

2020-21 Design, Build, Fly Rules

(DRAFT)

Boeing

Cessna

Fawker

TEXTRON AVIATION

Raytheon
Missiles & Defense

AIAA
FOUNDATION

Summary:

The AIAA through the Applied Aerodynamics, Aircraft Design, Design Engineering and Flight Test Technical Committees and the AIAA Foundation invites all university students to participate in the Textron Aviation/Raytheon Missile Systems - Student Design, Build, Fly Competition. The contest will provide a real-world aircraft design experience for engineering students by giving them the opportunity to validate their analytic studies.

Student teams will design, fabricate, and demonstrate the flight capabilities of an unmanned, electric powered, radio controlled aircraft that can best meet the specified mission profile. The goal is a balanced design possessing good demonstrated flight handling qualities and practical and affordable manufacturing requirements while providing a high vehicle performance.

To encourage innovation and maintain a fresh design challenge, the design requirements and performance objectives are updated for each new contest year. The changes provide new design requirements and opportunities, while allowing for application of technology developed by the teams from prior years.

Check the rules package carefully as items and approaches that were legal in past years may not be legal for this contest year. Only the contents of this year's Rules package along with the current FAQ and Q&A documents hold bearing on the requirements and/or allowances for the current contest year.

NOTE: Items in the rules that are critical to the safety and execution of the competition or are new are highlighted in RED text. Please take note of these requirements and rules.

It is the responsibility of the teams to know and follow all provided rules, the FAQ and Q&A, and all contest day briefings.

Cash prizes are **\$3000** for 1st, **\$2000** for 2nd and **\$1500** for 3rd place. The winning team may be invited to present their design at AIAA's AVIATION Forum. The team with the best Report Score will receive a \$100 prize from the Design Engineering Technical Committee.

General Information

Team Requirements:

All team members (except for a non-student pilot) must be full time students at an accredited University or College and student members of the AIAA. At least 1/3 of the team members must consist of freshman, sophomores or juniors (below senior year, for non-four year programs). The pilot must be an AMA (Academy of Model Aeronautics) member. Teams may use a non-university member for the pilot if desired. We will provide qualified pilots at the contest on an as-available basis to assist teams who are unable to have their pilot attend.

There is no set requirement for the number of students that must attend the fly-off. It is preferred, but not required, for the team advisor or responsible faculty member to attend.

Team members may be updated/changed at any time during the contest but must always comply with the 1/3 rule. Following the initial team postings at the contest beginning we will make a "One Time" update to the team member lists posted on the website. We will notify teams when the website update change information may be sent, normally in February. Teams wishing a team member list update at that time must submit an updated copy of the contest entry form with all fields fully filled (but only the team member information may be changed).

Each educational institution may submit one (1) team entry.

The team members may be changed during the contest period, so schools may use an internal selection process to determine their final design and team members prior to the written report submission and fly-off. For schools with multiple campuses in different cities each campus will be considered as a separate entity.

Two or more schools may combine to submit a single entry.

Schools which already have an entry may not have additional students from their school participate as members of a team from a different (shadow) school.

There is no entry limit this year.

Past Year Reports:

Winning team design reports from [prior contest](#) years are posted on the contest website as examples. Note that the formatting and content has evolved from one year to the next. Only the rules noted in **Reports** apply for the current year. The top scoring report(s) from this year's contest will be placed on the contest web site for the next year's competition.

Sponsorship:

Teams may solicit and accept sponsorship in the form of funds or materials and components from commercial organizations. All design, analysis, and fabrication of the contest entry is the sole responsibility of the student team members.

Communications:

The contest administration will maintain a website containing the latest information regarding the contest schedules, rules, and participating teams. The contest web site is <http://www.aiaadbf.org>

Questions regarding the contest, schedules, or rules interpretation may be sent to the contest administrator by email at: director@aiaadbf.org

Please note that rules interpretation questions will not be answered by e-mail until after the entry date (when all participant e-mail address are known), so that all teams will have equal access to all rules information. Official questions and answers received following the entry submission date will be posted on the website **Q&A** and delivered by email to all teams.

The DBF Organizing Committee will utilize [Facebook](#) as an additional means of communicating with the teams during the contest weekend only. This will NOT be a means of communicating rules, FAQ's, Q&A, protests, etc., but only used in case of emergencies, weather delays or contest weekend schedule updates. Additional information will be included in a contest site/schedule email to be sent out to the registered teams prior to the fly-off.

Flight Line and Order:

A flight order list will be generated and emailed to the teams on the Wednesday prior to the fly-off weekend. Teams will always rotate in this order. The flight order will be repeated continuously.

The flight order list will carry over from Thursday to Friday, Friday to Saturday and Saturday to Sunday at whatever spot in the rotation it leaves off.

Each team's position in the flight order will be determined from their **written report score**, highest report score goes first.

Report scores will be available following the pilot briefing at the start of the contest (they will not be included with the rotation sequence e-mail).

There will be staging box positions near the flight line.

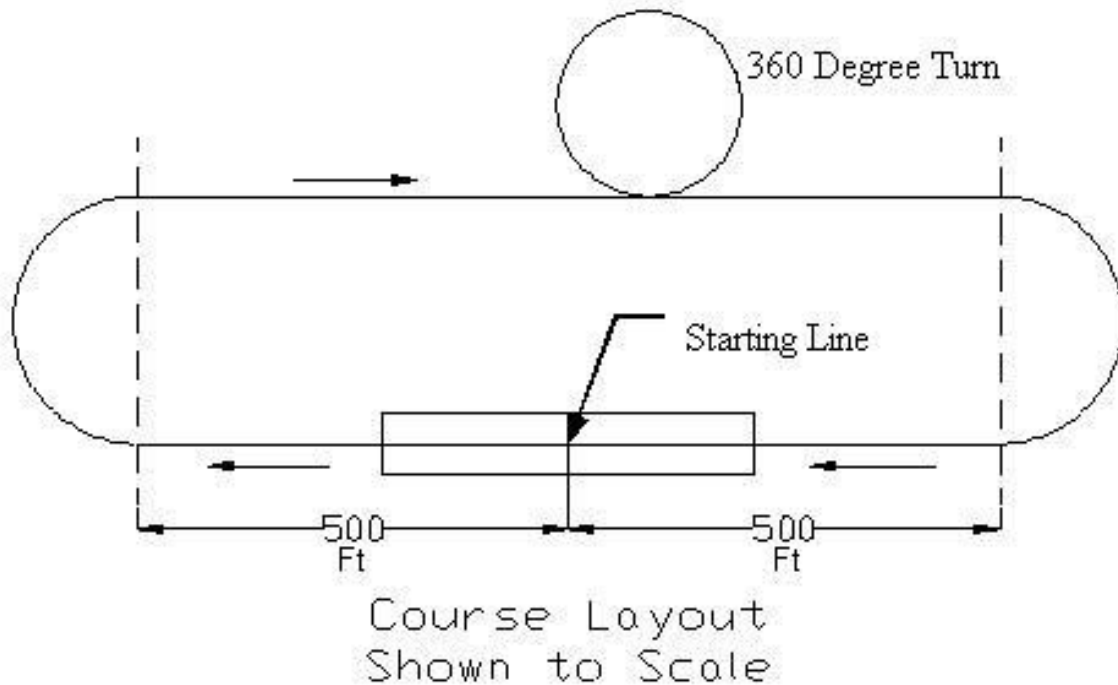
If you are not ready to enter a staging box when your rotation number comes up, you will miss (forfeit) your opportunity for that rotation.

Note: It is each team's responsibility to monitor the notifications from the scoring table in order to respond if ready. A contest official will be available to help teams enter the staging box.

If you choose to leave the staging box for any reason, you may not attempt a flight until your turn comes up again in the rotation order.

Flight Course:

The orientation (direction) of the flight course will be adjusted based on the prevailing winds as determined by the Flight Line Judge. The flight course will be positioned to maintain the greatest possible safety to personnel and facilities. The nominal flight course is shown in the Figure below.



Protest Procedure:

Submitting a protest is a serious matter and will be treated as such. Teams may submit a protest to the Contest Administration at any time during the competition. Protests may not be submitted after the conclusion of the competition. Protests must be submitted in writing and signed by the team advisor, designees are not allowed for protest submissions. If the team advisor is not present, he may FAX or email a signed protest to the team for them to present. Remotely submitted protests must be on hard copy (printed by the team) and have the advisor's signature. A phone number where the advisor may be contacted must be provided. Protests may be posted for review at the decision of the administration.

Protests and penalties (up to disqualification from the contest for deliberate attempts to misinform officials, violate the contest rules, or safety infractions) will be decided by the Contest Administration. Protests submitted but not upheld by the judges may be given a penalty of the loss of one flight score to the team submitting the protest. The decision of the Contest Administration is final.

Schedule

Entries:

The entry period OPENS 15 October at 8AM (0800) **US Eastern Time**. No entries will be accepted before that time. A completed entry must be RECEIVED by 5 PM (1700) **US Eastern Time** on 31 October. Entries will be collected through the AIAA Online Submission System.

Proposals and Team Rosters must be submitted as part of the entry process. Proposals and Team Rosters will not be accepted outside of the online submission system.

Be sure to include ALL required information requested by the online submission. Once submitted, corrections to the entry, including any corrections or updates to the Proposal, will not be accepted.

If AIAA membership has been applied for, but a member number has not been issued, use "pending" for the member number in the Team Roster form. The data must then be updated and resubmitted. Team rosters may be resubmitted during the Proposal and Design Report phases of the competition.

Incomplete entries will not be accepted.

It is the team's responsibility to make sure the e-mail contact addresses they supply remain active during the entire period from entry to the close of the competition as e-mail will be the primary means to provide information and updates. Do not use an internal team correspondence e-mail list server as your point of contact e-mail address.

Note: The AIAA mail servers will not send e-mail to @hotmail.com addresses. Do NOT use a hotmail address for any of your team contacts or e-mail.

An entry is not complete until the "Save and Finalize" function is selected in the online submission system and confirmed.

Proposal:

Teams are required to submit the proposal with the entry via the online submission system.

The proposals will be scored as defined in the proposal requirements section. The top 110 proposals plus ties will be invited to submit design reports and potentially become eligible for the fly-off. Teams will be notified no later than 20 November whether or not their proposal has been accepted.

Proposals submitted by email will not be accepted.

Proposals will be judged "as received". No corrections/additions/changes will be allowed by the organizers so check your proposals carefully before submitting them. Once a Proposal is submitted, no changes are allowed.

Submission of Proposals is electronic only (no hard copy required). The details for the electronic format and submission are at the end of the proposal section in this rules document.

Design Report:

Design Reports will be [submitted](#) using the online system.

The design report submission period OPENS 1 February at 8AM (0800) **US Eastern Time**. The design report must be submitted by 5 pm (1700) **US Eastern Time** on 19 February 2021.

The reports will be scored as defined in the design report requirements section. Reports submitted by email will not be accepted.

Reports will be judged “as received”. No corrections/additions/changes will be allowed by the organizers so check your reports carefully before submitting them. Once a Report is submitted, no changes are allowed.

Submission of Reports is electronic only (no hard copy required). The details for the electronic format and submission, including a requirement for an additional, separate 3-view, are at the end of the report section in this rules document.

Contest Fly-off:

The contest fly-off is tentatively scheduled for 15 - 18 April 2021 and is anticipated to run from 12PM (1200) to 6PM (1800) on Thursday, 7AM (0700) to 6PM (1800) on Friday, 7AM (0700) to 6PM (1800) on Saturday and 7AM (0700) to 5PM (1700) on Sunday. Awards will be presented at 5:30PM (1730) on Sunday. All teams should plan their travel so that they may stay for the awards presentations on Sunday. A final contest schedule will be e-mailed to the teams prior to the contest date.

Tech inspections will begin on Thursday and will continue as required on Friday, Saturday and Sunday.

To help streamline the contest flow and maximize opportunities for each team to get their flights in, the Tech inspections will be conducted in the same order as the flight rotation (which is based on report scores) so that the first teams inspected will be the first teams in the flight queue. Teams may use the sequence to help estimate when they need to arrive at the contest site to make sure they do not miss their slot in the first tech inspection rotation.

PLEASE NOTE: All schedule deadlines are strictly enforced

All deadlines are based on when an entry or submission is **Received** (Save and Finalize) by Contest officials via the online submission system.

Late entries and proposals will **NOT** be accepted.

Late report submissions will **NOT** be accepted.

There is no allowance for computer, internet, or power outages by the submitter, or any other type of error beyond the control of the DBF Organizing Committee.

Teams which do not submit the required electronic report and additional 3-view will **NOT** be allowed to fly.

It is the team’s responsibility to assure that all deadlines are known, understood and met.

Mission and Vehicle Design

Mission Task Matrix:

UAV with Sensor Suite

The objective for this year is to design, build and test a UAV with a towed sensor. Missions will include delivery of the UAV, transportation of sensors in shipping containers, and surveillance by deploying, operating, and recovering a towed sensor.

General

- Maximum allowable wingspan is 5 feet
- A second payload transmitter may be used for deployment, operation and recovery of the towed sensor only and must be operated by the Observer crew member
- Payloads
 - Mission 1 – no payload
 - Mission 2 – sensor(s) in shipping container(s)
 - All sensor shipping containers (includes the sensor in its shipping container and all shipping container simulators) and the deploy and recovery mechanism must be secured sufficiently to assure safe flight without possible shift of aircraft CG outside of design limits during flight
 - Mission 3 – deployable sensor
- Sensor requirements:
 - The sensor must have a minimum diameter of 1.00 inch with a minimum length to diameter ratio of 4.
 - The sensor must be aerodynamically stable while deploying, operating and recovering the sensor [aerodynamically stable is defined as remaining in a fixed orientation (not spinning or rotating) with no effect on the stability of the aircraft at the discretion of the Flight Director]
 - The sensor must have the following functionality:
 - It must have a minimum of 3 external lights that can be viewed while in flight in the deployed position
 - The lights must operate one at a time in the deployed position in a pattern to be determined by each team
 - The lights must be visible by the Flight Director (lots of plentiful sunshine in Arizona in April!!)
 - The lights must be turned on and off remotely via the flight or payload transmitter

- The sensor lights must be controlled by a physical connection to the airplane via the tow cable
 - The sensor must contain its own battery power supply compliant with the battery requirements herein
- The sensor must be carried internally to the airplane. No part of the sensor can be part of or extrude outside of the airplane external surfaces or features
- The deploying and recovery mechanism for the sensor must be internal to the airplane
- The deploying and recovery mechanism is not required on all missions, but any pylons, covers or fairing required for the mechanism must be included in all missions
- The deploying and recovery mechanism must be carried on Mission 2, but does not have to be in the Mission 3 location or configuration
- The deploying and recovery mechanism must deploy the sensor a minimum of 10X the total length of the sensor from the exit location of the airplane. The tow line must include a marker such that the Flight Line Director can verify it is fully deployed in flight.
- Sensor shipping container requirements:
 - The sensor shipping container must fully enclose the sensor and protect it from drop shock events
 - All shipping container simulators must be the same size (within +/- 1/8 inch) and same or greater weight as the sensor shipping container with sensor
 - The sensor shipping container must protect the sensor from damage during drop testing in the Ground Mission

General:

Mission Sequence:

- Aircraft must be capable of performing all required missions
 - During Tech Inspection, the aircraft must pass the wing tip load test in the flight condition with the maximum Mission 2 payload intended to fly
 - The maximum load demonstrated will be recorded and cannot be altered after completing tech inspection
- The Flight Missions must be flown in order
 - A new mission cannot be flown until the team has obtained a successful score for the preceding mission
 - The ground mission can be attempted at any time

- After successfully completing all three flight missions, teams will be allowed one additional attempt for both Mission 2 and Mission 3 in an attempt to improve their score
- After successfully completing the ground mission, teams will be allowed one additional attempt to improve their score
- The aircraft will be brought to the staging box in the ready to fly configuration without payloads installed (shipping container with sensor, shipping container simulators, and sensor deployment and recovery mechanism for Mission 2; sensor and sensor deployment and recovery mechanism for Mission 3)
- If you forget something you must leave the staging box and forfeit the flight attempt
- Only the assembly crew member, pilot and observer may go to and enter the staging box or Ground Mission area
- **The assembly crew member is the only person who can touch the airplane while inside the staging box while preparing the aircraft for flight**
- The payload installation must be completed in less than 5 minutes
- There is no work allowed on the aircraft after the 5-minute loading and checkout time including connection of batteries, receivers, etc. The aircraft must be ready to fly prior to being called to the flight line, less the installation of the arming plug
- After loading and checkout is complete, the assembly crew member may be swapped for a different flight line crew member, if desired
- Aircraft will use ground rolling takeoff and landing
- The aircraft must take-off within 100 feet of the start/finish line
- The initial upwind turn on the first lap of each mission will occur after passing the turn judge (signaled by raising a flag). The aircraft must remain in unaided visual control distance of the pilot at all times. The Flight Line Judge may require turns to be made to remain in a safe visual control range at his discretion
- Aircraft must complete a successful landing at the end of each mission for the mission to receive a score
 - A successful landing is outlined in the general mission specifications section below

Tech Inspection

- The Aircraft will enter Tech Inspection in the flight configuration with all payload items not installed
- Weight and size of the sensor, sensor in shipping container, and shipping container simulators will be verified

- Team members will load the sensor in shipping container, the maximum number of shipping container simulators, and the deploying and recovery mechanism for Mission 2 and the aircraft will undergo the wing tip lift test in this configuration
- The sensor container and deploying and recovery mechanism restraint systems will be verified
- Team members will unload the payload items
- Team members will install the deploying and recovery mechanism in the Mission 3 configuration
- The deploying and recovery mechanism will be operated and the deployment distance will be verified
- All batteries and battery packs must be inspected during Tech Inspection. Teams should bring all possible batteries for use over the full duration of the competition to Tech Inspection

NOTE: Teams will be allowed to have additional batteries or battery packs inspected after passing Tech Inspection due to damage, real time power change requirements, etc. However, teams must follow the Tech Inspection queue or wait until Tech Inspection is open for all for additional battery inspections. Any team that uses batteries that have not passed a Tech Inspection will lose that flight attempt and cannot attempt any further flights until the batteries have passed inspection.

Flight Missions:

Mission 1: Staging Flight

- There is no payload for Mission 1
- The aircraft must enter the staging box in the flight configuration
- Takeoff field length is 100 feet
- Teams must complete 3 laps within the flight window
- There will be a 5 minute flight window for this mission
- Time starts when the aircraft throttle is advanced for the (first) take-off (or attempt)
- A lap is complete when the aircraft passes over the start/finish line in the air (the landing is not part of the 5 minute time window)
- Must complete a successful landing to get a score

Scoring:

M1 = 1.0 for successful mission

Mission 2: Delivery Flight

- The payload for Mission 2 is sensor in shipping container, shipping container simulators, and deploying and recovery mechanism; the minimum payload must include the sensor in shipping container and deploying and recovery mechanism.
- Teams may select the number of additional sensor container simulators flown but cannot exceed the maximum number declared at Tech Inspection
- Takeoff field length is 100 feet
- Teams must complete 3 laps within the flight window
- There will be a 5 minute window for this mission
- The score will be a function of the number of shipping containers (sensor in shipping container plus shipping container simulators) flown / flight time
- Time starts when the aircraft throttle is advanced for the (first) take-off (or attempt)
- A lap is complete when the aircraft passes over the start/finish line in the air (the landing is not part of the 5 minute time window)
- Time stops when the aircraft passes over the start/finish line in the air at the end of the third lap
- Must complete a successful landing to get a score

Scoring:

M2 = 1 + [N_(#containers/time) / Max_(#containers/time)] , where Max_(containers/time) is the highest #container/time score of all teams

Mission 3: Sensor Flight

- The payload for Mission 3 is the sensor and deploying and recovery mechanism
- The aircraft must enter the staging box in the flight configuration
- Takeoff field length is 100 feet
- After a successful take-off, the sensor will be deployed by remote command and must be fully deployed prior to the first 360 degree turn
- After completion of the final 360 degree turn, the sensor will be recovered by remote command; the sensor must be fully recovered inside the aircraft prior to landing; the recovery does not have to be complete prior to crossing the finish line (the aircraft can continue to fly until full recovery and then complete a successful landing)
- There will be a 10 minute window for this mission
- Time starts when the aircraft throttle is advanced for the (first) take-off (or attempt)

- A lap is complete when the aircraft passes over the start/finish line in the air (the landing is not part of the 10 minute time window)
- Must complete a successful landing to get a score
- The sensor weight will be recorded after a successful mission

Scoring:

M3 = 2 + [N_(#laps X sensor length X sensor weight) / Max_(#laps X sensor length X sensor weight)] , where Max_(#laps X sensor length X sensor weight) is the highest #laps X sensor length X sensor weight score of all teams

Ground Mission – Operational Demonstration:

- The Ground Mission is a timed mission for a ground demonstration of Missions 2 and 3 with validation of sensor shipping container performance
- Prior to the timed mission, the teams will demonstrate the ability of the shipping container to protect the sensor
 - The assembly crew member will drop the sensor in shipping container on all six sides from a height of 10 inches
 - The assembly crew member will remove the sensor from the shipping container and demonstrate there is no physical damage and that the sensor meets all functional performance requirements for M3
 - The assembly crew member will then place the sensor back in the shipping container and place it in the mission box
- The timed mission will begin with the aircraft in the flight configuration inside the “mission box” along with the uninstalled sensor in shipping container, maximum allowed number of container simulators and deploying and recovery mechanism; the mission box is approximately a 10 foot by 10 foot box
- The assembly crew member and a pilot may participate in the Ground Mission; only the assembly crew team member can touch the aircraft, sensor/shipping container, container simulators, and deploying and recovery mechanism
- The assembly crew member and pilot will start behind the start/finish line
- Time will start when the ground mission official says “GO”
- The assembly crew member will load the full Mission 2 payload then run back to the start finish line; time will stop when he/she crosses the line
- The pilot will then demonstrate the flight controls are active
- The assembly crew member will again start behind the start/finish line and time will restart when the ground mission official says “GO”
- The assembly crew member will return to the mission box and remove the Mission 2 payload

- The assembly crew member will then install the deploying and recovery mechanism and sensor in the stowed configuration onto the aircraft then run back to the start finish line; time will stop when he/she crosses the line
- The pilot will then demonstrate the flight controls are active
- With the assembly crew member holding the aircraft, the pilot will then demonstrate deployment and recovery of the sensor to complete the mission (only partial deployment of the sensor is required to demonstrate deploy and recovery performance)

Scoring:

GM = [Min_time / N_time] , where Min_time is the fastest time for all teams

Aircraft Requirements:

General

- The aircraft may be of any configuration except rotary wing or lighter-than-air
- No structure/components may be dropped from the aircraft during flight
- No form of externally assisted take-off is allowed. All energy for take-off must come from the on-board propulsion battery pack(s)
- Must be propeller driven and electric powered with an unmodified over-the-counter model electric motor. May use multiple motors and/or propellers. May be direct drive or with gear or belt reduction
- Motors may be any commercial brush or brushless electric motor
- For safety, each aircraft will use a commercially produced propeller/blades. The propeller can have folding blades. Teams may modify the propeller diameter by clipping the tip and may paint the blades to balance the propeller. No other modifications to the propeller are allowed. Commercial ducted fan units are allowed
- You can change the propeller diameter/pitch for each flight attempt
- Aircraft and pilot must be AMA legal. This means that the aircraft TOGW (take-off gross weight with payload) must be less than 55-lb, and the pilot must be a member of the AMA.
- Since this is an AMA sanctioned event, the team must submit proof that the exact aircraft being presented at Tech Inspection has been flown prior to the contest date to the technical inspection team. **Proof of flight is a video showing controlled straight and level flight. There are no exceptions to this requirement.**
- We will provide qualified pilots at the contest on an as-available basis to assist teams who are unable to have their pilot attend
- The aircraft must remain substantially the same as documented in the report (for example you cannot change a flying wing design to a conventional tail design). You may make small modifications to the design to improve flight performance after the report submission (one example would be changing a

control surface size). The three-view drawing supplied in PDF form as described below in the electronic report section will be used to verify the flight article during tech inspection.

- **The aircraft must have an externally accessible switch to turn on the radio control system. It cannot be internal or under a panel or hatch.**

Batteries

- **Teams may choose between NiCad/NiMH OR Lithium Polymer (LiPo) batteries with the following provisions:**
 - **Teams may only use one battery type for propulsion**
 - **Once a team completes tech inspection with a specific battery type, the team must use that battery type for the remainder of the competition**
 - **Teams may use either battery type for Rx/Servo and Transmitter power regardless of the propulsion battery type**
 - **Propulsion power total stored energy cannot exceed 200 watt-hours**
- **NiCad/NiMH Battery requirements:**
 - **Must be commercially procured battery pack assemblies or individual battery cells**
 - **Battery packs must be properly labeled indicating cell chemistry**
 - **Individual battery cells must have the manufacturer's label readable/documented (i.e. clear shrink wrap preferred)**
 - **All battery disconnects must be "fully insulated" style connectors**
- **LiPo Battery requirements:**
 - **LiPo battery packs must be un-altered and commercially procured**
 - **Individual battery packs cannot exceed the FAA limits for hand carry on commercial air flights of 100 watt-hours per battery pack and as further defined in:**
https://www.faa.gov/hazmat/packsafe/resources/media/Airline_passengers_and_batteries.pdf
 - **LiPo Propulsion batteries must have a fuse in line with the positive battery terminal with a maximum continuous current rating not to exceed the maximum continuous discharge current rating of the LiPo battery pack (battery capacity X C-rating) and located as closely as possible to the battery connector without altering the connector or wiring that is part of the commercial battery pack.**
 - **If more than one battery pack is implemented for a single purpose such as propulsion, the following rules apply:**
 - **All commercial battery packs must be identical (same manufacturer, part number, size, voltage, power, rating, etc)**

- **All battery packs must be connected in parallel to each other. There is no limit on the number of batteries connected in parallel**

NOTE: Teams will present the battery configuration with the most battery packs to tech inspection. Once tech inspection is complete, teams may not use more batteries than in the approved configuration

- **Each battery pack must have an individual fuse as defined herein**
- **Battery packs must be installed and secured with a minimum air gap of 0.25 inches between it and any other battery pack**
 - **LiPo batteries must be stored and charged in a commercially available, unaltered LiPo charging sack – the only time they can be out of the sack is for tech inspection or while in the airplane**
 - **The Manufacturer's Label stating the Battery Capacity (mAh), Voltage (V), and C-Rating must be clearly visible**

NOTE: It is the responsibility of each team to assure compliance with all laws and regulations for shipping or hand-carrying LiPo batteries.

- Batteries may not be changed or charged during a flight mission attempt.
- There is no limit to **total** battery weight.

Safety:

All vehicles will undergo a safety inspection by a designated contest safety inspector prior to being allowed to make any competition flight. All decisions of the safety inspector are final.

To speed the tech inspection process, each team must present a signed Pre-Tech and First-Flight Certification when called to begin their on-site tech inspection. Teams may not begin the on-site tech inspection without a completed certification. The Pre-Tech and First-Flight Certification sheet is available on the contest website.

The Pre-Tech must be conducted by, and signed off by, a non-team member RC pilot or the team faculty advisor. The Pre-Tech will cover the same safety of flight requirements as the on-site tech inspection and will assist teams in making sure they are ready and able to pass the on-site tech inspection the first time. An expanded First-Flight requirement, which also must be signed off by a non team member RC pilot or the team faculty advisor, requires demonstration of a complete flight including take-off, flying a minimum flight pattern, and landing in a pre-designated location without damage to the aircraft. The non team member RC pilot who signs the inspection and flight certifications may be the same as a team's non-student contest pilot.

Safety inspections will include the following as a minimum:

Physical inspection of vehicle to ensure structural integrity:

1. Verify all components adequately secured to vehicle. Verify all fasteners tight and have either safety wire, locktite (fluid) or nylock nuts. Clevises on flight controls must have an appropriate safety device to prevent their disengaging in flight

2. Verify propeller structural and attachment integrity
3. Visual inspection of all electronic wiring to assure adequate wire gauges and connectors in use
4. Radio range check, motor off and motor on
5. Verify all controls move in the proper sense
6. Check general integrity of the payload system

Structural verification:

All aircraft will be lifted with one lift point at each wing tip to verify adequate wing strength (this is "roughly" equivalent to a 2.5g load case) and to check for vehicle cg location. Teams must mark the expected empty and loaded cg locations on the exterior of the aircraft. Special provisions will be made at the time of the contest for aircraft whose cg does not fall within the wing tip chord. This test will be made with the aircraft filled to its maximum payload capacity.

Radio fail-safe check.

All aircraft radios must have a fail-safe mode that is automatically selected during loss of transmit signal. The failsafe will be demonstrated on the ground by switching off the transmit radio. During fail safe the aircraft receiver must select:

- Throttle closed
- Full up elevator
- Full right rudder
- Full right aileron
- Full Flaps down

For aircraft not equipped with a particular control, then the safety inspector must be satisfied that the intended function of the fail-safe system will be carried out.

The radio Fail Safe provisions will be strictly enforced

All aircraft must have a mechanical motor arming system separate from the onboard radio Rx switch. This may be a "blade" style fuse or an arming plug such as such as shown at:

http://wsdeans.com/products/plugs/ultra_plug.html

This device must be located so it is accessible by a crewmember standing ahead of the propeller(s) for pusher aircraft and standing behind the propeller(s) for tractor aircraft (i.e. the crew member must not reach across the propeller plane to access the arming system). The "Safety Arming Device" will be in "Safe" mode for all payload changes. The aircraft Rx should always be powered on and the throttle verified to be "closed" before activating the motor arming switch. The arming system MUST be **hard** mounted on the outside the aircraft (it cannot be behind an access panel or door) and MUST act as the "safeing" device.

Note: The aircraft must be "safed" (arming fuse/plug removed) any time the aircraft is being manually moved, or while loading/unloading payload during the mission. The arming fuse must be removed anytime the aircraft is in the hanger area.

General Mission Specifications and Notes:

- The aircraft propulsion system(s) must be "safed" (fuse or arming plug removed) during any time when crew members are preparing/handling the aircraft
- Maximum flight support crew is: pilot, observer, and ground crew
- Observer and all ground crew must be students. Only the pilot may be a non-student
- The upwind turn will be made after passing the upwind marker. The downwind turn will be made after passing the downwind marker. Upwind and downwind markers will be 500 ft from the starting line. Aircraft must be "straight and level" when passing the turn marker before initiating a turn
- "Successful" Landing - Aircraft must land on the paved portion of the runway. Aircraft may "run-off" the runway during roll-out. Aircraft may not "bounce" off the runway
- Aircraft obtaining "significant" damage during landing will not receive a score for that flight. Determination of "significant" is solely at the discretion of the Flight Line Judge
- Flight altitude must be sufficient for safe terrain clearance and low enough to maintain good visual contact with the aircraft. Decisions on safe flight altitude will be at the discretion of the Flight Line Judge and all rulings will be final
- **All instructions from the Flight Line Judge must be followed IMMEDIATELY. Failure to do so may result in a loss of mission attempt or in the case of multiple or serious infractions, loss of future flight attempts**
- Additional information is included in the [FAQ](#) (Frequently Asked Questions)

Reports

All material contained within all proposals and design reports must be original work of the teams or appropriately cited in the bibliography section of the report or in the footnotes of the proposal. All proposals and reports will be reviewed using standard AIAA tools. Any material that is found to be uncited and non-original work will be subject to a penalty as determined by the DBF Organizing Committee. Based on the severity, penalties can include points deducted from the proposal or report score up to a 100% reduction or full disqualification for the competition year.

Proposal

Each team will submit a proposal as outlined below that will be judged.

Examples of top scoring proposals from [prior contest years](#) are posted on the contest website. Note that the formatting and content may have changed from one year to the next. Prior year proposals may not reflect or meet the rules listed for the current year.

Note: Proposals must strictly adhere to the following requirements. Failure to meet requirements will result in penalties that range from score reduction to elimination from the contest.

Formatting Requirements

- Proposals must be in PDF format

Proposals that are not in PDF format will not be accepted

- Proposals must be one and one half line spacing with a 10-pt Arial font recommended. Text, tables and figures should be clear and readable for the judges. The proposals will be assessed for format and readability at the judges' discretion.
- Proposals must have the University name on the first page
- Absolute maximum page count for the proposal is 5 pages, the PDF reader "pages" value will be used as the official page count

Proposals exceeding the maximum page count will not be accepted

- Proposal PDF must be formatted as 8.5" x 11" pages

Submission Requirements

Each team must provide an electronic copy of their proposal as outlined below to the online [Submission](#) site.

- Electronic proposal must be named: "2021DBF_[university name]_PROPOSAL.pdf"
 - University name should not be an acronym
 - Universities with multiple campuses should specify which campus in university name.

Proposals that do not meet the file naming convention above will incur a 10 point penalty

- Electronic proposal must be a single file with all figures/drawings included in the proper sequence in PDF format.

- Electronic proposals should have all figures compressed to print resolution to minimize file size.
- Electronic proposals must be less than 20 MB in size

Proposals exceeding the file size will incur a 10 point penalty

Summary of Proposal Non-Compliance Penalties

| Requirement | Penalty |
|---|--------------------------|
| Must be in PDF format | Rejection (Not Accepted) |
| Maximum page count of 5 pages | Rejection (Not Accepted) |
| File naming convention (2021DBF_[university name]_PROPOSAL) | 10 points |
| File size (</= 20 MB) | 10 points |

Scoring

Proposals will be scored on a 100 point basis following the guidelines outlined below.

All information used for scoring must be in the outlined sections. **Content that is out of sequence will be treated as missing and scored accordingly.**

ALL items requested below should be present, easy to locate and identify, well documented and in the correct section for full scoring. Note that all proposals are assessed relative to each other so that simply addressing each of the sections below may not be sufficient for full credit. Proposals will be assessed on how well they communicate the required information given the size and length constraints.

Proposal Scoring Rubric

All section scores include format, completeness and readability

Executive Summary (10 points)

- Objective Statement
- Planned approach to achieve all objectives
- Includes main points from subsequent sections

Management Summary (40 points)

- Describe the organization, the roles of each team and individual skill sets required
- Organization chart (by team/function, individual names are not required for the proposal)
- Schedule / Major Milestone chart
- Budget (not only for expected materials and manufacturing of the airplane, but for travel to the competition site and any other expenses associated with the competition)

Conceptual Design Approach (20 points)

- Decomposition of mission requirements into sub-system requirements.

- Preliminary design / sizing results; concept sketch, if available (does not have to be representative of the final design)
- Sensitivity Study of Design Parameters

Manufacturing Plan (15 points)

- Preliminary manufacturing flow
- Describe critical processes or technologies required

Test Planning (15 points)

- Component and ground test plan
- Flight test plan

Design report

Each team will submit a design report as outlined below that will be judged.

Examples of winning team design reports from [prior contest years](#) are posted on the contest website. Note that the formatting and content has changed from one year to the next. Prior year reports may not reflect or meet the rules listed for the current year.

Note: Reports must strictly adhere to the following requirements. Failure to meet requirements will result in penalties that range from score reduction to elimination from the contest.

Formatting Requirements

- Reports must be in PDF format

Reports that are not in PDF format will not be accepted

- Reports must be one and one half line spacing with a 10-pt Arial font recommended. Text, tables and figures should be clear and readable for the judges. The reports will be assessed for format and readability at the judges' discretion.
- Reports must have the University name on the cover page.
- Absolute maximum page count for the report is 60 pages, the PDF reader "pages" value will be used as the official page count.

Reports exceeding the maximum page count will incur a 10 point penalty for each additional page

- Report PDF must be formatted as 8.5" x 11" pages.
- May use 11" x 17" pages for the drawing package
- An additional stand-alone three view drawing must be submitted along with the report file. See description below in the electronic submission section.

Submission Requirements

Each team must provide an electronic copy of their design report as outlined below to the online [Submission](#) site.

- Electronic report files must be named: “2021DBF_[university name]_DESIGN_REPORT.pdf”

Reports that do not meet the file naming convention above will incur a 10 point penalty

- Electronic report must be a single file with all figures/drawings included in the proper report sequence in PDF format.
- Electronic reports should have all figures compressed to print resolution to minimize file size.
- Electronic reports must be less than 20 MB in size

Reports exceeding the file size will incur a 10 point penalty

Stand Alone 3-view requirements:

- In addition to the drawings included in the report drawing package, an additional, separate file with a one page 3-view drawing formatted to fit 8.5" x 11" paper must be submitted with the report for confirmation of the basic configuration. Note that this page does not count toward the report total
- The 3-view file shall be named as per above: “2021DBF_[university name]_THREE_VIEW.pdf”
 - University name should not be an acronym
 - Universities with multiple campuses should specify which campus in university name.
- The university and team names shall be clearly shown on the drawing
- The 3-view file is limited to 2 MB in size

Summary of Report Non-Compliance Penalties

| Requirement | Penalty |
|---|-------------------------------|
| Must be in PDF format | Rejection (Not Accepted) |
| Maximum page count of 60 pages | 10 points per additional page |
| Report File naming convention (2021DBF_[university name]_DESIGN_REPORT) | 10 points |
| Report file size (</= 20 MB) | 10 points |

Scoring

Reports will be scored on a 100 point basis following the guidelines outlined below.

All information used for scoring must be in the outlined sections. **Content that is out of sequence, including the drawing package, will be treated as missing and scored accordingly.**

ALL items requested below should be present, easy to locate and identify, well documented and in the correct section for full scoring. Note that all reports are assessed relative to each other so that simply addressing each of the sections below may not be sufficient for full credit. Reports will be assessed on how well they communicate the required information given the size and length constraints.

Design Report Scoring Rubric

All section scores include format, completeness and readability

Executive Summary (5 Points)

- Maximum of 1 page. If exceeded, score as 0 points
- Summary description of selected design and why it best meets the mission requirements
- Main points from subsequent sections
- Document the performance/capabilities of your system solution

Management Summary (5 Points)

- Describe the organization of the design team
- Chart of design personnel and assignments areas
- Milestone chart showing planned and actual timing of major elements

Conceptual Design (15 Points)

- Describes mission requirements (problem statement)
- Translate mission requirements into sub system design requirements
- Present a scoring sensitivity analysis.
- Review solution concepts/configurations considered
- Describe concept weighting and selection process and results

Preliminary Design (20 Points)

- Describe design/analysis methodology
- Document design/sizing trades
- Describe/document methodology for prediction of aircraft performance (include capabilities and uncertainties)
- Provide estimates of the aircraft lift, drag and stability characteristics and method of prediction
- Provide estimates of the aircraft mission performance

Detail Design (15 Points + 15 Points for Drawing Package)

- Document dimensional parameters of final design
- Document structural characteristics/capabilities of final design
- Document systems and sub-systems selection/integration/architecture

- Document Weight and Balance for final design
- Must include Weight & Balance table empty and with each possible payload/configuration
- Document flight performance parameters for final design
- Document mission performance for final design
- Drawing package:
 - 3-View drawing with dimensions of all configurations
 - Structural arrangement drawing
 - Systems layout/location drawing
 - Payload(s) accommodation drawing(s)

Manufacturing Plan (5 Points)

- Document the process selected for major component manufacture
- Manufacturing processes investigated and selection process and results
- Manufacturing milestones chart: plan and actual

Testing Plan (5 points)

- Describe all major ground and flight tests performed.
- Objectives and schedule for each.
- Data to be collected and how applied.
- Test and flight check lists

Performance Results (10 Points)

- Describe the demonstrated performance of key subsystems following execution of testing plan
- Compare to predictions and explain any differences and improvements made
- Describe the demonstrated performance of your complete aircraft solution
- Compare to predictions and explain any differences and improvements made

Bibliography (5 Points)

- List of all published works referenced in the text must be present in this section.
- Any material taken from a published source in all previous sections must have a numerical subscript corresponding to the appropriate citation in this section.
- References should appear in numerical order.
- Format should match AIAA provided guidelines:

<https://www.aiaa.org/publications/journals/reference-style-and-format>

Scoring

In the event that, due to time or facility limitations, it is not possible to allow all teams to have the maximum number of flight attempts, the contest committee reserves the right to ration and/or schedule flights. The exact determination of how to ration flights will be made on the contest day based on the number of entries, weather, and field conditions. In the event of a tie, Report Score will take precedence over Flight Score as a tie-breaker.

Judging

Students must design, document, fabricate, and demonstrate the aircraft they determine to be capable of achieving the highest score on the specified mission profile(s). Mission scores will be based on the demonstrated mission performance obtained during the contest.

Each team must also submit a written Design Report. A maximum of 100 points will be awarded for the team design report. The overall team score is a combination of the Design Report score and Total Mission Score. The team with the highest overall team score will be declared the winner. Scores will be FINAL 7 working days after the completion of the contest. This period will allow for review of the scores in a timely fashion following the contest.

All submitted reports are the property of AIAA, Textron Aviation and Raytheon Missiles and Defense and may be published or reproduced at their discretion.

Units of Measure

The units of measure for scoring will be based on the US English system. All times or physical measurements will be rounded to the number of decimal places shown in Table 1. Conventional rounding will be implemented (<0.5 --> round down, >= 0.5 --> round up).

| Units of Measure and Number of Decimal Places | | |
|---|-----------------|----------------|
| Item | Unit of Measure | Decimal Places |
| Time | Seconds (s) | 2 (e.g. X.XX) |
| Length | Inches (in) | 2 (e.g. X.XX) |
| Weight | Ounces (oz) | 2 (e.g. X.XX) |
| | Pounds (lbs) | 2 (e.g. X.XX) |

Total Score

Each team's overall score will be computed from their Written Report Score and Total Mission Score using the following formula:

$$\text{SCORE} = \text{Written Report Score} * \text{Total Mission Score}$$

The Total Mission Score will be computed from the individual Flight Mission and Ground Mission Scores using the following formula:

$$\text{Total Mission Score} = \text{M1} + \text{M2} + \text{M3} + \text{GM}$$

Fly-off Site

Host for the competition will be Raytheon Missiles and Defense. The fly-off is planned to be held at the TIMPA RC Field in Tucson, AZ. Details on the contest site and schedule will be sent to registered teams early in the fly-off calendar year. You can check on historical weather conditions at www.weatherbase.com or www.weatherunderground.com.

Teams are advised to check with their airlines on what materials they will be allowed to bring both to and from the contest site. Hazmat items like paints, thinners and glues may need to be purchased locally and PROPERLY disposed of following the contest.

****NOTE: It is the team's responsibility to ensure that their aircraft arrives at the fly-off location. Neither AIAA nor the corporate sponsors will assist in getting your aircraft or materials to the fly-off location. Teams may hand carry their aircraft, use a shipping company to have it delivered to their hotel, or use any other means of transportation that they feel is appropriate. But each team must coordinate all aspects of getting the aircraft to the fly-off.**

International Teams: Special information for non-US teams can be found [here](#).