two = 2.5 pts</li> </ul>	10
Route Following: <ul style="list-style-type: none"> <li>UAMS remains within 50m of route centreline at all times = 30 pts</li> <li>Each excursion beyond 50m = deduct 2 pts</li> <li>Each error in route (eg, misses waypoint) = deduct 10 pts</li> <li>Deductions can reduce 'Route Following' score to zero, not negative</li> </ul>	30
Diversion Response: <ul style="list-style-type: none"> <li>Does not enter restricted airspace = 10 pts</li> <li>Rejoins route at correct waypoint = 10 pts</li> </ul>	20
Autonomy: Points per autonomous action: <ul style="list-style-type: none"> <li>Takeoff (from pushing 'activate' button to UAMS on route) = 5 pts</li> <li>Route tracking (from 'on route' to diversion) = 3 pts</li> <li>Diversion response (from receipt of message to rejoining route) = 8 pts</li> <li>Pad selection = 10 pts</li> <li>Landing = 4 pts</li> </ul> Note: Judge will determine in the event of pilot intervention whether each individual autonomous action was achieved.	30
Landing: <ul style="list-style-type: none"> <li>Land safely on correct landing pad = 20 pts</li> </ul>	20
Passenger Security: <ul style="list-style-type: none"> <li>All passengers in place after flight = 10 pts</li> </ul>	10
Time: <ul style="list-style-type: none"> <li>UAMS with quickest pax delivery (Start of flight window to landing) = 10 pts</li> <li>UAMS with slowest delivery, or no delivery = 0 pts</li> <li>Other points allocated in proportion</li> </ul>	10
<b>Total Possible Score</b>	<b>140</b>

## Task 2 – On-Demand Passenger Transport

46. An overview of the Task requirements is in Para 19; routes must be flown in the order shown on the Bidder’s Flight Plan. Bidders will be scored on the criteria shown in Table 6:

**Table 6: On-Demand Passenger Transport (Task 2) Scoring<sup>3</sup>**

Criteria	Score
Revenue: <ul style="list-style-type: none"> <li>Bidder with greatest earnings = 120 pts</li> <li>Other Bidders pro-rata points in comparison to highest earning Bidder</li> </ul>	120
Route completion: <ul style="list-style-type: none"> <li>EACH completion of a full Flight Plan (in order, no skipped routes) = 20 pts</li> <li>EACH skipped route on a Flight Plan = deduct 5 pts from overall score</li> </ul>	
Computer Optimization: <ul style="list-style-type: none"> <li>An optimization algorithm uses the QR code as provided, outputs a Flight Plan email with no manual intervention within 60 minutes (on Thursday) = 20 pts</li> </ul>	20
<b>Total Possible Score</b>	<b>140 pts +/- route bonus</b>

## Flight Preparation

47. Teams will be scored on their preparation, according to the criteria in Table 7:

**Table 7: Flight Preparation Scoring**

Criteria	Score
Team is on the flight line with all required equipment 30 minutes before their flight window, and ready to fly at the start of the flight window.	5
Team is well organized, with an obvious and effective leader and obvious tasks for team members, good cooperation between team members, good problem solving. <ul style="list-style-type: none"> <li>All characteristics observed = 10 pts</li> <li>Some disorganization, lack of leadership or cooperation = 5 pts</li> <li>Disorganized, no real leader, arguing, poor problem solving = 0 pts</li> </ul>	10
UAMS is designed for easy set-up, with easily assembled components, use of switches rather than connectors at flight line, logical and efficient set-up/initialization procedures, etc. <ul style="list-style-type: none"> <li>All characteristics observed = 10 pts</li> <li>Some flaws in design for easy set up, but overall well designed = 5 pts</li> </ul>	10

<sup>3</sup> Example: There are 15 routes provided on the QR code from the Judges (your Flight Plan then must include 8 routes). You can use manual or algorithmic means to determine your Flight Plan. If an algorithm reads the provided QR code, automatically puts the routes in an optimized order, and sends the specified Flight Plan email, you get 20 pts; if not, you get zero. If your plan is to do 12 of the routes in a specific order, you must follow the order. If you do every route on your Flight Plan successfully you get a 20 pt bonus. Every route you choose not to do on your Flight Plan, for whatever reason, you lose 5 pts. So, let’s say your machine crashes on the first flight, you’d get zero points. Let’s say you fly 8 of the routes successfully, you’d lose 20 pts for routes not flown from your earnings score (recall, there are disappointed booked pax standing at the gates of the four routes you ignored!)



<ul style="list-style-type: none"> <li>• Easy set up clearly not part of the design = 0 pts</li> </ul>	
Checklists are used for flight preparation: <ul style="list-style-type: none"> <li>• Effective and organized use of written checklists = 5 pts</li> <li>• Ad-hoc semi-use of checklists = 2 pts</li> <li>• No checklists = 0 pts</li> </ul>	5
<b>Total Possible Score</b>	<b>30</b>

## Post-Flight Report

48. Bidders must submit a report no later than 90 minutes following the close of their last flight window, submitted to the specified URL. The report will be scored according to the criteria in Table 8, which includes how well it is written and how clearly the results are presented. Actual performance of the Tasks is evaluated in other criteria, and will not be scored in this report.
49. The report should contain the following information at a minimum:
- Title Page.
  - Overview of the required Tasks.
  - Detailed results of each Task, eg, how technology worked, the success of optimization, route planning and diversion, etc.
  - Overall comments on the flights – how well things went, lessons learned, etc.
  - Conclusion.
50. The Report may be in English or French.

**Table 8: Post-Flight Report Scoring**

Criteria	Score
Content: <ul style="list-style-type: none"> <li>• All required information is present and thoughtful comments are made about the Tasks = 5 pts</li> <li>• Information is missing or comments are lacking = 2 pts</li> <li>• Majority of information is missing or no comments = 0 pts</li> </ul>	5
Presentation: <ul style="list-style-type: none"> <li>• The report is well formatted, with good grammar, effective presentation of the results = 5 pts</li> <li>• Some formatting or grammar issues; results presentation is not effective = 2 pts</li> <li>• Report is poorly formatted, grammar is difficult to understand, results are difficult to understand = 0 pts</li> </ul>	5
<b>Total Possible Score</b>	<b>10</b>

## Overall Flight Assessment Scoring

51. To summarize, the total score available for Phase 2 is 340, weighted as shown in Table 9:

**Table 9: Overall Phase 2 Scoring**

Criteria	Score
Presentation	20
Task 1 – <i>Long-Range Passenger Transport</i>	140

Task 2 – <i>On-Demand Passenger Transport</i>	140 +/- bonus
Flight Preparation	30
Report	10
<b>Total Possible Score</b>	<b>340 + bonus</b>

## Annex A – Eligibility and Administrative Requirements

### General

52. All team members must be enrolled part- or full-time at a Canadian College or University for Fall 2022 and/or Winter 2023.

### Team Size and Composition

53. Traditionally, there is no maximum or minimum Team size and no maximum crew size in the preparation area, but a maximum of five people in the flight-line crew. However, it is possible that COVID-19 considerations will limit the number of team members allowed to attend Phase 2. Availability of accommodation may also limit numbers. Any such limitation will be communicated as soon as possible.
54. Teams may be organized internally at the discretion of their members and may include graduate and undergraduate students. Joint teams consisting of students from more than one institution are permitted; for example, a joint university-college team is allowed.

### Number of Teams

55. There is no restriction on the number of teams from any one institution; however, no individual student may be on more than one team, and proposals from different teams at the same institution must be substantially different. Teams will be accepted at the discretion of the Procurement Authority (or Judges ©). Depending on registrations and accommodation or COVID-19 restrictions, it may be necessary to limit institutions to one team, or to limit the number of teams in the competition.

### Applications and Registration

56. Teams must send an email indicating their interest to [competition@erialevolution.ca](mailto:competition@erialevolution.ca), and complete the online registration on [www.erialevolution.ca](http://www.erialevolution.ca), including paying the team registration fee of \$600+tax. Registration is non-refundable. Once fully registered, teams will have access to more information. The registration deadline is 28 November 2022 at 1700 EST.
57. Teams are responsible for their own costs, including travel to/from and during the Phase 2 competition. The onsite participant cost is \$300+tax and includes most meals and lodging. Accommodations will be arranged by Alma, and teams are not allowed to stay other than in the provided rooms. Food will be provided most days, excluding Saturday evening.

## Annex B – Safety Requirements

1. The competition ends at about 2200 hrs after the awards banquet on Sunday night. Departing immediately following the banquet is NOT endorsed by AEAC; plan to leave on Monday to ensure safe driving home. Ensure all drivers on a rental car have a full driver’s license in good standing. The awards banquet will be held at a different location than the accommodations – Teams must plan appropriate transportation.
2. Each individual vehicle must have a separate operator while being flown or moved, e.g, concurrent operation of vehicles requires separate operators. **All UAV pilots must hold an Advanced Pilot certificate.**
3. All UAVs must be equipped with a safety flight termination system that can be activated either automatically or remotely (kill switch). For fixed wing, this could consist of using a parachute, or shutting down the engine and performing aerodynamic termination, which corresponds to full aileron, elevator up, full rudder and no motor. Circling down is not acceptable. For rotary wing, a quick vertical descent of a minimum of 2 m/s and touchdown must be performed. The flight termination mechanism must be operational at all times. If the flight termination method is not working, the aircraft must terminate the flight itself automatically and rapidly. In other words, if unable to kill the aircraft, the aircraft should have already killed itself. Under no possible situation should the UAV be in flight with the crew unable to activate a kill mechanism. This is valid for all flight modes. For instance, losing C2 link while in auto mode shouldn’t remove the capability to kill the aircraft. Aircraft must be in termination mode within 10 seconds of the termination function being activated. The flight termination mechanism will be validated during the Flight Readiness Review (FRR) check. In previous years, one way that teams achieved this successfully was ensuring their RC controller has sufficient range, and configuring the system so that the aircraft is killed automatically if the RC link is lost.
4. The Flight Readiness Review performed on the Friday is represented in the Table below:

**Table B1: FRR Checklist - AEAC Student Competition**

Provided a copy of the Advanced RPAS pilot certificate for Canadians?
Provided copies of: proof of training (a), flight review (b), and SFOC(c) for Non-Canadian RPAS Pilots?
Provided a copy of the RPAS registration?
Provide a copy of the email where the proof of flight was submitted to AEAC.
Weight under 15 kg, pass list of weights to Chief Judge
Demonstrate that the flight termination system is functional at all times and in all flight modes. Propellers should have been removed already. Make the motor(s) spin, and show that at all times, it is possible to kill the aircraft in all flight modes. Also show this kill mechanism has already been activated if the datalink for the kill switch is lost (this is often the RC controller, based on previous years).
Demonstrate operation of the Flight Readiness Button – drone may not be capable of operating until the button is pushed.

5. Teams may turn on transmitters at the start of their flight window. Teams must turn their transmitters OFF after their flight window has elapsed. NO transmissions of any sort are allowed outside the flight window, including Wi-Fi hotspots and the like.
6. During flight, the GCS must always show the aircraft and the competition flight area.
7. Rehearsals are not permitted unless specifically authorized by the judges.
8. If the aircraft leaves the flight boundaries, the operator will be asked to bring it back within the boundary. If the operator is unable to do so, they will be asked to activate the kill mechanism.
9. All anomalies with respect to the GPS, Datalink, RC and flight boundaries must be reported to the Air Program Director.
10. Teams must have an electrical or mechanical way of preventing propellers from accidentally spinning when the aircraft is not in takeoff position and ready for takeoff (i.e. when working on the aircraft).
11. Video proof of previous successful flight of the aircraft in the configuration planned for the competition must be presented to judges by 11 April 2023. It must show at least the following elements:
  - a. Takeoff;
  - b. Fly by, circle, and (if applicable) hover to demonstrate the stability of the vehicle;
  - c. Approach; and
  - d. Full-stop landing.
12. All flying, including flight testing at local test sites and at the competition, is to be performed under Part IX regulations for RPAS.
13. Alma Airport is a certified airport, and consequently each pilot (not each team member, only pilots) must hold an Advanced RPAS Pilot Certificate. To be clear, the Basic operator certificate is not sufficient. It is recommended to initiate this process as soon as possible, as a relatively difficult online exam, in addition to a flight review at a UAV training school, must be passed successfully to obtain the Advanced Operator Certificate. A copy of the Advanced RPAS Pilot Certificate for each pilot must be provided to the Air Program Director as part of the flight readiness review.
14. Each RPAS must be registered in accordance with Part IX regulations. It is best if registration is done by a Canadian citizen, under the name of the University, through the Transport Canada portal. For each RPAS to be flown, the registration certificate must be provided to the Air Program Director as part of the flight readiness review.
15. To Confirm: No SFOC is required by teams. Instead, all pilots and UAVs must conform to Part IX – for which a high level overview is provided above. AEAC will independently apply for a Special Aviation Event Certificate; no action is required from the teams.
16. Non-Canadian Citizens acting as RPAS pilot at the competition must provide proof of completing Ground School training to TP15263 Standard; this step replaces the online advanced exam. Non-Canadians must also pass a flight review, with results on paper instead of being in the portal. Non-Canadian Citizens will then apply for a SFOC in their name; for testing, training and operations for USC 2022 Competition. There is no fee, but the process takes 30 business days.
17. Insurance requirements for flying in Alma have not been determined – to be communicated to teams later.
18. If you need any assistance with regulatory approval, please contact us as soon as possible.



## Annex C – Waypoint Locations for Phase 2

This list may be exported from the Google Maps link,

[https://www.google.com/maps/d/u/0/edit?mid=1oOUCTVP\\_N2zcsJVg9x6hNHBcJyK1S\\_I&usp=sharing](https://www.google.com/maps/d/u/0/edit?mid=1oOUCTVP_N2zcsJVg9x6hNHBcJyK1S_I&usp=sharing)

WKT	name
POINT (-71.6375025 48.5166707)	Alpha
POINT (-71.6317518 48.5060947)	Bravo
POINT (-71.6340069 48.4921159)	Charlie
POINT (-71.6404442 48.5150341)	Delta
POINT (-71.6782955 48.5005337)	Echo
POINT (-71.6040591 48.5088395)	Foxtrot
POINT (-71.6522101 48.5101473)	Golf
POINT (-71.6426006 48.5129917)	Hotel
POINT (-71.6428152 48.5117408)	India
POINT (-71.6229056 48.5193311)	Juliette
POINT (-71.6568088 48.4984623)	Kilo
POINT (-71.6253089 48.5019885)	Lima
POINT (-71.6720008 48.520525)	Mike
POINT (-71.6461702 48.5090567)	November
POINT (-71.6516848 48.5107057)	Oscar
POINT (-71.6298198 48.5039667)	Papa
POINT (-71.6345802 48.5262308)	Quebec
POINT (-71.6804996 48.511563)	Point 18
POINT (-71.6425625 48.4984266)	Romeo
POINT (-71.6320911 48.5258329)	Sierra
POINT (-71.6758648 48.4996779)	Tango
POINT (-71.6290012 48.4937058)	Uniform
POINT (-71.6228085 48.510353)	Victor
POINT (-71.6216069 48.5093153)	Whiskey
POINT (-71.6034018 48.4969248)	Xray
POINT (-71.6312968 48.5112557)	Yankee
POINT (-71.6664874 48.4932846)	Zulu

## Annex D – Bidders' Questions – Responses in Red

### UTAT 21 SEP 22

#### General

- Are there any altitude restrictions during flight? **The usual altitude restriction of 400' applies.**
- To clarify the QR code formatting, can you provide a set of example QR codes? **Provided in doc.**
- What kind of terrain will the landing pads be placed on? **You'll find out when you fly over the landing areas. However, you can assume that some will be on largish flat surfaces, some will have at least one obstacle to avoid (no closer than 2 m away), and one will have 'edges' such that if the drone lands half on the pad it is likely to topple over. Note that the RFP Para 12 said that only Task 2 could have obstacles - this will be changed to say 'both Tasks'.**

#### Task 1

- Can parts of the passenger cabin (eg. doors) be moved by hand while boarding the passengers? **All movable parts in the passenger cabin for entry of the passengers may be moved by hand - without moving or lifting the UAMS**
- What is the exact Barbie doll model? Will they have bendable legs and arms? **The Barbies will have moveable and bendable arms and legs. They may be male or female**
- Is the "Flight Readiness Button" equivalent to an arming/disarming switch? **Yes.**
- Can we swap batteries during Task 1? **No.**
- How many landing pads will there be at the final waypoint? **You'll find out when you fly over the landing area.**

#### Task 2

- To clarify: if our UAMS exceeds 5 kg during the FRR, then the transport route list we are given will not include any routes with the 5 kg-limit landing pads, correct? **All teams will be given the same list of routes, and it is the point of your optimization process to determine which routes to choose for your Flight Plan, considering fares you can gain and limitations of your UAMS including weight.**
- Does swapping batteries during a not-yet-completed route automatically disqualify us from completing that route? **You may not, see Para 25, swap batteries with passengers on board. So, yes, if you land and swap batteries with pax on board, that's the end of that flight and you'd have to return to the route's origin and restart the route.**
- Are the possible landing pad obstacles 2 meters from the pad's edge, or is 2 meters the diameter of the clear landing region? **There will be obstacles near some pads no closer than 2m from the pad edge.**

### WARG 11 OCT 22

#### Task 1

- Does the 30km distance include the distance to reroute around the restricted airspace? **See 16b, no.**

- Once the airspace is announced as restricted, is this the case for the remainder of the flight, or only until the next waypoint? **Restricted until the end of time.**
  - Do we know how many waypoints will be associated with the restricted airspace? **No.**
  - Do we need to reroute to another waypoint, or can we follow the edge of restricted areas? See 16c. **Route to the re-join waypoint is up to you, so long as you stay out of the restricted area.**
- Is there an altitude associated with the waypoints? **No.**
- Can the barbies be loaded via a removable top section, or can the aircraft be temporarily disassembled (provided there is a realistic entrance elsewhere) to load the barbies? **See 16a (ii) and (iii), no.**
- What will the barbies be wearing (could their outfits impact our seating designs)? **Do airlines get to choose what real passengers are wearing?**
- Does "Route tracking (from 'on route' to diversion)" refer to the autonomous flight of the aircraft from waypoint to waypoint? **Yes.**
- Will multi-action autonomous flight still earn full points (a sequence of buttons/switches need to be pressed before an autonomous action begins) or would it need to be entirely autonomous from the moment the aircraft was armed? **Explanatory text added – judge will determine if each 'autonomous action' was achieved if intervention is required.**
- Are realism points pro-rated, or is there a hard limit for how much we have to do to get 100% realism points. **Same judge will score all teams, it'll kinda be comparative based on the criteria shown.**

## Task 2

- Can the route be optimized such that multiple pickups are completed before drop-offs (think bus instead of taxi). **Good question, no they cannot be combined. Note added to text.**
  - What is the maximum number of passengers per route? (can it be more than 6?) **See 16a, no.**
- Can batteries be replaced on aircraft if we are not on the original take-off point? **See 25, no.**
- Are the same landing pads being used for both tasks? **Yes, added to text.**
- Can a negative score be achieved? **I guess mathematically you could 😊.**

## General Questions

- What are the shape / dimensions of the landing pads. 32" size is mentioned, but it is not clear if this is a diameter, radius or some other (non circular) measure. **Circular.** (is there an amazon link we can reference?)
  - When landing, do we need to land directly on the pad, or can we land outside the pad and taxi on to complete the landing **On Pad.**
  - What types of obstacles might be near pads? **Dunno.**
  - Do we need to take off from the landing pads as well (can we expect any sort of runway)? **Yes, no.**

- Are points for various sections all or nothing (e.g. part marks for realism or semi-autonomous flight capabilities)
  - i.e. autonomy points - autonomous following of most waypoints, but manual intervention required to ensure aircraft does not deviate from route **Doesn't sound autonomous to me.**
- What is the data format & schema provided to the competitors?
  - What format will they be in (e.g. named files on a usb stick we plug into our groundstation, recording played into a mic, spoken word, printed QR code that needs to be scanned by a webcam?) **Read the document.**
- What accommodations are included with team registration fees and individual registration fees? (hotel, food) what would we need to prepare to spend money on at the event? **Most is covered except dinner Saturday night.**
- Can we drive stakes into the ground for our groundstation setup **Yes.**
- How much communication will we have with visual observers? **None.**
  - Will we be allowed to supply our own visual observers and be in contact with them? **No.**
- Will there be power at the flightline? **Yes.**
- Will we be allowed to use radios to communicate between team members at competition? Are there restricted channels, or are we going to be OK if we use designated frequencies? **We would need more info on what you want to do.**
- What weather conditions will impact the flight schedule (what weather should we design our aircraft to withstand)? **Wind, sun, rain.**

## UTAT 25 SEP 22

- Is there a minimum flight altitude at which we must fly for both tasks? **No.**
- What are the exact landing pads we are using, is it this? [https://www.amazon.ca/Labs-Quadcopter-imperm%C3%A9able-respectueux-l'environnement/dp/B06XQP7MHQ/ref=sr\\_1\\_6](https://www.amazon.ca/Labs-Quadcopter-imperm%C3%A9able-respectueux-l'environnement/dp/B06XQP7MHQ/ref=sr_1_6) **Will be these or something very similar. Added to document.**
- "Bonus if the Flight Plan was created using an optimization algorithm, with no manual input from reading the QR code to sending the Flight Plan email." Does this mean that reading the QR code and sending the flight plan email must be automated too, or can those tasks be done by hand? **'Done by hand' doesn't sound very much like 'Automated'.**
- Can we have multiple, separate passenger cabins on one airframe? (provided we use the same configuration for Task 2) **No – have you ever seen an airliner of any sort with multiple pax cabins?**
- We are timed from "loading to landing". Does "loading" mean when we start loading, or when we finish loading? **Oops, doc was inconsistent! Timed from start of flight window to landing.**
- How many members of the flight crew can we have loading the passengers at the same time? **Good catch – only one member of the team can load/secure, doc amended.**

## UBC 1 OCT 22

General

- What altitude(s) are we flying at? Do waypoints only have latitude and longitude, or do they also include altitude? **Max 400' per rules applies.**
- What is the nature of the obstacles (i.e. are they more 2d or 3d in the sense of how they affect our approach to land)? Is there a max height that can be specified? **Can't say.**

## Task 2

- Can we overlap routes (e.g. can we cover 2 routes at the same time if one is A -> B and another is A -> B -> C)? **No, individual routes as given must be flown.**
- Does the direction of the routes matter (forward or reverse order of listed points)? **Are the passengers at the start of the route going to be happy when you tell them they're at the end of your flight?**
- Do we have to come back to the start landing pad before the time is up? **No. Added to text.**
- Do we have to land at each and every waypoint (eg for route ABC, do we have to land the drone at all points ABC)? **How you gonna unload the mythical passengers otherwise, kick them out in mid-flight?**

## UBC 26 November 2022

- What is the margin of error for the restricted airspace around the given obstacle as defined by the waypoints? i.e., how far in/out of the obstacle airspace may the UAS be before being considered as entering restricted airspace? **See Para 44 Table 5 scoring, the UAS must stay within 50m of the centreline between waypoints, and must stay out of the restricted area as defined by the QR code. The GPS tracker which will be attached to your UAS per Para 13 has not been confirmed, but you can expect accuracy in the <5m range. You can also expect the judges will invent an assessment methodology that's fair. We'll provide confirmation of the exact tracker later.**
- Will landing pads for each waypoint on routes also have obstacles/colours that we need to identify and avoid? **Only a single landing pad, blue in colour, obstacles or other considerations per QR code.**

## TMU 30 November 2022

- The QR code after paragraph 15 has the waypoints organized by numbers ex. "Waypoint 1, Waypoint 2". The waypoints in Annex C have phonetic alphabet organization ex. \*Waypoint Alpha, Waypoint Beta". Does waypoint 1 correspond to waypoint alpha, waypoint 2 correspond to waypoint bravo, etc.? **The names in Annex C are correct and will be the same in the final map (although the waypoint locations will likely be changed in the final map, see footnote on Page X). The QR code in Para 15 has been amended. Note that the QR codes in Paras 16 and 18 of this document have also been amended to use the full waypoint names per Annex C.**
- Will the real QR code in competition use numbers or the phonetic alphabet to organize the waypoints? **The real QR codes will be per the revised version in Para 15, 16, and 18 – using the full waypoint names per the list in Annex C.**