Vertical Flight Society

2020-2021 Design-Build-Vertical Flight Competition

Request for Proposal

REV 3 dated December 1, 2020

Website: www.vtol.org/FLY

Questions: FLY@vtol.org

Summary of Revisions

Revision 1 dated Sept. 17, 2020

1. Teams will only be limited in capacity at the competition fly-off. The limit is 10 students and 2 faculty advisers.
2. A final team roster will be requested in February to clear students and faculty for entrance to the ARL fly-off location. Teams are still free to change team members throughout the year, but only students and faculty that are on the final team roster may be permitted at the competition fly-off in April. Foreign nationals are permitted, but additional information may be requested at the discretion of ARL.
3. The requirement for the team pilot to hold an FAA Part 107 Drone Certification must be met and documented in the final roster submission in February. More information on this will be distributed to selected teams.
4. A typo was found in a provided metric equivalent. Please use the 20 lbs. maximum aircraft weight. The vehicle along with any power supply and payload may never exceed 20 lbs.
5. A statement on photography at the ARL competition fly-off has been added under Section 9.

Revision 2 dated Sept. 23, 2020

1. To clarify points 1 and 2, above, teams can have as many students involved as they would like, but a maximum of 10 students will be allowed at the competition fly-off in April.
2. Transmission frequencies as defined in Section 6 were corrected to reflect the appropriate values for transmitters, telemetry, and video feed.
3. Submission window for proposals has been extended to Oct. 15, 2020. Selected teams will be notified roughly two weeks later.
4. “Overview of Technical Approach” has been added to the list of topics for the proposal submission.
5. Figure 1 has been added to show the ARL R2C2 test site at Graces Quarters with shipping containers that will be on the test field at the time of the competition.

Revision 3 dated Dec. 1 2020

1. Additional FAQs relevant to the RFP have been received and answered on the separate competition FAQ document dated Dec. 1, 2020. The FAQ document can be found on the competition website at www.vtol.org/FLY.
2. Additional guidance has been added to section 1.2 for the Preliminary Design Report.
3. In sections 1.2-3 and 3.1-2, the category titled “CAD Models” were renamed to “Design Definition” and the category titled “Report Clarity” was renamed to “Presentation and Organization.”

Executive Summary:

The Vertical Flight Society (VFS) invites student teams to participate in the 1st Annual VFS Design-Build-Vertical Flight (DBVF) Student Competition. The fly-off portion of the competition is scheduled to take place at the U.S. Army Combat Capabilities Development Command (CCDC) Army Research Laboratory (ARL) Robotics Research Collaboration Campus (R2C2) at Graces Quarters located in Middle River, Maryland, on April 16-17, 2021. This electric-powered remote-control vertical take-off and landing (VTOL) competition seeks to encourage interest in unmanned aircraft technology and small air vehicle design and fabrication.

With respect to the COVID-19 pandemic, VFS recognizes that the fly-off portion of the competition will be contingent on the state of affairs prior to April 2021. If the competition fly-off date approaches and VFS, along with input from the Army Research Lab, decides that the competition is not safe enough, then the scoring will take into account the deliverables accomplished prior to the competition fly-off.

Team eligibility rules are as follows:

- Full-time university students with at least one faculty advisor. Students may be at the undergraduate or graduate level, but they must be currently enrolled during the competition semester.
- Teams will be limited to 10 students and 2 faculty advisors at the competition fly-off. Selected teams will fill out a final team roster in February that will be used to clear students for entrance onto the fly-off location at ARL. Foreign nationals (non-US Citizens) may be permitted, but additional information will be requested by ARL from the student and faculty adviser following the February final roster submission.
- Each team member must be a current VFS Student Member ($25/year) at the time of submitting the Preliminary Design Report — find VFS membership information at vtol.org/membership.
- Each team's pilot must also hold an FAA Part 107 Drone Certification. This requirement must be proven when the final team roster is submitted in February. More information on this final team roster will be distributed to the selected teams at a later date.
- If there is more than one team per school, VFS reserves the right to limit the number of teams based on review of the initial proposals. In the event that two or more separate teams from the same university apply and must be down-selected, the teams will be given the option to combine into a single team entry.

The aircraft requirements are detailed in the section(s) below, but in general the aircraft is restricted to the unmanned aircraft systems (UAS) Group 1, which limits the maximum take-off weight (MTOW) to no more than 20 lb (9.072 kg). Aircraft size and weight will factor into the competition scoring as described in the scoring section.

Awards

Competition awards will include the following.

- Overall competition winner 1st through 3rd will be awarded trophies/plaques and the following monetary amounts:
  - **1st –$2000**
  - **2nd – $1000**

- **3rd – $500**

- Monetary prizes will also be awarded following the review and scoring of the preliminary design reports (PDR) for the 1st through 3rd best scores as follows:
  - **1st – $750**
  - **2nd – $500**
  - **3rd – $250**
- Trophies/plaques will be awarded to 1st through 3rd place of the combined technical report and presentation scoring.

1.0: Timeline for Deliverables

1. Proposal Submission Window: Sept. 1–Oct. 15, 2020
2. Preliminary Design Report: Dec. 20, 2020
3. Final Technical Report: March 7, 2021
4. Competition Dates: April 16-17, 2021
    a. Optional Practice Day: April 16, 2021
    b. Competition Day: April 17, 2021

1.1: Proposal Submission

The VFS Design-Build-Vertical Flight Competition proposal submission window will be open from Sept. 1 to Oct. 15, 2020 and should be emailed to FLY@vtol.org.

The submission is limited to 5-pages (not including the cover page) and must be written by the students and should include the following sections:

- Cover page
- Introduction
- Organization: Include any supporting faculty and other team advisors, a team roster, the team's management plan (i.e. teams leads and working groups), and a tentative project schedule.
    - At least one faculty advisor is required to attend the competition fly-off. Up to 10 team members are encouraged, but not required, to attend.
- Team Inclusivity: VFS encourages teams to recruit students from a broad range of disciplines and class-standing in order to both accomplish the tasks and bring different perspectives to the design process. Please document all majors included and the break-down of class standing.
- Overview of Technical Approach
    - Briefly summarize any initial conceptual designs that the team is considering.
- University Support and Sponsorship: Please document any secured team funding, whether it be from your university or outside sponsors. Also include any plans for further fundraising.
- Letters of Support: Please include a 1-page letter of support from each team advisor. The letters of support do not count against the 5-page limit.

Teams will be notified of the status of their application to the competition by the end of October, 2020.

1.2: Preliminary Design Report (PDR)

The PDR is limited to 10-pages and is due Sunday, Dec. 20, 2020 at 11:59 PM Eastern Standard Time (EST), which is UTC-5 and emailed to FLY@vtol.org. **Reminder team members must be members of VFS at the time of the PDR submission** - vtol.org/what-we-do/benefits-of-membership

The details of the report must include, but are not limited to:

- Team Introduction
- Design Trade Studies
    - Major design drivers should be discussed with reasoning explained for choices made
    - Specify selected components for motors, propellers/rotors, electronic speed controller (ESC), and batteries

- Design Definition
    - Computer Aided Design (3D CAD) model of the aircraft concept including relevant subsystems and key interfaces
    - Identify which parts will be procured commercially, procured custom, and designed and fabricated by the team. Can reference Design Trade Studies section if needed.
- Technical Innovations
    - What unique design considerations make your aircraft special? What special technology, manufacturing techniques, etc. have been used or are being planned?
- Fabrication Methods
    - Details the processes used for vehicle construction
    - Consideration of manufacturing methods and materials on the design process and feasibility
- Vehicle Safety Considerations and Flight-Testing Safety Considerations
    - Detail the precautions taken to ensure safe construction of the vehicle as it pertains to vehicle integrity, and safe operation of the vehicle as it pertains to ground and flight testing around people
- Gantt Chart for Project Completion
    - Build timeline including identification of long lead or critical path and high-risk items
    - Flight Test Planning

1.3: Final Technical Report (FTR)

The FTR is limited to 20-pages and is due Sunday, March 7, 2021 at 11:59 PM EST (UTC-5) and must be emailed to FLY@vtol.org. The details of this report must include, but are not limited to:

- Team Introduction
- Design Trade Studies
    - Major Design Drivers
        - What constraints drove major design decisions?
    - Specify selected components for motors, propellers/rotors, ESC, and batteries
- Design Definition
    - Include 3D views of entire aircraft. Can also include additional views of any pertinent sub-systems as desired
- Technical Innovations
    - What unique design considerations make your aircraft special? What special technology, manufacturing techniques, etc. were used?
- Vehicle Analysis
    - Calculations, computational fluid dynamics, finite element analysis, etc.
    - Document any analysis that was carried out on your vehicle
        - Performance curves, estimated hover time, maximum range, etc.
- Manufacturing completed up to this point
- Fabrication Methods
    - Details the processes used for vehicle construction of major subsystems and any special manufacturing methods
- Documentation of Testing Completed
    - Static thrust, wind tunnel testing, flight testing
- Gantt Chart for Project Completion

2.0: The Competition

The goal of the final fly-off is to prove the capability of each team's prototype based on common mission requirements for urban air mobility (UAM) aircraft. The courses, course rules and scoring have been determined to best test the performance of each aircraft at the subscale level. Competition weekend scoring will be determined by two parts, the fly-off and the team presentations, of which the fly-off will carry the most weight in final scoring. The categories of focus are:

- Range
- Agility and Speed
- Landing Accuracy
- Payload Capacity

Payloads must be the commercially available SoftGrip hand weights. These weights can be found online and range in sizes from 0.5–10 lb (227g–4.536 kg). The Maneuverability Course will use a 2 lb (0.907 kg) payload, and there will be the option to use larger payloads for the Maximum Range Course to earn additional points. The payload and attachment are described more in section 2.3.1.

2.1: Judging

A panel of judges will be appointed for the scoring of each aspect of the competition. This includes the technical reports and team presentations. The safety tests and course scoring will be carried out by the VFS organizers. The majority of points for the fly-off portion of the competition will be awarded based on quantitative metrics, thus removing the potential for bias. The safety tests will be on a pass/fail basis.

2.2: Safety Checks

A series of safety checkpoints will be required in order for teams to participate in the final fly-off. These tests are put in place to ensure a safe, reliable, properly functioning aircraft to minimize risk during the fly-off. The safety checks will involve a bench check and a hover test.

2.2.1: Bench Check

The bench check will involve each team giving the judge an explanation of how the aircraft works, safety considerations, and operating procedure in front of the aircraft prior to a thorough inspection. This will provide an opportunity for judges to ensure safety of the aircraft, provide an opportunity for any required modifications before moving on, or disqualify an unsafe aircraft. If an aircraft does not meet all of the safety requirements, the team can apply modifications and ask for another bench check. If a team still does not meet the safety requirements, the team will only be allowed to perform the presentation, not the flight missions. If a team plans to attempt the autonomous bonus challenge (as described in Section 2.3.3), they must prove the remote-kill functionality of the vehicle's power system while operating in autonomy mode during this check. The judges will be looking for the following:

- The remote controller must demonstrate a lost-link power-cut functionality
- Proper operation of the shunt plug and verification of the correct location
- Battery type verification
- Weighing of the aircraft
- Measurement of the aircraft's maximum dimension

- Checking for suitable integrity and rigidity of the aircraft
- Demonstrating remote-kill functionality in autonomy mode for any team that elects to attempt the autonomous bonus challenge

2.2.2: Hover Test

The hover test will require each team to power on their aircraft, hover at approximately 5–6 ft (1.5-1.8 m), display each directional control input, and make a controlled landing. The aircraft must remain aloft under pilot control for at least 60 seconds before being set back down.

2.3: The Fly-Off

Teams that successfully complete the safety checks will be permitted to participate in the fly-off. This will consist of two courses — the maneuverability course to test a representative UAM mission, and the maximum range course to test the aircraft performance. The designated test site, located at ARL R2C2 GQ is shown below in Figure 1. It depicts a 600' diameter gravel pad and the location of multiple CONEX shipping containers that comprise the Military Operations in Urban Terrain (MOUT) environment. The MOUT environment will be present within the test area and must be accounted for during course runs. A majority of the MOUT building structures are made up of 40' x 9.5' x 8' (LxHxW) shipping containers. Only the tower is constructed of 20' x 9.5' x 8' (LxHxW) shipping containers. Consequently, single story structures are approximately 10' high, two-story structures are approximately 20' high, and so-on. The tower has an approximate ground footprint of 32' x 20' (LxW) and a top elevation of approximately 40' above the field.

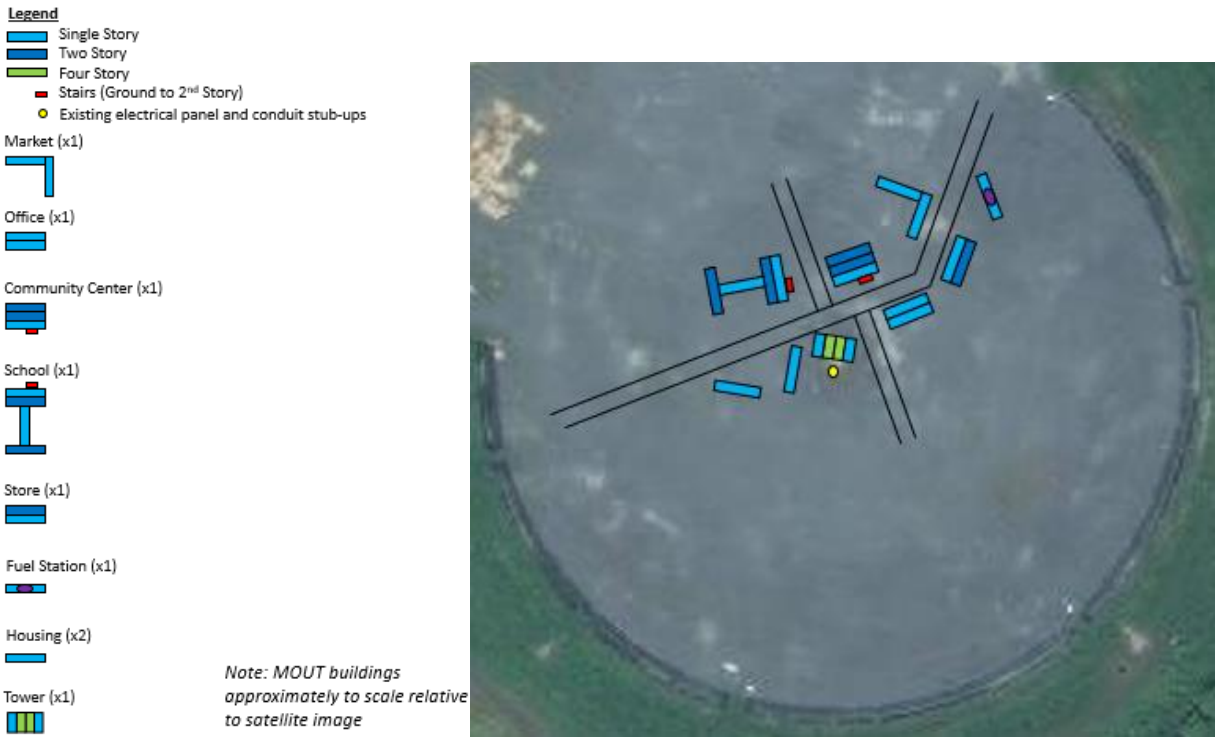

Figure 1: R2C2 Pad Layout with Shipping Containers

2.3.1: Maneuverability Course

This course tests the vehicle's capability to maneuver and complete a simulated UAM mission. The vehicle will be loaded with a 2 lb SoftGrip weight that is provided by the team and is installed before powering on the vehicle, and then must fly the course. The SoftGrip weight and vehicle will be weighed prior to the flight. The combined weight must remain within the UAS Group 1 weight class (i.e. no more than 20 lb / 9.072 kg). The SoftGrip weight is shown in Figure 2, below, and can be found online (e.g. Amazon.com or Walmart.com). The payload must be secured to the aircraft, either internally or externally with a safety wire running through the grommet that connects to the airframe. The course directions are specified below:

- Power on the aircraft (with the 2 lb SoftGrip weight already installed)
- Pilot and navigator enter pilot and navigator zone
- Lift off vertically to a height of approximately 5-6 ft (cleared by the course judge)
- Fly around the course as shown in Figure 3
    - Come to a full stop on top of each elevated pad (dimensions 3'H x 8'L x 4'W)
    - Members from your team will be stationed closer to each landing pad (just outside of the chain-link safety fence depicted by the circle in Figure 3) and will help the pilot navigate by giving instructions to the team navigator via walkie talkies (or cell-phones) supplied by your team
    - A range official will be stationed at each pad to give a "thumbs-up" for take-off
- After departing the third pad, the aircraft must enter the VTOL zone above 5 ft (1.5 m), and descend vertically to a controlled landing
- Time stops when vehicle is safely on the ground
- Power down the aircraft

Figure 2: SoftGrip 2 lb. Payload (1.0" H x 7.0" L x 2.0" W)

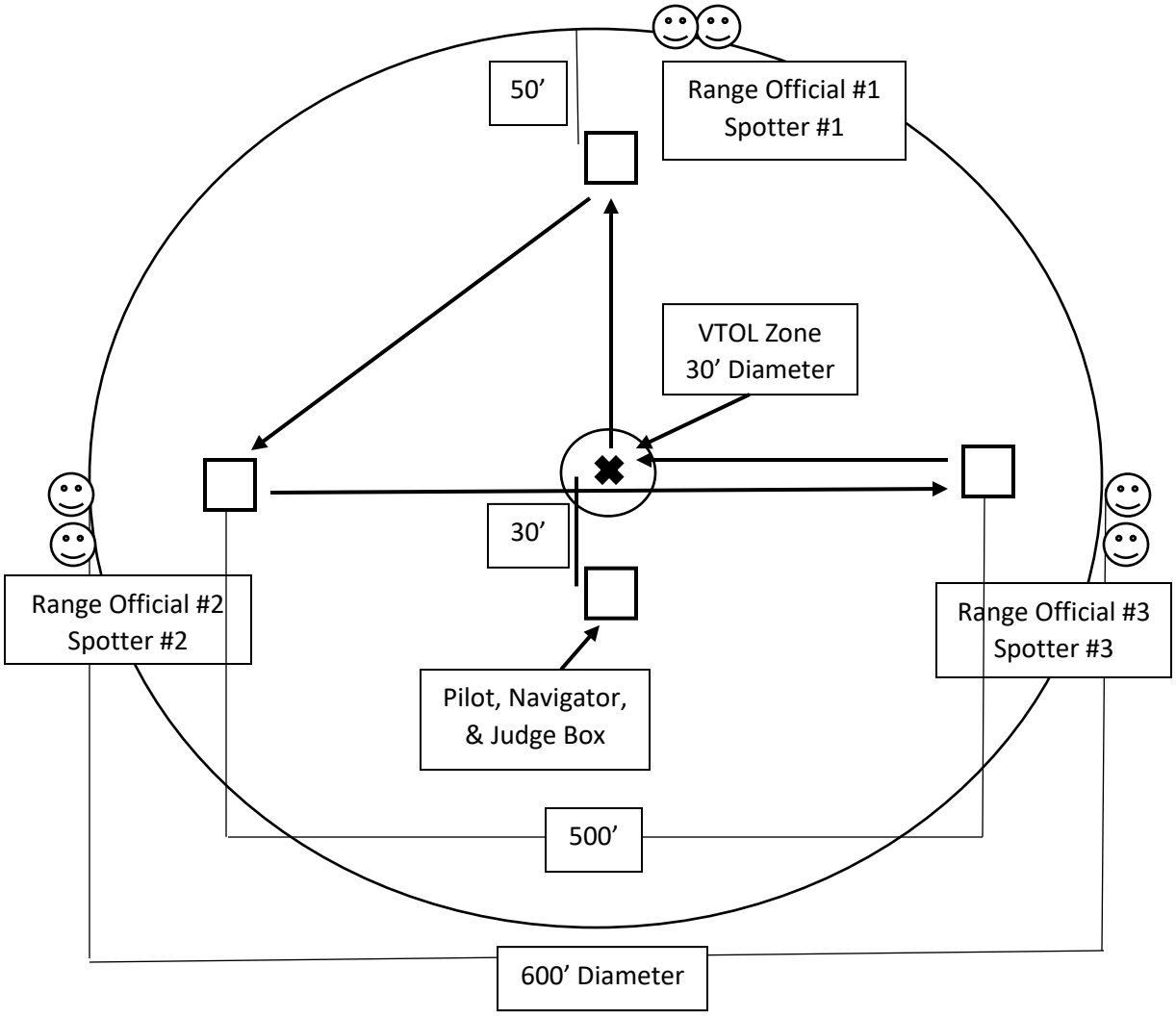

Figure 3: Maneuverability Course

2.3.2: Maximum Range Course

The maximum range course is meant to test the aircraft’s range and to some extent the vehicle’s endurance. A known challenge for electric aircraft is the low energy density in current battery technology. This means that to meet functional ranges, the aircraft must operate as efficiently as possible during cruise flight to achieve longer ranges and be marketable for mission success. The course starts and stops at the respective VTOL zone for the left or right track (see Figure 4).

Course officials will be seated along the plane perpendicular to the flight path at the two extremes of the course. They will raise a flag after the aircraft crosses the plane of their location, signaling that the pilot can turn around and continue back in the other direction. The pilot must bring the aircraft to a complete landing within the VTOL zone on each lap, and then can immediately take-off again after touching down. The number of complete laps, which are defined as one complete circuit from the VTOL zone to each end of the flight line and back to the VTOL zone, will be recorded for course scoring. Points will be awarded based on the total number of complete laps; no partial credit will be given for uncompleted laps. A maximum time limit of 10 minutes will be imposed on the course. The minimum payload for this mission is again the 2 lb payload from

Figure 2. Teams do, however, have the opportunity to add additional payload as they see fit. The payload fraction will be scored as shown in Table 6. The course directions are specified below:

- Power on the aircraft
- Pilot and navigator enter pilot and navigator zone
- Lift off vertically to a height of approximately 5-6 ft (cleared by the course judge)
- Fly around the course as shown in Figure 4
    - Must wait for range official to raise flag before beginning 180-degree turn
    - Aircraft must land in the VTOL zone on each lap
    - Up to two teams may be flying simultaneously in separate left and right tracks
- When the aircraft is either low on power, or has surpassed the 10-minute limit, it must enter the VTOL zone above 5 ft, and descend vertically to a controlled landing
- The number of complete laps will be recorded for scoring
- Power down the aircraft
- Note: Failure to land the aircraft under control in the VTOL zone (i.e. running out of battery mid-flight) will result in a two-lap penalty

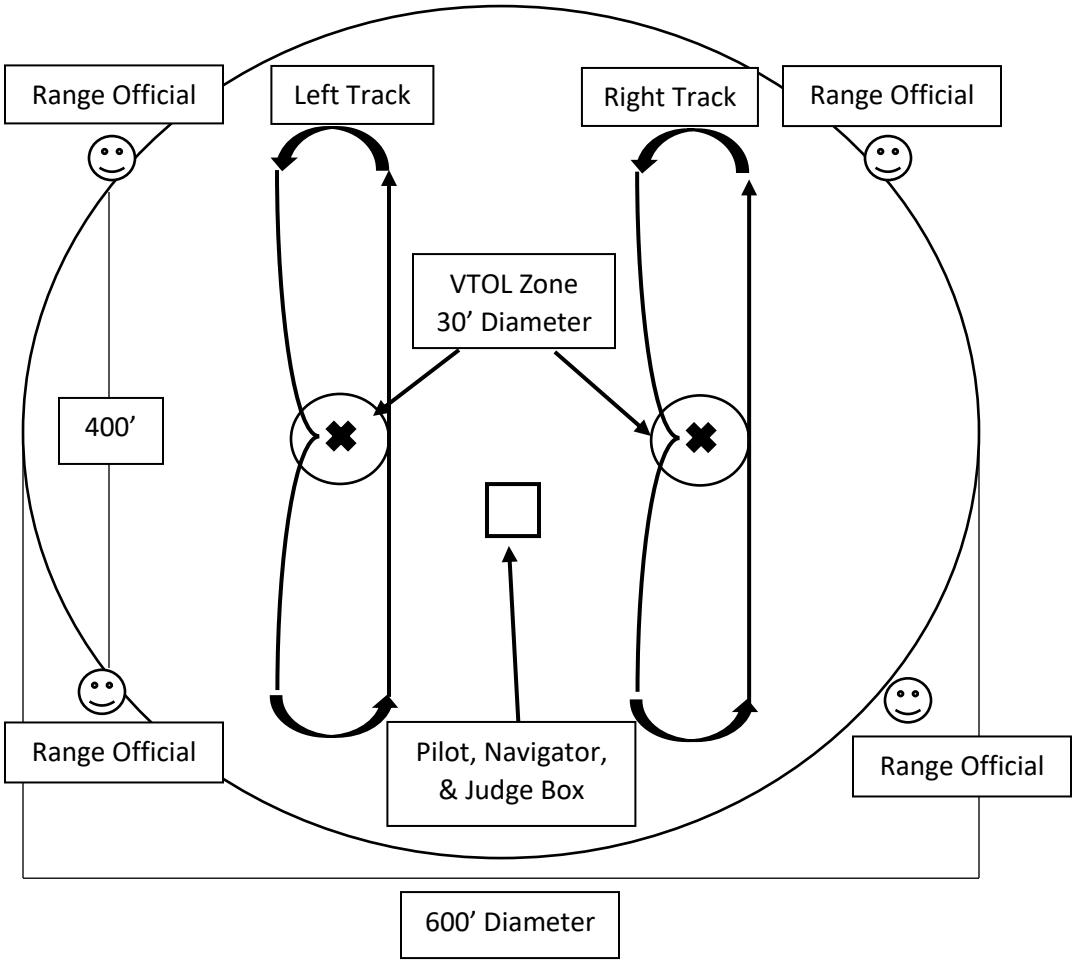

Figure 4: Maximum Range Course

2.3.3: Autonomous Bonus Challenge

A bonus challenge will be available for teams to attempt at their discretion. The challenge will require a series of waypoints to be programmed via GPS coordinates into the aircraft's control system that the vehicle will then autonomously fly. The course is shown below in Figure 5, and the scoring is shown in Table 7. The waypoints are numbered 1 through 4 as seen in Figure 5. The precise GPS coordinates will be supplied at a later date. If a team elects to participate in the bonus challenge, they will be required to prove the remote-kill functionality of the vehicle's power system while operating in autonomy mode during the bench check. A "how-to" guide that is specific to autonomy is also being published on the DBVF webpage with recommended equipment and helpful tips (see Section 8 of this document). The course directions are specified below:

- Power on the aircraft
- Pilot enters pilot zone and commands a start of the vehicle's autonomous flight
- Aircraft must climb vertically to a height of approximately 5-6 ft above the ground, and maintain that position for at least 10 seconds
- Fly around the course as shown in Figure 5
    - Land and take-off in the general location of each numbered point
- After departing the fourth way-point, the aircraft must enter the VTOL zone above 5 ft., and descend vertically to a controlled landing
- Power down the aircraft

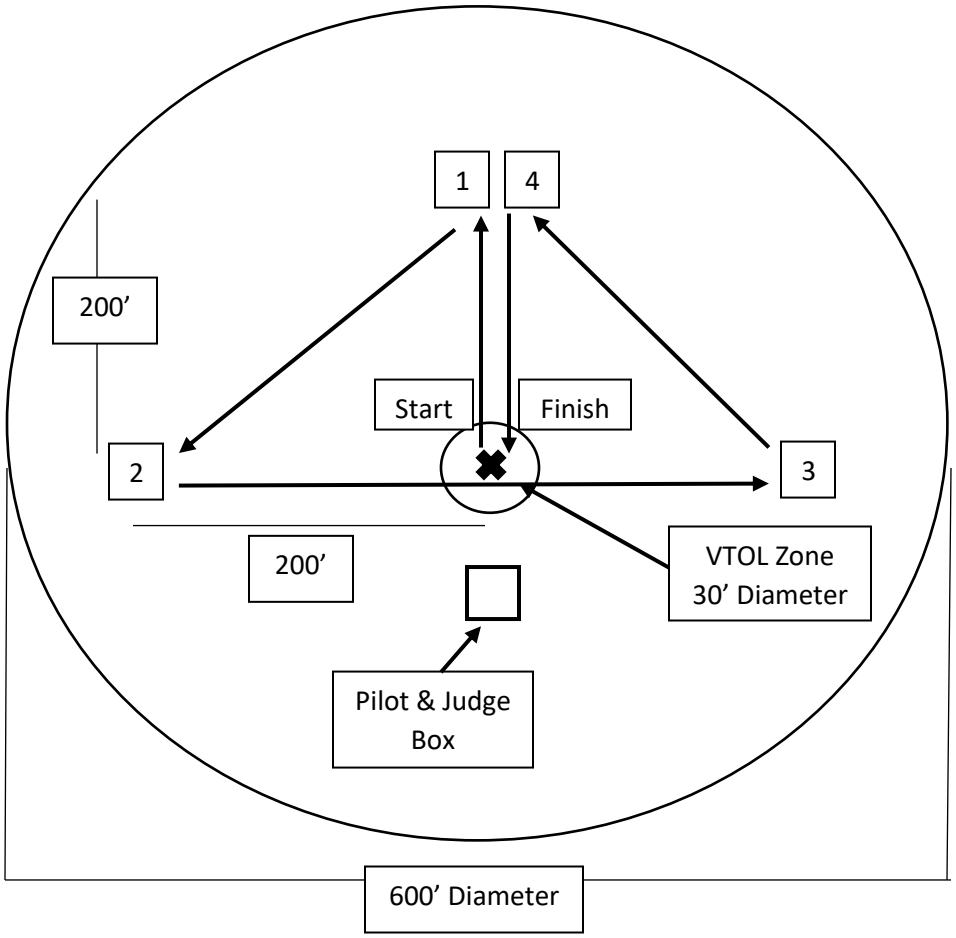

Figure 5: Bonus Challenge Course

2.4: Presentations

Final presentations given by each team will contain an overview of the content from the Final Technical Report. This will involve a deep look into the design drivers based on the initial trade studies, operating procedures, manufacturing methods, and overall project expenses. This material may be presented by no less than 2 people, and no more than 6 people. Each presenter must be a student member of the team. The presentations will be open to all competition participants, with a private Q&A session with the judges following each presentation.

The team should bring their presentation on a flash drive. The maximum time allowed for the presentation is 10 minutes. There is a 5-minute question period from the judges after each presentation.

The presentation should be in English and should include, but is not limited to:

- Team member introductions
- Trade studies and analysis leading to the selection of the conceptual design used
    - Plots, videos, or images of any quantitative methods including theoretical design and performance calculations, finite element analysis (FEA), or computational fluid dynamics (CFD) simulations completed
- Final design and fabrication
- Ground and flight testing
    - Videos or images of testing are encouraged

The presentations are graded according to the rubric in section 3.3.

3.0: Scoring

Scoring considerations will include the summation of the following:

- Preliminary Design Report (PDR); 100 Points Possible
    - Scoring carried out by the judges in accordance with the rubric in section 3.1 and will be returned to teams by Feb. 1, 2021
- Final Technical Report (FTR); 100 Points Possible
    - Scoring carried out by the judges in accordance with the rubric in section 3.2 and will be returned to teams by April 15, 2021
- Team Presentations; 100 Points Possible
    - Scoring carried out by the judges in accordance with the rubric in section 3.3
- Aircraft Mission Performance; 300 Points Possible + 25 Points Possible for Bonus Challenge
    - Scoring carried out by the VFS organizers in accordance with the rubrics in section 3.4

3.1: Preliminary Design Report (PDR) Scoring

Table 1. PDR Grading Rubric (100 possible points)

Category	Description	Scoring (X/100)
Design Trade Studies	Show which constraints drove major design decisions and what was eventually selected.	X/15 points
Technical Innovations	Detail any unique design considerations or technologies used by the team.	X/15 points
Design Definition	Include a computer aided design package with isometric views of the vehicle and detailed drawings (at least top, side, front views).	X/30 points
Fabrication Methods	Describe the various fabrication methods and approaches used thus far in creating prototype and flight vehicles.	X/15 points
Gannt Chart	Show your planned path to completing the design and build portions in time for the competition fly-off.	X/5 points
Presentation and Organization	Report should be easy to follow with good flow between sections, proper spelling, punctuation, etc.	X/20 points

Monetary prizes will also be awarded following the review and scoring of the preliminary design reports for the 1st through 3rd best scores as follows:

- **1st –$750**
- **2nd – $500**
- **3rd – $250**

3.2: Final Technical Report (FTR) Scoring

Table 2. FTR Grading Rubric (100 possible points)		
Category	Description	Scoring (X/100)
Design Trade Studies	Show which constraints drove major design decisions and what was eventually selected.	X/5 points
Technical Innovations	Detail any unique design considerations or technologies used by the team.	X/15 points
Design Definition	Include a computer aided design package with isometric views of the vehicle and detailed drawings (at least top, side, front views).	X/30 points
Fabrication Methods	Describe the various fabrication methods and approaches used thus far in creating prototype and flight vehicles.	X/15 points
Flight Test Results	Document the flight testing carried out thus far and any design changes or modifications that arose from them.	X/15 points
Presentation and Organization	Report should be easy to follow with good flow between sections, proper spelling, punctuation, etc.	X/20 points

3.3: Presentation Scoring

Table 3. Team Presentations Grading Rubric (100 possible points)		
Category	Description	Scoring (X/100)
Originality	Major subassemblies not off-the-shelf (other than powertrain and drive systems), involves innovative engineering to solve specific problems in an optimal way, solved challenging innovation problems, unique capabilities.	X/15 points
Presentation	Clear, easy to follow and understand, good flow guiding the audience, good graphics, good speaking presence, get points across.	X/15 points
Engineering	Judgement, analysis, design process, validation and testing process, good drawings and renderings.	X/30 points
Publicity	Good renderings showing mission utility, clear performance metrics making the given vehicle configuration the clear choice.	X/15 points
Teamwork	Inter-disciplinary teams optimizing across boundaries, leadership.	X/15 points
Public relations	Clear, concise, accurate answers to judge questions.	X/10 points

3.4: Aircraft Mission Performance Scoring

- Safety Checks (Pass/Fail)
    - Bench Check Completion
    - Hover Test Completion

3.4.1: Maneuverability Course Scoring

Points awarded for the maneuverability course will be broken down into interval achievements towards mission completion. The scoring breakdown consists of:

1. The aircraft rising vertically out of the VTOL zone (Pass/Fail)
2. Properly maneuvering around the course as described in Section 2.3.1 (Pass/Fail)
3. Controlled vertical landing inside of the designated VTOL zone (Pass/Fail)
4. Course time score (Points awarded as shown in Table 4)

Table 4. Maneuverability Course Scoring

Maneuverability Course Score (150 possible points); N = Total Number of Teams	
n^{th} Place (n = 1 for team with fastest time)	150 * ((N + 2) – n) / (N + 1)

3.4.2: Maximum Range Course Scoring

Points awarded for the maximum range course will be broken down into interval achievements towards mission completion. The scoring breakdown consists of:

1. The aircraft rising vertically out of the VTOL zone (Pass/Fail)
2. Properly maneuvering around the course as described in Section 2.3.2 (Pass/Fail)
3. Controlled vertical landing inside of the designated VTOL zone (Pass/Fail)
4. Course lap score (Points awarded as shown in Table 5)
5. Course payload fraction score (Points awarded as shown in Table 6)
    a. Payload fraction defined as (payload weight)/(aircraft weight without payload)

Table 5. Maximum Range Course Lap Scoring

Maximum Range Course Score (100 possible points); N = Total Number of Teams	
n^{th} Place (n = 1 for team with most laps)	100 * ((N + 2) – n) / (N + 1)

Table 6. Maximum Range Course Payload Fraction Scoring

Maximum Range Course Score (50 possible points); N = Total Number of Teams	
n^{th} Place (n = 1 for highest payload fraction)	50 * ((N + 2) – n) / (N + 1)

3.4.3: Bonus Challenge Scoring

Each team to successfully complete the bonus challenge will be awarded full points.

Table 7: Bonus Challenge Scoring

Maximum Range Course Score (25 possible points)	
Successfully Completed Course	25

4.0: Aircraft Design Restrictions and Requirements

1. Maximum Weight: Aircraft maximum take-off weight must be no more than 20 lb (UAS Group 1). This weight limit includes the 2 lb payload used in the maneuverability task. For example, an 18 lb aircraft would fly at the maximum allowable 20 lb when carrying the payload.

2. Power System: The aircraft must be electric (electric power source and electric motors).

3. Propulsion System Batteries: For the purpose of competition safety, unaltered commercially available LiPo batteries of six cells or less (6S or less) may be used. The team needs to select the proper capacity for their vehicle. Each battery is limited to 100 W-hr. Each battery used in the propulsion system must have a fuse directly in-line with its positive terminal that has a maximum continuous current rating equal to or less than the maximum continuous discharge rating of the battery (i.e. A-hr x Coulomb rating.) Multiple batteries following the above requirements can be combined in parallel for the propulsion system. Each battery must be identical and have its own fuse on its positive lead. All LiPo batteries at the competition must be charged and stored inside a LiPo charging bag. They are only allowed out while being actively used with the aircraft.

4. Aircraft must have a separate power source for the flight control system. A LiPo battery that also follows the specifications under point 3 must be used.

5. Minimum Payload: The aircraft must be capable of carrying a minimum payload of 2 lb (0.907 kg).

6. Maximum Dimension: 6.5 ft (1981 mm), including the propellers/rotors in their most outstretched positions.

7. VTOL: The aircraft must take-off and land vertically.

8. Kill Switch: The remote controller must demonstrate a lost-link power-cut functionality.

9. Shunt Plug: The purpose of the shunt plug is to provide an easy and quick way to manually disarm the aircraft. A shunt plug must be wired between the leads of the battery system and the ESC for manual disarming and arming of the aircraft's power system. The shunt plug must be red. The shunt plug must be removable with only one hand and without any tool. The tip of the shunt plug, where someone would grab it, must be located outside the dotted line as shown in Figure 6, below. The dotted line, if extended both into and out of the page, creates a box around the aircraft that extends outward from the rotors by 6 inches in all directions. Hint: Placing the shunt plug aft of the vehicle may be the best solution for aerodynamic and stability purposes in forward flight.

10. Transmission Frequencies: Must follow FCC Part 15 rules for transmission frequencies and International Telecommunication Union (ITU) Region 2 frequency allocations. This means that telemetry, video, and control transmitters must operate on 902-928 MHz, ~2.4 GHz, or ~5.8 Ghz.

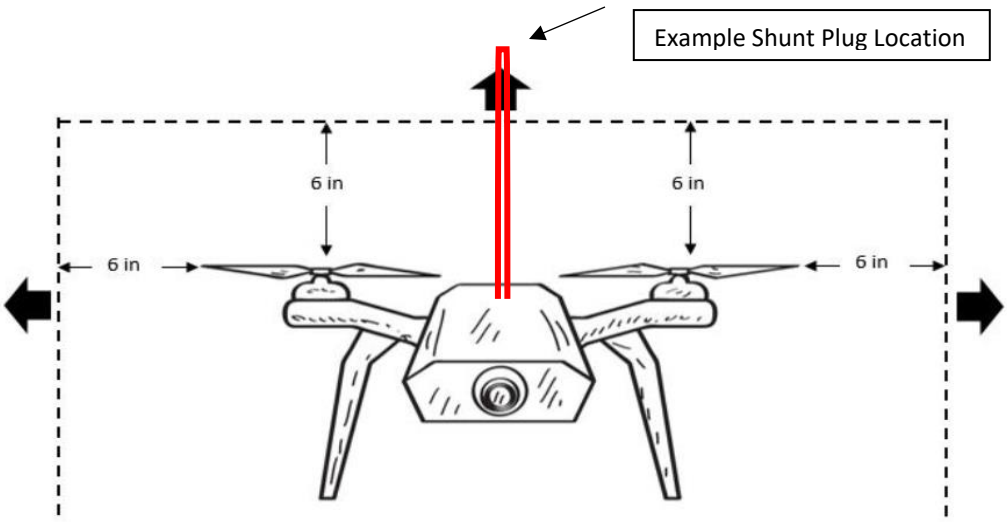

Figure 6. Allowable Location for Propulsion System Shunt Plug

5.0: Prizes

Competition awards will include 1st through 3rd place overall: trophies and following award amounts:

- **1st –$2000**
- **2nd – $1000**
- **3rd – $500**

Trophies will be awarded to 1st through 3rd place of the combined technical report and presentation scoring.

Monetary prizes will also be awarded following the review and scoring of the preliminary design reports for the 1st through 3rd best scores as follows:

- **1st –$750**
- **2nd – $500**
- **3rd – $250**

Additionally, awards may also be given for various "judges choice" categories to be announced at the end of the competition.

6.0 Expenses and Support

VFS will not provide any travel or accommodation support for competing teams, or pay or reimburse any other expenses. Teams are encouraged to search for company sponsors for travel, accommodation, equipment, etc., and are free to display their sponsor's logos on their team shirts and on their aircraft.

7.0 Pilot Requirements

Teams pilots must hold an FAA Part 107 Drone Certification. This certification is required by the time that participating teams submit their final team roster in February. It is not required for the initial proposal.

8.0 Autonomy

This RFP has an Appendix A, "Achieving Autonomy: An Overview," which is posted on the competition webpage: **www.vtol.org/FLY**. This appendix is meant to serve as a helpful guide to teams that choose to attempt the autonomous bonus challenge.

9.0 Disclaimers

Safety is paramount in this competition. The rules are designed specifically to minimize risk to all participants and to comply with US government restrictions at the test site. VFS assumes no responsibility for any actions caused by any participants of the DBVF Competition.

These rules are subject to change. Any updates will be published at the end of a revised document and it will be located at **www.vtol.org/FLY**. All registered competitors will be notified of any clarifications on the rules or necessary adjustments. Frequently asked questions (FAQ) will be posted with responses to questions sent to the competition email address, **FLY@vtol.org**.

Participation in the competition explicitly gives permission to VFS to use text, graphics, photographs and video documentation of the competition and all competitors for educational and promotional purposes only. The competition event, participating schools, and team names may be the subject of VFS *Vertiflite* magazine articles, web page postings, social media or other forms of publicity.

Taking photographs of the competition in certain areas at the ARL fly-off location will be permitted, however, ARL reserves the right to review and delete any pictures that are taken on a team or personal device at the discretion of the ARL organizers and employees.

10.0 Final Word

VFS wishes you all the success possible in undertaking this inaugural VFS Design-Build-Vertical Flight Competition and we look forward to meeting you at the fly-off competition in April. Good luck!