Vertical Flight Society

2023-2024 Design-Build-Vertical Flight Competition

Request for Proposal

Rev 2.2 Oct. 10, 2023

[See page 19 for list of Revisions]

Website: www.vtol.org/FLY

Questions: FLY@hq. vtol.org

Executive Summary:

The Vertical Flight Society (VFS) invites student teams to participate in the 4th Annual VFS Design-Build-Vertical Flight (DBVF) Student Competition. The fly-off portion of the competition will take place at Survice Engineering Applied Technology Operation (ATO) facility located at Harford Airport (3538 Aldino Rd., Hangar 6) in Churchville, MD from **April 10-12, 2024**.

This remote-controlled electric vertical takeoff and landing (eVTOL) competition seeks to encourage interest in unmanned aircraft technology and small air vehicle design and fabrication.

Team eligibility rules are as follows:

- All team participants:
  - Must be full-time university students: Students may be at the undergraduate or graduate level, but they must be currently enrolled during the competition semester(s).
  - At least one (1) Team Captain must be identified: this team member will by the POC for all VFS correspondence related to the competition.
  - One (1) faculty advisor must be named.
  - The student team captain(s), including faculty advisor(s), must be a current member of VFS (student membership is US$25/year) at the time of submitting the Letter of Intent. Find VFS membership information at vtol.org/membership.
- Teams can have any number of student participants working the design, development etc.
- For the fly-off portion of the competition:
  - **Teams are restricted to no more than five (5) participants, including students and faculty members.**
  - The team members attending the competition fly-off should attend the entire duration of the fly-off (three days).
  - These strict rules are set by available space at the competition host site to ensure safe support of the competition and teams. *Note: VFS and the competition host reserves the right to reduce or increase the maximum number of teams or team members allowed at the fly-off.*
- Teams can also adjust their team rosters as appropriate throughout the year: please notify VFS of any changes to the main team roster.
- Before the fly-off portion, teams will submit a list of students and faculty advisors to VFS following these guidelines:
  - A maximum of five (5) total team members, including faculty.
  - Attendance of at least one (1) Faculty Advisor at the fly-off is recommended but not mandatory.
  - Teams will fill out their team roster for the competition and submit to VFS by **March 15, 2024**.
  - Foreign national (non-US Citizen) team members are permitted to attend the fly-off, but additional information may be required from the competition host.
- Only teams that have submitted their Final Technical Reports will be allowed to compete in the fly-off.
- Each team's pilot must also hold an FAA Part 107 Drone Certification *or equivalent certifying authority for non-US based teams*, e.g. European A2 Drone Flying License. The name of the pilot(s) must be identified in the attendee list.
- 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~~ letters of intent. If 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 that meets all RFP requirements.

- Team Withdrawal: if a team needs to withdraw from the competition VFS must be notified in writing as soon as possible and **no later than March 15, 2024**. *Withdrawing from the competition after this date or not attending the fly-off may result in penalties, including your university being barred from competing the following year.*

***The aircraft requirements are detailed in the section(s) below but note that the aircraft is restricted to UAS Group 1, notably a maximum take-off weight (MTOW) of no more than 20 lbs (9.07 kg). The vehicle along with any power supply and payload may never exceed 20 lbs*. Aircraft weight will factor into the competition scoring as described in the scoring section.**

Awards

Competition awards will include the following.

- Overall competition winners will be awarded a trophy (1st place), plaque (2nd place) and certificates (3rd place, and other award categories) and the following monetary amounts:
  - **1st Place Overall: $2250**
  - **2nd Place Overall: $1125**
  - **3rd Place Overall: $650**
  - **Top Score Final Technical Report: $500**
  - **Top Score Fly-off: $500**

1.0: Timeline for Deliverables

- Letter of Intent to Compete: **NLT Oct. 9, 2023**
- Final Technical Report: **March 4, 2024**
- Team Fly-off Participant List: **March 15, 2024**
  - Must include pilot's proof of *FAA Part 107 Drone Certification or equivalent certifying authority for non-US based teams.*
- Competition Fly-off Dates: **April 10-12, 2024**
  - Final presentations will also be conducted during the fly-off competition.

1.1: Letter of Intent (LOI) to Submit

The VFS Design-Build-Vertical Flight Competition proposal submission window will be open until Oct. 9, 2023; LOIs should be emailed to FLY@HQ.vtol.org.

The LOI submission is limited to 4-pages (including the cover page but excluding the Letter of Support) and must be written by the students. The LOI should include the following sections:

- Cover page including university and team name
- Team Introduction
- Organization
  - Team roster to include name, email address and class standing.
  - Teams can have any number of student participants working on the different phases of the competition.
  - At least one (1) team lead/captain — and no more than two (2) co-leads/co-captains — must be identified. The team captain(s) will be the main contact for all communications related to the competition.

    - Tentative project schedule.
- Overview of Technical Approach
    - Briefly summarize any initial conceptual designs the team is considering.
- Letters of Support: Please include one (1) letter of support from a Faculty Advisor — letters of support do not count against the 4-page limit.
    - Include any secured or planned team funding, either through the university or outside sponsors.

Letters of intent are reviewed for completeness only.

1.2: Final Technical Report (FTR)

The FTR is limited to 15 pages and is due March 4, 2024 by 11:59 PM EST (UTC-4) and emailed to FLY@HQ.vtol.org.

All information should be within the 15-page limit, including any referenced materials. The details of this report must include (but are not limited to) the list below. The order of information is meant to be a template for how the document is structured — it's preferred that it be in this order for judging criteria; however, it is not mandatory. The scoring criteria for the FTR is in Section 3.1. Teams are strongly encouraged to create the document with the scoring criteria as a checklist for maximum possible points.

- Executive Summary
- Management Summary
- Design Trade Studies
- Technical Innovations
- Design Definition
- Drawing Package
- Fabrication Methods
- Test Plan
- Flight Test Results

2.0: The Competition

The goal of the final fly-off is to prove the capability of each team's unmanned aircraft system (UAS) as a subscale demonstrator for an advanced air mobility (AAM) aircraft. The courses, course rules and scoring have been determined to test the performance of each aircraft at the subscale level. Final competition scoring will be determined by three parts: the technical report, a presentation, and the fly-off, of which the fly-off will carry the most weight in final scoring. The fly-off categories of focus are:

- Range
- Agility and Speed
- Payload Capacity: the payload will be part of the flight performance course (refer to Section 2.3.1)
    - The payload quantity cannot be modified mid-attempt. Whatever weight the team chooses must be used for the entire course attempt. Multiple weights can be used to add up to a combined payload weight.
    - Payloads must be the commercially available SoftGrip hand weights. These weights can be found online and range in sizes from 0.5–10 lb (0.2–4.5 kg). The hand weights cannot be modified and will be inspected and weighed at the competition. Teams must supply their own SoftGrip payloads.

- *The payload can be secured internally, or externally with a safety wire running through the metal grommet securing it to the airframe. The securing of the payload must pass the safety inspection at the competition.*
- The payload and attachment are described more in section 2.3.1.

Components, other than batteries, cannot be changed out on the aircraft between phases of the competition. Any component that is used on the aircraft for a single course or aspect of the competition must be on the aircraft for all parts of the competition. Components may be switched 1-for-1 to replace a failed component between flight attempts. One exception to this rule is the payload. **The flight performance course has a minimum payload requirement of 2 lb, but there is no payload requirement for the autonomous flight course attempt. Teams may choose to leave some payload in the aircraft for the autonomous course at their discretion to satisfy stability and control needs of their aircraft.**

Varying battery packs will be allowed between course attempts, including a 1-for-1 swap or a change in battery capacity that still follows the RFP rules. Any change in battery capacity must not result in the total vehicle weight exceeding the 20 lb limit.

The aircraft configuration is also not allowed to be manually changed for the different challenges. Mechanical systems that actuate components mid-attempt, however, will be allowed. Each team's pilot will be required to demonstrate controlled operation of any such mechanical systems during the pilot-in-command certification portion of the safety checks. For example, retractable gear, tilting rotors, or a tilting wing would be allowed.

2.1: Judging

A panel of judges will be appointed for the scoring of each aspect of the competition.

The course scoring will be carried out by the competition host, VFS organizers, and other applicable judges. Points for the fly-off portion of the competition will be awarded based on quantitative metrics, thus removing the potential for bias. If there are safety tests required by VFS and the host, they will be on a pass/fail basis.

2.2: Safety Checks

A series of pilot and vehicle safety checks are required for teams to participate in the final fly-off. Teams can anticipate safety checks like those outlined in Sections 2.2.1 and 2.2.2. These checks are put in place to ensure a safe, reliable, properly functioning aircraft to minimize risk during fly-off.

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 procedures in front of the aircraft, prior to a thorough inspection. This will provide an opportunity for judges to ensure the safety of the aircraft, provide an opportunity for any required modifications before moving on, or disqualify an aircraft deemed unsafe or non-compliant.

If an aircraft does not meet all the safety requirements, the team can apply modifications and ask for an additional bench check. If a team still does not meet the safety requirements, the team will not be permitted to fly. For the autonomous mission (as described in Section 2.3.2), the team 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 plugs 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

2.2.2: Flight Test Check

The host will run a pilot-in-command certification procedure to certify each team's pilot for operations at the host's facility. The pilot certification checklist consists of a straightforward demonstration of basic remote piloting skills and safety. The safety check is not meant to test a pilot's skill, but rather the general ability of the pilot to control their aircraft in routine flight. Team pilots may also be required, as part of this check, to demonstrate safe and controlled operation of any mechanical systems used to actuate vehicle components mid-flight, as mentioned in Section 2.0.

The flight test check will require each team to power their aircraft, hover at a specified height, 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. VFS and the competition host reserve the right to run the pilots through additional checks or tasks during the flight test check in addition to the above.

2.3: The Fly-Off

- Team pilots must have proof of their *FAA Part 107 Drone Certification (US based teams) or equivalent certifying authority (non-US based teams)* to compete. Refer to Section 7.0 Pilot Requirements
    - **FPV piloting is permitted in this year's competition.**
- Teams that successfully complete the safety checks will be permitted to participate in the fly-off. This will consist of two courses — the flight performance course to test aircraft performance and the autonomy course to test the aircraft's autonomous flight capability.
- Teams will have a pre-determined time allotted to complete each course attempt. A rotation type flight lineup will be used to schedule teams and track who is currently on the flight line, teams 'on-deck' in the ready tent situated alongside the flight line, and teams 'in the hole'. A team's time allotment begins once the range official clears them to exit the on-deck ready tent and enter the flight line.
- The event host will make the final go-no go call for inclement weather. Teams may elect to pass on their flight opportunity if they deem the weather to be too adverse for operation of their aircraft. The next team in the flight line would then move forward in the rotation. Time pending, a team that gave up its flight slot may have another opportunity later to fly their aircraft.
- A power station will be available both on the flight course and back in the team working locations for laptops, ground stations, and other powered equipment. The charging of LiPo batteries will happen at a separate location as described in Section 4.3.

Figure 1: SURVICE Flight Area (COA)

2.3.1: Flight Performance Course

This course tests the vehicle's performance. A known challenge for electric aircraft is the low specific density in current battery technology. This means that to meet functional ranges, the aircraft must operate as efficiently as possible during cruise flights to achieve longer ranges and be marketable for mission success.

- The vehicle will be loaded with a minimum of a 2 lb SoftGrip weight that is provided by the team and is installed before powering on the vehicle, see Figure 2.
- Teams can use a heavier payload as they see fit, subject to the above restrictions and those in Section 2.0.
- The payload fraction will be scored as shown in Table 5.
- The vehicle with any SoftGrip payload will be weighed prior to the flight. The combined weight must be less than 20 lbs.
- The SoftGrip weights can be found and purchased 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 chosen payload already installed)
    - The pilot will immediately activate the remote-kill function if either the pilot or the head range official deems it necessary.
- Lift off vertically from the VTOL landing zone (LZ)
    - There is only one take-off and landing zone, and it will be within easy visual line of sight of the pilot. The landing zone will be in front of the pilot, with appropriate spacing for safety. The LZ

will be marked on the ground. The LZ will be 30' in diameter. For the autonomous course attempt, the team should plan to program in waypoints prior to the course attempt.

- Fly the course as shown in Figure 3
  - A navigator standing next to the pilot could be equipped with a pair of binoculars or similar, to help the pilot see the flag signaler if needed.
  - A range official will be stationed near each end of the course to waive a flag signaling the pilot can turn around and proceed along the course in the opposite direction
    - Range officials will be in communication with the head range official via walkie-talkie and can communicate to the pilot through the head range official if the vehicle did not properly pass the required plane.
  - Within the landing zone, which is encountered at the start and finish of each lap, the aircraft must land vertically and take-off vertically. The aircraft's rotors may remain spinning during the touchdown, but the aircraft must be in contact with the ground and not translating for a satisfactory touchdown. Rolling touch and go is not permitted.
    - A VTOL touch and go is required. **Only once the head range official verbally certifies a complete touchdown can the pilot take-off and proceed with the next lap**. There is no minimum touchdown time requirement.
- The number of completed laps will be recorded for the lap score portion; no partial credit will be given for partially completed laps.
- A maximum time limit of 10 minutes will be imposed on the course.
- When the aircraft is either low on power, or has surpassed the 10-minute course limit, it must enter the start/end VTOL zone, and descend vertically to a controlled landing
  - Each pilot must make the 'safe-pilot' determination as to when they must return to the start/end VTOL zone.
  - There is no penalty for not making it back to the VTOL zone, but teams should be careful to safely land the aircraft at the end of each flight.
- Power down the aircraft

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

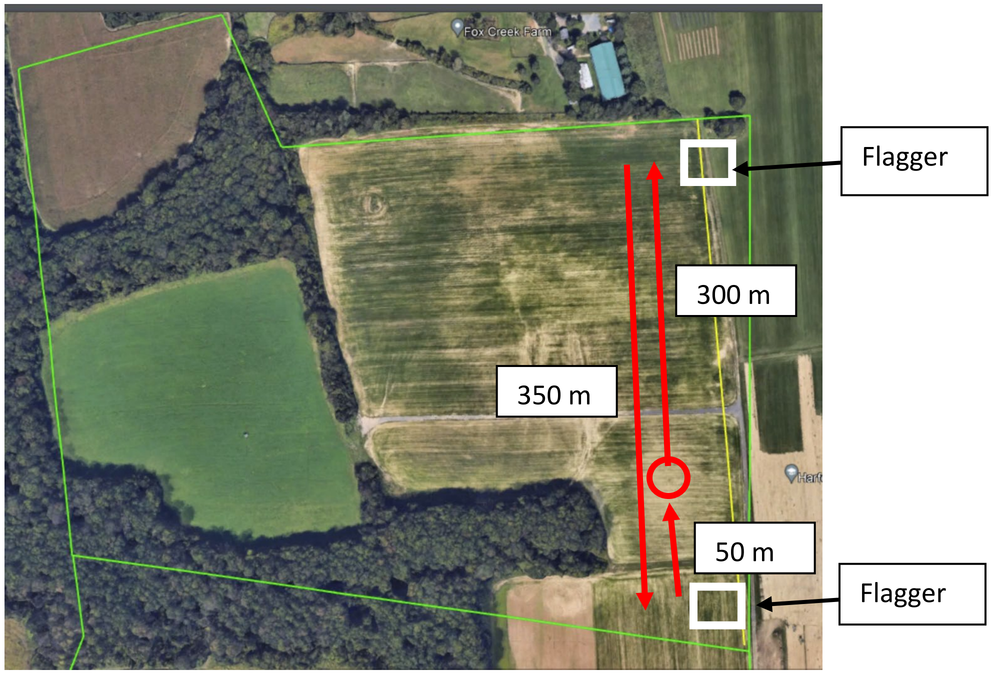

Figure 3: Flight Performance Course Layout

2.3.2: <u>Autonomy Course</u>

The autonomy course requires the same locations from the flight performance course to be programmed via GPS coordinates into the aircraft's control system that the vehicle will then autonomously fly. The course scoring is shown in Table 6.

- The waypoints must be followed in the same order as depicted in Figure 3.
- The precise GPS coordinates will be provided later. Teams attempting the autonomy course are 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
    - The pilot will immediately activate the remote-kill function if either the pilot or a range official deems it necessary.
- Pilot commands a start of the vehicle's autonomous flight
- Aircraft must execute a vertical take-off
- Fly around the course as shown in Figure 3
    - The range officials will still signal if the UAS has passed the requisite location during the course attempt, so teams should set the way point far enough beyond the range official's station to ensure passing the required location
- After completing the course, the UAS must enter the VTOL zone and descend vertically to a controlled landing
    - Non-VTOL landings may result in disqualification for the attempt
- Power down the aircraft

2.4: Presentations

Final presentations will take place during the competition fly-off. Teams should include an overview of the content from the Final Technical Report to share with fly-off attendees. This will involve the design drivers based on the initial trade studies, manufacturing methods, project budget and timeline, and flight testing.

The teams must bring their presentation on a USB flash drive. The maximum time allowed for the presentation is 10 minutes. There is a 5-minute Q&A session after each presentation.

The presentation must 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 3.2. Teams are strongly encouraged to use the scoring criteria as a checklist for maximum possible points.

3.0: Scoring

Scoring considerations will include the summation of the following for a total possible 500 points:

- Final Technical Report (FTR); 100 Points Possible
  - Scoring carried out by the judges in accordance with the rubric in Section 3.1
- Team Presentations; 100 Points Possible
  - Scoring carried out by the judges in accordance with the rubric in Section 3.2
- Aircraft Mission Performance; 300 Points Possible
  - Scoring will be carried out by the VFS organizers and other applicable judges in accordance with the rubrics in Section 3.3

3.1: Final Technical Report (FTR) Scoring

Table 1: Final Technical Report Scoring Criteria	
Section	**Requirement**
Executive Summary (10 points)	Contains objective statement
	Brief description of problem to be solved (purpose of design)
	Discussed the planned approach to achieve all objectives
	Summarizes main point from subsequent sections
	Clear and concise, uses proper grammar; 2 pages max.
Management Summary (5 points)	Overall description of team organization (leadership, sub teams and responsibilities)
	Schedule includes key actions through report deliverable and presentation
	Schedule includes detail on design, prototype, and testing phases
	Schedule includes detail for subcomponent design
Design Trade Studies (5 points)	Mission requirements decomposed into aircraft subsystem requirements
	Sensitivity study of design parameters discussed; major design drivers detailed
	Review of configurations considered
	Describe concept weighting, selection process and results (e.g. configuration, motors, props, etc.)
Technical Innovations (10 points)	Detail any unique design considerations or technologies used by the team
	Describe "mission model" used for predicting system performance
	Mission model description includes equations
	Mission model discusses source of inputs (aero, propulsion, environment, etc.)
	Mission model includes discussion of assumptions and uncertainties
Design Definition (15 points)	Sub system discusses all key components (airframe, propulsion system, electronics)
	Structural analysis of key structural components, includes max. expected loads
	Document dimensional parameters of final design
	Document mission performance for final design
	Weight and balance of final design
	Provide estimate of aircraft lift and drag and method of prediction
	Provide estimate of static and dynamic stability and method of prediction
Drawing Package (15 points)	Drawing of aircraft: front view
	Drawing of aircraft: side view
	Drawing of aircraft: top view
	Drawing of aircraft: isometric view
	Structural arrangement drawing present (showing mechanical interfaces, spars, ribs, gear, etc.)
	Systems layout/location drawing present (showing motor, servos, speed controllers, batteries, receiver, etc.)

	Quality, detail and thoroughness of drawings
Fabrication Methods (10 points)	Manufacturing processes investigated, discussed, and compared
	Discussion on how investigated materials and methods were down-selected
	Final manufacturing process presented in detail
Test Plan (5 points)	Discussion of major tests planned (i.e. wind tunnel, structural, propulsive, flight, etc.)
	Test objectives for each
	Describes proposed set up and data to be collected for each
Flight Test Results (5 points)	Describe the demonstrated performance of key subsystems (propulsion, structure, electrical, etc.)
	Compare to predictions and explain any differences and improvements made
	Describe the demonstrated performance of your complete aircraft solution (flight testing)
Presentation and Organization (20 points)	Proper grammar, spelling, formatting
	Figures & texts taken from published works are referenced
	Reference list at the end of the document in numerical order as cited in the text
	Logical progression of report; easy to read with headings, etc.
Total (100 points)	

3.2: Presentation Scoring

Table 2: Final Presentation Scoring Criteria	
Section	**Requirement**
Team Organization (10 points)	Showed breakdown of team roles and responsibilities throughout competition
	Gantt chart discussing timelines proposed vs. actual
Originality (15 points)	Major subassemblies not off-the-shelf (e.g., airframe — excludes motors, props, batteries)
	Innovative engineering used to solve the competition challenges (out of the box ideas)
Engineering (25 points)	Presentation of concepts considered and down selection process to final design concept
	Validation/testing process (bench testing, wind tunnel, flight testing, etc.)
	flight video
Drawings (15 points)	Aircraft 3D CAD renderings of vehicle and pertinent sub-systems
	Structural arrangement drawing or rendering (showing mechanical interfaces, spars, ribs, gear, etc.)
Publicity (15 points)	Use of graphics or charts to convey vehicle performance
	Successfully conveyed why final design was the rational choice given their assumptions
Presentation (15 points)	Clear, easy to follow, logical presentation of material
	Good speaking presence and breakdown of material across presenting team members
Public Relations (5 points)	Successfully fielded audience and/or judges' questions
Total: 100	

3.3: Aircraft Mission Performance Scoring

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

3.3.1: Flight Performance Course Scoring

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

1. The aircraft rising vertically out of the start/end VTOL zone (Pass/Fail)
    a. Failing this portion results in zero points for the course attempt.
2. Properly maneuvering around the course as described in Section 2.3.1 with controlled **VTOL** touch and goes inside the designated landing zone (Pass/Fail)
    a. Failing this portion results in a 1-lap penalty per violation.
3. Controlled final landing (Pass/Fail)

a. Failing this portion results in a 1-lap penalty per violation.

4. Course time score (points awarded as shown in Table 3)
   a. Time for the first lap will be recorded for this scoring section.
5. Course lap score (points awarded as shown in Table 4)
   b. Total number of laps completed will be recorded for this scoring section.
6. Course payload fraction score (points awarded as shown in Table 5)
   a. Payload fraction defined as (payload weight)/(MTOW)

Table 3. Flight Performance Course Scoring

Flight Performance Course Time Score (50 possible points); N = Total Number of Teams	
n^{th} Place (n = 1 for team with fastest time)	50 * ((N + 2) – n) / (N + 1)

Table 4. Flight Performance Course Lap Scoring

Flight Performance Course Lap Score (50 possible points); N = Total Number of Teams	
n^{th} Place (n = 1 for team with most laps)	50 * ((N + 2) – n) / (N + 1)

Table 5. Flight Performance Course Payload Fraction Scoring

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

3.3.2: Autonomy Course Scoring

Each team to successfully complete the autonomy course will be awarded full points.

Table 6: Autonomy Course Scoring

Autonomy Course Score (150 possible points)	
Successfully Completed Course	150

4.0: Aircraft Design Restrictions, Requirements, and Operational Procedures

1. Maximum Weight: Aircraft maximum take-off weight (MTOW) must be no more than **20 lb**.

- This weight limit includes any payload used for the flight performance course. For example, an 18-lb aircraft would fly at the maximum allowable 20 lb when carrying a 2-lb payload.
- **A vehicle will not be allowed to fly if it is over 20.0 lb. This means that the aircraft, all systems, power sources, and any payloads are all counted against this 20-lb maximum.**

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

3. Propulsion System Batteries and Fuses: 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.

- Multiple batteries following the requirements in this section can be combined in parallel for the propulsion system.
  - For batteries tied together in parallel, each battery must be identical.

    - Note that a separate battery is required to power the ESC/flight control system. It can be a different capacity from the main flight batteries but must still follow the battery guidelines specified throughout the RFP.
- 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.
- The host will provide power and a location to charge batteries, but teams should bring their own charging equipment.
- A 6S LiPo battery has a nominal voltage of 22.2V (3.7V/cell) and charging these batteries to the manufacturer's specified capacity is allowed (typically 4.2V/cell).
- When connecting multiple batteries, ensure that the batteries are a) of the same chemistry, voltage and capacity; b) at the same charge level; and c) of the same age, charge cycle history, and health. Running LiPo batteries in parallel can cause reduced battery performance, which may lead to a crash and subsequent damaging of the batteries, but usually not in itself leading to a thermal event. However, if you try and charge those damaged batteries, it can lead to a thermal event. As such, batteries will be inspected after any crash to assess their readiness for continued use.
- The propulsion and flight control systems must have separate batteries. A propulsion system battery monitor run through the flight control battery is acceptable so long as the connection between the propulsion system battery and the flight control system is not a high-power carrying line. i.e. Any connection should transmit a signal only, and no substantial amount of power. This separation of propulsion and flight control system battery is commonly done to allow continued control of an aircraft even after a remote-kill command has been issued to the main propulsion system battery, or if it has otherwise failed.

4. <u>Power Source</u>: Aircraft must have a separate power source for the flight control system. A battery that also follows the specifications under point 3 and throughout the RFP must be used, except that it can differ in capacity from the propulsion system battery/batteries.

5. <u>Minimum Payload:</u> The aircraft must be capable of carrying a minimum payload of 2 lb (907 g) for use in the flight performance course. There is no maximum payload limit, but teams must stay under the 20-lb MTOW limit. No payload is required for the autonomous course attempts; however, teams can fly the autonomous course with a payload if they deem it necessary to maintain vehicle stability and control.

6. <u>Maximum Dimension:</u> 10 ft (3.048 m), including the propellers/rotors in their most outstretched positions. i.e. vehicle must fit within a 10 ft diameter sphere.

7. <u>VTOL:</u> The aircraft must take off and land vertically.

8. <u>Kill Switch:</u> The remote controller must demonstrate a lost-link power-cut functionality. A failsafe system that cuts throttle to zero on signal loss is one way to meet this requirement.

9. <u>Shunt Plug:</u> 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 electronic speed controller 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 for the configuration shown.
- A physical switch mounted on the drone would not be permitted and is not considered a valid shunt plug.

10. Transmission Frequencies: Must follow US Federal Communications Commission (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.

11. FAA waivers: No FAA waiver will be required at the competition. The UAS will be operated within the host's COA airspace. As such, the host (SURVICE) will set any rules and restrictions for flight operation within their private airspace such that all teams operate in a safe fashion and in accordance with the rules given to SURVICE by the FAA for their airspace. Teams and team pilots must adhere to the rules set forth during the safety and pre-flight briefs at SURVICE by the range officials. Non-compliance may result in immediate disqualification from the competition.

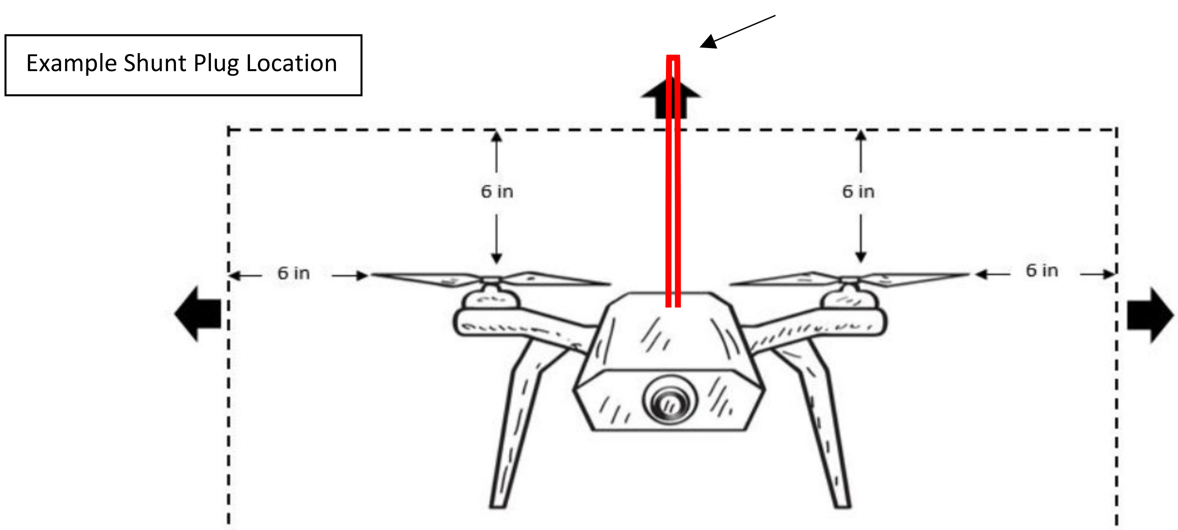

Figure 6. Allowable Location for Propulsion System Shunt Plug

5.0: Awards

Final competition awards will be based on Final Technical Reports, Flyoff Competition, and presentation scores. The top three teams will receive the following awards and monetary amounts:

- **1st Place Overall – $2250**
- **2nd Place Overall – $1125**
- **3rd Place Overall – $650**
- **Top Score Final Technical Report – $500**
- **Top Score Flyoff – $500**

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 university or company sponsors for travel, accommodation, equipment, etc., and are free to display any sponsors logos on their team shirts and on their aircraft.

7.0 Pilot Requirements

Team pilots must hold an FAA Part 107 Drone Certification or hold an equivalent UAS pilot certification for non-US teams in order to fly at the competition.

- Pilot(s) must be identified by **March 15, 2024,** when the fly-off team list is due the competition host**.**
- Pilots of non-US-based team may hold an FAA Part 107 certification or hold an equivalent UAS pilot certification from another certifying organization.
- Teams can name more than one (1) pilot if all pilots hold FAA Part 107 Drone Certification or an equivalent UAS pilot certification for non-US based teams.
- The pilot(s) will be required to complete the flight test check at the competition before being permitted to make course flight attempts.

8.0 Autonomy

Refer to the *Appendix A, "Achieving Autonomy: An Overview,"* which is available on the competition web page at www.vtol.org/FLY . This document, created in 2020 for the inaugural competition, provides a helpful guide on the autonomous flight portion of the competition.

Assistive autonomy is permitted in the piloted performance course. An example of assistive autonomy would be a system that keeps altitude at 20 ft during cruise or a system that holds the aircraft in place when the pilot releases control input.

9.0 Questions

Questions should be sent to fly@HQ.vtol.org. The Frequently Asked Questions (FAQ) document will be posted to the competition site on a semi-monthly basis.

- Updated FAQ document will be periodically posted to the DBVF website https://vtol.org/FLY

10.0 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 posted to www.vtol.org/FLY. All registered competitors will be notified of any clarifications on the rules or necessary adjustments.

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.

11.0 Final Word

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

Explanation of RFP Revisions [9/13/2023]

2.3: The Fly-Off (page 6)

- Team pilots must have proof of their *FAA Part 107 Drone Certification (US based teams) or equivalent certifying authority (non-US based teams)* to compete. Refer to Section 7.0 Pilot Requirements
  - **FPV piloting is permitted in this year's competition.**

4.0: Aircraft Design Restrictions, Requirements, and Operational Procedures (page 14-15)

3. Propulsion System Batteries and Fuses: 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.~~ [No longer limited to 100 W hr.]
- Multiple batteries following the requirements in this section can be combined in parallel for the propulsion system.
  - For batteries tied together in parallel, each battery must be identical.

Explanation of RFP Revisions [9/30/2023]

1.1: Letter of Intent (LOI) to Submit

The VFS Design-Build-Vertical Flight Competition proposal submission window will be open until Oct. 9 ~~2~~, 2023; LOIs should be emailed to FLY@HQ.vtol.org.

Explanation of RFP Revisions [10/10/2023]

Team eligibility rules are as follows:

- 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~~ letters of intent. If 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 that meets all RFP requirements.

11.0 Final Word

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