

## 2004 Rules and Vehicle Design

**Note: Rules are “Draft” until 31 October 2003**

### 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 **Cessna/ONR 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 for each new year, the design requirements and performance objectives will be updated for each new contest year. The changes will provide new design requirements and opportunities, while allowing for application of technology developed by the teams from prior years.

Cash prizes are \$2500 for 1<sup>st</sup>, \$1500 for 2<sup>nd</sup> and \$1000 for 3<sup>rd</sup> place. The winning teams will be invited to present their designs at the 2004 AIAA Flight Test & Evaluation conference.

### Judging:

Students must design, document, fabricate, and demonstrate the aircraft they determine as best capable of achieving the highest score on the specified mission profile(s). Flight 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. Scores for the written reports will be announced at the beginning of the fly-off.

Each aircraft will have computed a Rated Aircraft Cost, reflecting the complexity/technology of the design.

The overall team score is a combination of the Design Report, Rated Aircraft Cost and

Flight scores. The team with the highest overall team score will be declared the winner.

### Contest Site:

Host for the competition will be the Cessna Aircraft Company. The fly-off will be held at The Cessna Pawnee East Field at Wichita Kansas.

You can check on weather historical conditions at [www.weatherbase.com](http://www.weatherbase.com) or [www.weatherunderground.com](http://www.weatherunderground.com).

### Team Requirements:

All team members (except for a pre-approved designated pilot) must be full time students at an accredited University or College and student members of the AIAA. The team must be composed of both under classmen and upper classmen, with at least 1/3 of the members being under classmen (Freshman, Sophomores or Juniors). 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 also provide qualified pilots on the contest day for any teams who are unable to have their pilot attend.

### Past Year Reports:

The top scoring report from the past years competition will be available for reference on the contest web site. The team with the top scoring report from this years contest will be required to submit an electronic copy of their report following the competition, which will be placed on the contest web site for the next years 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.

### Schedule:

A completed electronic entry form is due to the contest administrator on or before **31 October 2003**.

The entry form for the DBF is different than that used for all other AIAA student competitions. The DBF entry form is a MS-Word file and can be found on the contest web site. It must be submitted by e-mail to the contest administrator at [gregory.s.page@nrl.navy.mil](mailto:gregory.s.page@nrl.navy.mil). Be sure to include the Phone and FAX number for your team advisor and at least one student contact so we may reach you in case of any last minute problems or changes. All teams are required to provide two point-of-contact e-mail addresses with their contest application, one of which must be the teams advisor. ***It is the teams 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.***

**Please Note:** the *Entry Name* may not be changed once the form is submitted, but must be

retained and used in all reports and correspondence during the competition year.

Written reports (**5 hard copies, electronic reports will not be accepted**), are due to the contest administrator by COB **9 March 2004**. Reports will be judged "as received", no "corrections/additions/page changes" will be made by the organizers so check your reports carefully before sending them. COB is taken as 5 pm local time at the address provided for delivery of the written reports. Scores for the written reports will be announced at the beginning of the fly-off.

*(A note primarily for foreign entrants but also allowed for domestic teams. If sending the report by courier is prohibitive you may send it electronically to a commercial printer (KINKO's comes to mind) local to the report submission address and have them print/collate and DELIVER the reports to meet the deadline. No deadline exceptions will be made, but this may be easier than international courier service.)*

The contest is scheduled for **23-25 April 2004**. The competition will run from noon to 5PM on Friday, and 8AM to 5PM on Saturday and Sunday. Final awards will be presented at the end of Sunday's competition. All teams are encouraged to stay and attend the awards presentations on Sunday.

Please note that tech inspections will be available on Friday **23 April**. Teams are encouraged to be prepared to have your plane inspected on Friday. Inspections will also be available on Saturday, but waiting until Saturday to go through tech may mean that your team will miss one or more rounds through the flight queue. If we have a full turnout you may not be able to get in a full set of scoring flights unless you are "ready to fly" at every opportunity.

Late entries will **NOT** be accepted. Late or incomplete report submissions will **NOT** be judged. Teams who do not submit the required written reports will **NOT** be allowed to fly. It is the teams responsibility to assure that all deadlines are met, as they will be **strictly** enforced.

## Communications:

The contest administration will maintain a World Wide Web site containing the latest information regarding the contest schedules, rules, and participating teams. The contest web site will also contain a list of potential suppliers for materials and equipment available to build an entry. The contest web site is located at:

<http://www.aae.uiuc.edu/aiaadbf>

Later in the academic year, the website will be moved to

<http://www.ae.uiuc.edu/~aiaadbf>

Questions regarding the contest, schedules, or rules interpretation may be sent to the contest administrator by e-mail at:

[gregory.s.page@nrl.navy.mil](mailto:gregory.s.page@nrl.navy.mil)

The contest administrator will provide e-mail copies of questions received and their

answers to all teams of record.

Written reports (only) should be sent to the chief of scoring at:

AIAA Design/Build/Fly Contest/Report Judging  
Kelly Laflin  
Cessna Aircraft Company  
Dept. 363 P  
Cessna Aircraft Company  
5800 East Pawnee  
Wichita, KS 67218  
316-831-2247

## Aircraft Requirements - General

- The aircraft may be of any configuration except rotary wing or lighter-than-air.
- No payload may be carried internal to the wing proper. Payload in the "fuselage" may be carried in the area where the wing carry-over structure passes. For blended-wing configurations, the "fuselage" is defined to be the inner most **9 inch** of semi-span, the remainder is "wing" for payload considerations.
- 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.
- All motors must be from the *Graupner* or *Astro Flight* families of brushed electric motors, only (motor should have manufacturers label visible to the judges during the technical inspection).
- For safety, each aircraft will use a commercially produced propeller. 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.
- Motors and batteries will be limited to a maximum of 40 Amp current draw by means of a 40 Amp fuse (per motor or pack) in the line from the positive battery terminal to the motor controller. Only ATO or blade style plastic fuses may be used. ("Maxi" size Slow Blow, 1.15"x0.85". Available online [www.Mcmaster.com](http://www.Mcmaster.com) part #7460K51 \$1.66 each)
- Must use over the counter NiCad batteries. For safety, battery packs must have shrink-wrap or other protection over all electrical contact points. The individual cells must be commercially available, and the manufacturers label must be readable (i.e. clear shrink wrap preferred). All battery disconnects must be "fully insulated" style connectors.
- Maximum battery pack weight is 5 lb. Battery pack must power propulsion and payload systems only. Radio Rx and servos **MUST** be on a separate battery pack. Batteries may not be changed or charged between sorties during a flight period.
- 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 aircraft has been flown prior to the contest date (in flight photo) to the technical inspection team. Contest supplied qualified pilots will be available to teams who require them.
- Teams will present a completed a signed (by the teams faculty advisor) copy of their Rated Aircraft Cost worksheet to the judges during technical inspection for verification. The Rated Aircraft Cost assigned at the technical inspection will be used for the competition and may not be modified during the event.

## Aircraft Requirements - Safety

All vehicles will undergo a safety inspection by a designated contest safety inspector prior to being allowed to make any competition or non-competition (i.e. practice) flight. All decisions of the safety inspector are final. Safety inspections will include the following as a minimum.

- Physical inspection of vehicle to insure structural integrity.
  1. Verify all components adequately secured to vehicle. Verify all fasteners tight and have either safety wire, locktite (fluid) or nylock nuts.
  2. Verify propeller structural and attachment integrity.
  3. Visual inspection of all electronic wiring to assure adequate wire gauges and connectors in use. Teams must notify inspector of expected maximum current draw for the propulsion system.
  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. **Both upright and inverted wing lift tests will be performed.** Teams must mark the expected empty and loaded cg locations on the exterior of the aircraft fuselage. 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 fail-safe 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 (or left) aileron  
 Full Flaps down (if so equipped)

**During Fail Safe the payload release system must NOT activate.**

**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 **MUST** be the contest specified "blade" style fuse. 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 fuse). 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. Fuses **MUST** be accessible from outside the aircraft and act as the "safeing" device.

## Mission Profile:

Teams must complete the flight missions as outlined in the mission matrix below. Teams will have a maximum of **5** flight attempts. A flight attempt is defined as advancing the throttle "stick" for take-off. The best **Single Flight Score** from each of **2 different**

**mission types** will be summed for the team's **Total Flight Score**.

*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.*

Each team's overall score will be computed from their **Written Report Score**, **Total Flight Score**, and the **Rated Aircraft Cost** using the formula:

$$\text{SCORE} = \frac{\text{Written Report Score} * \text{Total Flight Score}}{\text{Rated Aircraft Cost}}$$

## Mission Task Matrix

Mission	Description
	<p style="text-align: center;"><b>General Mission Information</b></p> <p>... Aircraft must fit in a 2-ft wide by 1-ft high by 4-ft long (interior dimensions) box. Note: The aircraft does not need to “fold” to fit in the box, but may employ “plug-in” joints for rapid assembly/disassembly. All electrical connections should be keyed so they cannot be misassembled. Tape may be used as a non-structural “latch” to hold components in place, such as taping a wing joint when using a plug-in spar arrangement to keep the wing from sliding loose.</p> <p>... Teams must select one of the following missions for each flight. Teams may select a different mission for each of their scoring flight attempts.</p> <p>... Take-off distance is 150 ft wheels off the runway.</p> <p>... On landing the aircraft must land on the runway (but may roll off) to obtain a score for that flight.</p> <p>... All payloads must be adequately secured using mechanical means. Tape and Velcro are not acceptable forms of restraint.</p> <p>... Maximum mission time is <b>10</b> minutes.</p>
<p style="text-align: center;"><b>Fire Fight</b></p> <p style="text-align: center;">Heavy Lift/Slow Flight</p>	<p style="text-align: center;"><b>Fire Bomber DF = 2.0</b></p> <p>... Aircraft will begin the mission time empty.</p> <p>... The flight mission will consist of two sorties.</p> <p>(1) Aircraft will be loaded, take-off, dump its water load during the downwind leg, and return to land.</p> <p>(2) Aircraft will be reloaded, take-off, dump its water load during the downwind leg, and return to land.</p>

	<p>... Maximum allowed aircraft water capacity is 4 liters. <i>(Aircraft will be emptied then filled to overflow during the tech inspection. Total volume must be 4 liters or less.)</i></p> <p>... Teams will load the aircraft during the mission from four 2-liter plastic “soda” bottles. Teams may use gravity loading or “pumped” loading. Soda bottles may NOT be pressurized to assist loading.</p> <p>... On all laps flown the aircraft must complete a <u>single</u> 360° turn in the direction opposite of the base and final turns on the downwind leg of each lap.</p> <p>... Water may only be dumped during the downwind leg between the upwind and downwind turn markers/flags. <i>Aircraft must fly slow enough to allow sufficient time for the water to be emptied.</i></p> <p>... Maximum dump orifice diameter is 0.5 inch. <i>(Measured <u>at the exit</u> so it may be easily verified during the tech inspection).</i></p> <p>... The <u>pilot</u> must call “Dump On” and “Dump Off” so the observer judge can easily verify that the water dump is restricted to the downwind leg.</p> <p>... <b>Early or Late water dumping, including inadvertent release of water during a hard landing, will incur a 3-min time penalty per occurrence.</b></p> <p><b>Excessive water spillage during loading will incur a 1-min time penalty per infraction. The flight line judge will notify the team of the penalty at the time of the infraction. Gross and/or deliberate spillage will disqualify the flight but will count as one of the teams’ flight attempts.</b></p> <p><b>A 3-min time penalty will be added if the aircraft is not empty on landing after the final lap.</b></p> <p>... A time penalty of 3 minutes will be added for an incomplete second lap. If the second lap is not attempted or the 360° turn is not completed the second lap will be timed as “incomplete.”</p> <p>... The weight of the water will be determined by the starting and ending weight of the team’s ground-based storage “tanks,” taken when entering and leaving the flight box.</p> <p>... <b>Single Flight Score</b> is:</p> <p style="text-align: center;"><math>DF * Lbs\_Water / Mission\_Time</math></p>
<p style="text-align: center;"><b>Ferry</b></p> <p>High Speed Flight</p>	<p><b>Ferry DF = 1.0</b></p> <p>... Aircraft must take-off, complete four laps, and land.</p>

	<p>The aircraft will have no water payload for this flight</p> <p>... On all laps flown the aircraft must complete a 360° turn in the direction opposite of the base and final turns on the downwind leg of each lap.</p> <p>... <b>Single Flight Score</b> is:</p> <p style="text-align: center;">DF / Mission_time</p>
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"Mission Flight Time" is the time from when the official calls "go" until the aircraft comes to a **complete stop PAST** the starting line at the completion of all laps. Aircraft that run off the runway before reaching the start line may be carried to the line to end the time. Aircraft that are damaged may NOT be carried to the line to end the time, but will instead have the time end where the aircraft stops with the last lap scored as "incomplete."

For aircraft not completing the full number of laps specified for a mission, a penalty of 3 minutes will be added to the aircraft's **measured** "Total Mission Time" for **each** lap not completed. For example, if an aircraft completes only 3 laps of a 4 lap mission in 5 minutes, the "Total Mission Time" would be: 5 minutes + 1 incomplete laps @ 3 minutes each = 8 minutes.

## Aircraft Cost Model

$$\text{Rated Aircraft Cost, \$ (Thousands)} = (A * \text{MEW} + B * \text{REP} + C * \text{MFHR}) / 1000$$

Coef.	Description	Value
A	Manufacturers Empty Weight Multiplier	\$300 (NEW)
B	Rated Engine Power Multiplier	\$1500
C	Manufacturing Cost Multiplier	\$20 / hour
MEW	Manufacturers Empty Weight	Actual airframe weight [lb] <b>with</b> all flight and propulsion batteries but without any payload.
REP	Rated Engine Power	$(1 + .25 * (\# \text{ engines} - 1)) * \text{Total Battery Weight [lbs]}$  <i>"Total Battery Weight"</i> will be the weight of the propulsion battery pack(s) as determined by the judges scale during technical inspection. Total propulsion battery pack weight may not exceed 5 lb, but it may be lighter.

MFHR Manufacturing Man Hours

Prescribed assembly hours by WBS (Work Breakdown Structure).

MFHR =  $\sum$  WBS hours

**WBS 1.0 Wing(s): (NEW)**

10 hr/ft<sup>2</sup>

Wing Span \* Chord \* # wings

Wing Span is longest distance perpendicular to fuselage axis on any wing. Chord is maximum exposed wing chord on any wing. For a blended wing-body, exposed wing starts 9 inch out from the body centerline.

5 hr \* control\_function\_multiplier

aileron = 1

flaperon = 1.5

aileron + flap = 2

aileron + spoiler = 2

aileron + flap + spoiler = 3

**WBS 2.0 Fuselage (NEW)**

20 hr/ft<sup>3</sup>

Body Length x Width x Height

Length is maximum body length. Width is maximum body width. Height is maximum body height (does not include landing gear height). Maximum body width and maximum body height may occur at different fuselage locations.

For a blended wing-body, body width is fixed at 18 inch.

Note: Maximum length of the body is defined to be the longest longitudinal length possible to measure on the aircraft, and may include spinner and part of vertical or horizontal surfaces.

	<p><b>WBS 3.0 Empennage</b></p> <p>5 hr/Vertical Surface (Any vertical surface, including winglets, struts, end plates, ventral etc) with no active control</p> <p>10 hr/Vertical Surface (Any vertical surface) with an active control</p> <p>10 hr/Horizontal Surface. A horizontal surface is a "wing" if it is more than 25% of the span of the greatest span horizontal surface.)</p> <p>A "V" tail is considered to be a Vertical surface without control (5 hr) plus a horizontal surface with controls (10 hr), for a total of 15 hr.</p> <p><b>WBS 4.0 Flight Systems</b></p> <p>5 hr/servo or motor controller</p> <p><b>WBS 5.0 (Deleted)</b></p>
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**Rated Aircraft Cost** must be supplied when the aircraft enters the technical inspection. The RAC worksheet must be signed by the **team advisor**. RAC may not be changed during the competition unless it is determined by the contest officials to be inaccurate or inappropriate. The contest officials reserve the right to audit and revise the RAC for omissions or errors at any time.

## General Mission Specification and Notes:

- ... Aircraft are to remain assembled while waiting in the queue. Teams will install the propulsion batteries once reaching the **3<sup>rd</sup> "On Deck"** position (i.e. when the aircraft is 3<sup>rd</sup> in the queue, the team must begin to install the batteries).
- ... Aircraft **may not** have any work performed in the starting line queue, other than as specified above at the 3<sup>rd</sup> On Deck position. Aircraft propulsion batteries may be left out of the aircraft when in line.
- ... Aircraft batteries may be charged while the aircraft is in the queue **IF AND ONLY IF** the batteries are removed from the aircraft.

- ... The aircraft propulsion system(s) must be disarmed or "safed" during any time when crew members are preparing the aircraft.
- ... Maximum flight support crew is: pilot, observer, and 3 ground crew. Only the designated ground crew may reload the aircraft payload . Pilot and observer may be members of the ground crew, provided total ground crew size remains 3 people.
- ... 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 pylon. The downwind turn will be made after passing the downwind pylon. Upwind and downwind pylons will be 500 ft from the starting line. Aircraft must be "straight and level" when passing the pylon before initiating the turn.
- ... Aircraft must land on the paved portion of the runway. Aircraft may "run-off" the runway during roll-out.
- ... After landing, aircraft **may** taxi back to the starting line. Alternatively, aircraft may be carried back to the starting line; however, the team may not leave the pit area to retrieve the aircraft until the aircraft has come to a complete stop, and they are signaled it is "Ok" to retrieve the aircraft by the flight line judge. *Aircraft experiencing damage during landing will be considered to have completed their flight where they come to rest and may not be "carried" to the starting line to "complete" a lap.*
- ... Aircraft will be considered to have only *minor damage* if they can be repaired and presented as flight worthy within 30 minutes of the end of that flight period. Aircraft with only *minor damage* will be credited with their full **Single Flight Score**.
- ... Aircraft that can be repaired during the competition, but not within 30 minutes of the flight period, will NOT be credited with a score for that flight period.
- ... 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 judges and all rulings will be final.

Additional information is included in the [FAQ](#) (Frequently Asked Questions).

## Protest Procedures

Submitting a protest against a competing team is a serious matter and will be treated as such. Teams may submit a protest to the Contest Administrator at any time during the competition. Protests must be submitted in writing and signed by the team advisor (if present at the competition) or the team captain if a faculty advisor is not present. Protests will be posted for all teams to review.

If the protest is rejected, the submitting team(s) will forfeit one of their remaining flight attempts. If all flight attempts have been used, the team(s) will forfeit their lowest Single Flight score.

Protests and the appropriate penalty (ranging from a requirement to repeat a flight for minor infractions to disqualification from the contest for deliberate attempts to misinform officials or violate the contest rules) will be decided by the Contest Administrator and the Contest Director, in consultation with other Contest Officials. The decision of the Contest Administrator and Contest Director is final.

### **NEW for This Year**

- ... Inverted wing tip lift test was added
- ... Aircraft missions are revised.

- ... Missions have different difficulty factors applied.
- ... Aircraft must fit in a specified size shipping container, but assembly time is NOT part of the mission scoring.
- ... RAC formulas have been rescaled.
- ... 3-view drawing in report must be on an 11 x 17 inch page for easier reading by judges

## Design Report:

Each team will submit a judged design report as outlined below. The submission date is contained in the schedule section of this document. Reports must be bound. (Simple spiral bindings are sufficient and preferred; 3-ring binders are not allowed.) All information used for scoring must be in the outlined sections. **Reports exceeding the total page limit will be scored as "1 of 100"**. Appendices may not be included.

All reports will be space and one half, 10-pt Arial font. Tables and figures will also be 10-pt Arial font. Margins are 1 inch on all sides. Report pages will be 8 1/2 x 11 inch with the exception of the drawing package. The drawing package may be 11 x 17 inch pages. The 3-view drawing **must** be on an 11 x 17 inch page.

Absolute maximum page count for the report is **60 pages**, including text, tables, and figures (cover/title page and table of contents is extra). Drawing package may not comprise more than 5 of the pages of the report page limit.

All figures must be either half (1/2) page or full (1) page format. No exceptions.

*Please note that the judges will be using this same report outline for evaluating reports. ALL items listed will be expected to be present, easy to locate and identify and well documented in the report for a maximum score.*

## Design Report

1. Executive Summary: (5 points):  
Provide a summary of the development of your design. This should be a narrative description highlighting the major areas in the development process for your final configuration and a broad description of the range of design alternatives investigated.
2. Management Summary (5 points):  
Describe the organization of the design team. Provide a chart of design personnel and assignment areas. Include a (single) milestone chart showing planned and actual timing of major elements of the design process, including as a minimum the conceptual design stage, preliminary design stage, detailed design stage, flight testing and report preparation periods.
3. Conceptual Design (20 points):  
Describe the key elements of the mission requirements (problem statement). Document the alternative configuration concepts (e.g. biplane, canard, flying wing, pusher -Vs tractor, number of engines etc.) investigated during the conceptual design stage and the reason why each concept was considered. Describe and document the numerical figures of merit (FOM's) used to screen competing concepts, and the mission feature each FOM was selected to support. *Rated Aircraft Cost* should be one of the FOM's used during the screening process. Numerical data need not be extensive at this stage, but should include as a minimum: a final ranking chart giving the quantitative value of each design for each

FOM.

4. Preliminary Design (30 points):

Document the design parameter and sizing trades investigated during the preliminary design stage, and why each was felt to be important to the mission. Describe the analysis methods used. Describe the mission model used and the predicted performance. Provide estimates of the aircraft lift, drag and stability characteristics. Document the design optimization and trade studies conducted and their results.

5. Detail Design (15 points for discussion items, 10 points for drawing package, 25 points total for the section):

Document component selection and systems architecture selection. Include your final competition aircraft's *Rated Aircraft Cost* using the contest supplied cost model. RAC table should include all input parameter, intermediate and final computation.

Include a table giving data for the sized aircraft. A copy of this table must be posted by the team at their "pit" area (poster board). The table should include;

Geometry: length, span, height, wing area, Aspect Ratio, control volumes

Performance: CL max, L/D max, maximum Rate of Climb, stall speed, maximum speed, take-off field length (two sets, empty and gross weight)

Weight Statement (airframe, propulsion system, control system, payload system, payload, empty weight, gross weight)

Systems (radio used, servos used, battery configuration used, motor used, propeller (nominal), gear ratio (if used))

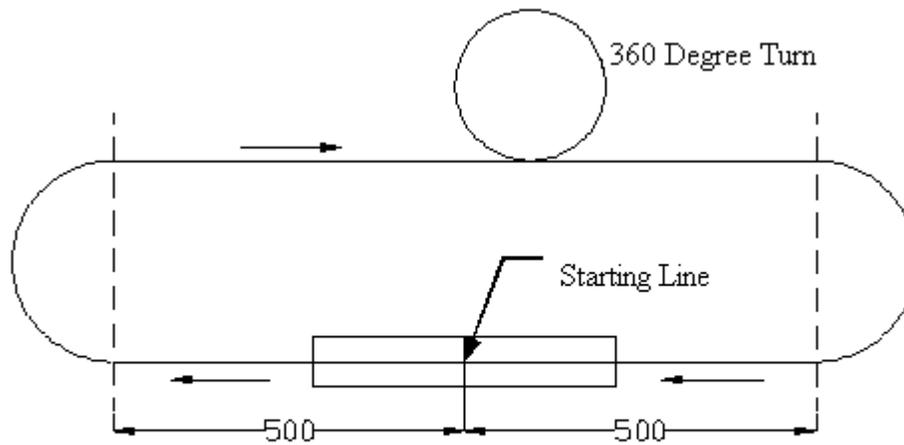
The Drawing Package will be included with this section and must contain **as a minimum** a 3-view drawing of the design in sufficient detail to indicate aircraft size and configuration; primary structure component size and location; payload size, location and restraint method; and location of propulsion and flight control system components.

6. Manufacturing Plan and processes (10 points):

Document the process selected for manufacture of major components and assemblies of the final design. Detail the manufacturing processes investigated, and describe the FOM's used (including but not limited to: availability, required skill levels and cost) to screen competing concepts. Describe the analytic methods (cost, skill matrix, scheduling time lines) used to select the final set of manufacturing processes. Include a manufacturing milestone chart showing scheduled event timings.

7. Testing Plan (5 points):

Detail testing objectives, schedules, check-lists, results and any lessons learned for component and full aircraft testing, both static and dynamic (ie. in flight).

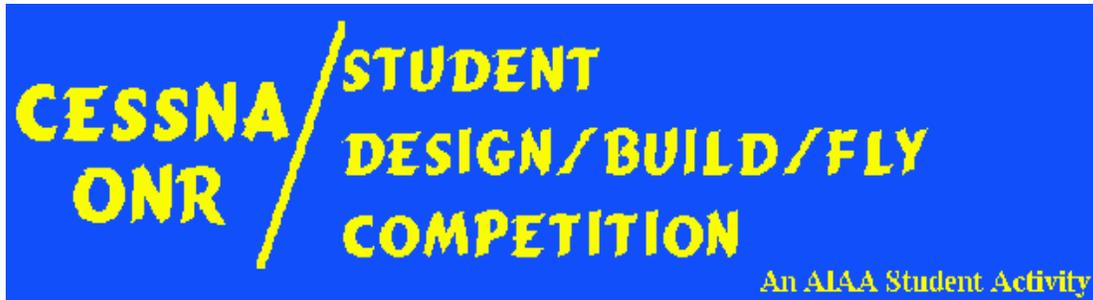


Course Layout  
Shown to Scale

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[\[Top\]](#) [\[AIAA Student Design/Build/Fly Competition homepage\]](#) [\[AIAA Homepage\]](#)

7 October 2003 Revision



## Frequently Asked Questions (FAQ) 2004 Competition Specific

**Please check the FAQ often during the competition. Please note that rules interpretation questions are not 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.**

### General Notes:

1. A question was submitted asking if the Plattenburg “Graupner Style” motors are legal for the competition. The answer is No. Teams should make sure they have documentation for their motor, preferably the purchase invoice(s) and the manufacturers labeling should be easily visible to the judges during the technical inspection. Teams may be asked to remove their motor so the manufacturers label may be checked.
2. We receive many questions about using Ni-mH, or lithium batteries. We are well aware that battery technology is making some significant improvements. We continue to monitor the capabilities of these new chemistries (and use them in the UAV systems designed here at NRL). While the other chemistries offer improved energy density, and are making significant strides at accommodating high current drains, they are still significantly more expensive. For the present contest, NiCad batteries remain the only allowed chemistry.

### Payload Questions:

1. **Question:** Are external pods for carrying the cargo permitted?  
**Answer:** External pods (wing or fuselage mounted) may NOT be used for carrying the payload. (rev 22Oct02)
2. **Question:** Does the internal water tank also have to be fabricated from 2 Liter plastic soda bottle (s)?  
**Answer:** No. The internal water tank may be of any construction as long as it’s capacity is 4 Liters or less (which will be verified during the technical inspections).
3. **Question:** Can we fabricate our own servo-controlled water release valve or must we use a specific commercial component?  
**Answer:** You may use a commercial electronically controlled valve, may fabricate your own servo controlled valve, or any combination of commercial and fabricated parts.
4. **Question:** Can we use a pump or pressurized tank to help EMPTY the water tank?  
**Answer:** No. The tank must be emptied by gravity alone. The sole exception is you may align

the tank vent tube into the onset airstream, giving a very slight positive pressure assist.

5. **Question:** Can we have more than one water outlet?  
**Answer:** No. The rules specify a single, round outlet with a maximum allowed diameter.
6. **Question:** Can the water tank(s) be removed for the ferry mission?  
**Answer:** No. The aircraft configuration for the ferry flight must exactly match the fire-fight configuration. For the ferry mission the tank MUST be empty.
7. **Question:** Can we use a pump to assist in FILLING the aircraft with water?  
**Answer:** Yes, you may use a pump that moves WATER to assist in filling the aircraft. You may not use a pump that compresses AIR and pressurizes the supply bottle to increase the filling rate.
8. **Question:** Is there a minimum capacity of water the aircraft must be capable of carrying?  
**Answer:** No. You may design the aircraft to carry less than the specified maximum capacity.
9. **Question:** Can we connect the soda bottles together when using them to fill the aircraft? Can the outlet of the connected bottles be larger than the outlet of a single bottle?  
**Answer:** You can "connect" more than one bottle using any type of manifold/assembly you desire. The outlet of the manifold/assembly and the inlet of the aircraft are not regulated in size. You may not modify the soda bottle itself in any fashion, but you may modify the "cap" to accommodate your manifold/assembly. Also see the answer to Q&A #7 above.
10. **Question:** Can we swap out or replace the aircraft's internal tank between sorties instead of re-filling it?  
**Answer:** No.
11. **Question:** Can we seal the vent for the water tank for the inverted lift test during the technical inspection?  
**Answer:** Yes, you can seal the vent with a plug, tape, or other. You can also just leave it alone, as if the "outlet" is closed very little water would leak out when turned inverted for the short period of time of the test.
12. **Question:** Can we use a collapsible or variable volume tank in the aircraft?  
**Answer:** Yes, you may use a collapsible or bladder style tank as long as it is made from a non-elastic (ie. will not expand under pressure) material and it's maximum volume does not exceed the allowed volume.

## Flight / Mission Questions

1. **Question:** Does the ten minute mission window apply to one flight attempt (chosen from Mission A, or B) or to two different Missions flown in one uninterrupted sequence?  
**Answer:** The 10 minute window is for a single mission event (A, or B).
2. **Question:** In the rules examples, all the times are in round minutes. What accuracy will be used for determining flight times?  
**Answer:** It's just to make the rules document cases simple. We will record times to the accuracy possible, probably to nearest second.
3. **Question:** Is there a minimum altitude for flying the course?  
**Answer:** No. Altitude must be high enough for safe flight as set by the discretion of the Contest Director.
4. **Question:** How are the turns made, and is there a set turn radius?  
**Answer:** The turns may not be initiated until the turn judge raises his flag (for the two 180 degree turns), but may then proceed to be any turn radius and rate the aircraft is capable of. The 360 degree turn can be initiated anytime the aircraft is on the "downwind" leg and also may be any turn radius and rate the aircraft is capable of.
5. **Question:** In the rules, it says that the flight time lasts "...until the aircraft comes to a complete stop past the starting line at the completion of all laps..." Does the ground crew have to return the aircraft to the runway before the time is stopped?  
**Answer:** If the airplane rolls off of the runway BEFORE reaching the starting line it must be

returned to the runway to taxi or be carried to the starting line. If it rolls off of the runway PAST the starting line it does not need to be returned to the runway.

6. **Question:** Is it safe to assume that if the rules do not explicitly forbid something, it is allowed?  
**Answer:** The rules are intentionally designed to not impose too many limitations while allowing each team an equal chance. If something adheres to the "spirit" of the rules it is likely to be allowed. If you have any specific questions you would like clarified they may be addressed in a private e-mail to the contest administrator. Ideas will not be disclosed to other teams if they represent a legal and innovative approach. If it is deemed to be not legal, it may be added to this FAQ or posted to the other teams at the administrators discretion.
7. **Question:** Can we tailor the configuration of the aircraft differently for the Fire Fight and Ferry missions? For example, could we use different sized propulsion systems for each flight?  
**Answer:** You cannot change the hardware configuration of the aircraft for the different missions. You could however run only 1 motor of a two motor aircraft for the Ferry flight, and run both motors for the Fire Fight flight, provided both motors and propellers are installed for all flights and you simply "shut down" one motor for the Ferry flight.

You can also change the propeller diameter/pitch for each flight. We will allow this "change" since it can be thought of as mimicking a variable pitch propeller and would be impossible for the judges to police anyway.

## Report Questions

1. **Question:** For the "Testing Plan" section of the report in-flight tests are required. Is there a point penalty for not completing the in-flight tests?  
**Answer:** To obtain the maximum points **all** information asked for in a section must be present. Point deductions will be determined by the judges based on provided-vs-missing information.
2. **Question:** In the RAC is "motor controller" the same as "speed controller".  
**Answer:** Yes, the two terms could be taken interchangeably.
3. **Question:** In the RAC do electric brakes count as a type of controller  
**Answer:** Yes. A single servo or solenoid controlling air or hydraulic brakes would count as one controller. If a separate electric actuators are used for each wheel, that would count as two (or more) controllers
4. **Question:** The RAC states: "A "V" tail is considered to be a Vertical surface without control (5 hr) plus a horizontal surface with controls (10 hr), for a total of 15 hrs" .How is the horizontal span of the V-tail applied under the provision that: "A horizontal surface is a 'wing' if it is more than 25% of the span of the greatest span horizontal surface."?  
**Answer:** For the "25% span" rule the horizontal projection of a V-tail will be used as the effective horizontal span.
5. **Question:** Could you please define "control volumes" as stated in the Rules, Design Report section, paragraph 5  
**Answer:** These are the classic static control volumes,  $(\text{Surface\_area} \times \text{Lever Arm}) / \text{Reference\_length}$
6. **Question:** How will the maximum exposed wing chord would be measured for a flying wing. For payload considerations, it is stated that the "fuselage" is the inner most 9" of semi-span. Does this also apply for the maximum exposed chord measurement, or will the max chord be measured at the centerline (if this is the largest chord length).  
**Answer:** For "All Wing" configurations the maximum wing chord will be measured 9" out from the centerline or at the largest chord location that is MORE than 9" out from the centerline.

## General Questions

1. **Question:** Can there be thrust vectoring via rotating the engine, nozzles, blown surfaces etc.?  
**Answer:** Yes. Any of the above options is allowed, and may be varied during flight. However, "rotary wing" vehicles are not allowed, so you may need to consult the judges with your specific design and it's thrust levels to be sure it doesn't cross over the line into vertical flight capability.
2. **Question:** Do all of the team members need to be student members of AIAA?  
**Answer:** Since the DBF is part of the AIAA competitions sanctioned by the Student Activities Committee and the AIAA Foundation, all team members should be student members of the AIAA.
3. **Question:** What was the maximum number of people that can make-up a team.  
**Answer:** There is no specific limit on team size. It is up to the team itself to determine a size sufficient to meet the required tasks and small enough to remain manageable. It is expected most teams would fall in the 5 to 10 member size range, but this is only an estimated guideline.

There is a maximum size of the flight crew (pilot and assistant) and ground crew (3) for this years competition. Please see the RULES section for more details on the limitations on the flight and ground crews.

4. **Question:** Is it necessary to list all team members on the entry.  
**Answer:** Yes, we need to know all the team members to verify the under/upper classmen rule.
5. **Question:** What is meant by "Upper and Under Classmen"  
**Answer:** Upper Classmen are (for purposes of the contest) seniors and/or graduate students. Lower Classmen are Freshmen, Sophomores and Juniors.
6. **Question:** Is it allowed to have/declare more then 1 pilot in a team (in case one of them can not go to the contest, or simply have a back-up pilot)?  
**Answer:** Yes, teams may register multiple pilots as long as each meets the requirements listed in the rules.
7. **Question:** Can we have corporate sponsors? If so, can we put their logo on the UAV at any place that pleases them?  
**Answer:** 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 team members.

Sponsor and university decals or logos may be placed as desired. Teams should make sure that the final color scheme of the aircraft provides good visibility of the aircraft location and orientation for the pilot.

8. **Question:** What is COB in the submission dates mean?  
**Answer:** COB - Close of Business: data must ARRIVE by 5 PM local time at the specified location.
9. **Question:** The contest day is graduation. Is there any possibility of moving the contest.  
**Answer:** In selecting the contest date we have tried to minimize the conflicts with graduation, finals, mothers day,... We can't miss all possible conflicts as each university is on a slightly different schedule. Moving the date earlier would greatly increase the risk of unacceptable weather, and further shorten the time available to design and build the entries (which will seem VERY short by then).
10. **Question:** We were wondering if it wouldn't be easier to just send an official representative from the competition to our school, fly our plane, and take down the score. Then compare with all the other schools competing(they'd probably be on home turf as well), and make the final decision that way?  
**Answer:** The single site -vs- fly-at-home issue was discussed much by the contest organizers prior to selecting the current contest structure for many of the same reasons you raised. We realize that it is difficult for students to obtain funds for fabricating an entry, even without the added costs of travel. In the end we selected the single-site format for mainly two reasons: (1) the single-site format will allow the teams to see each others entries and learn from each other and will add to the

competitive fever always present when pitting your best efforts against others; and (2) the single site is the only way to assure a level playing field for all entries, as weather variations at multiple sites and days would inevitably help some entries and hinder others.

11. **Question:** At what wind speed will the contest be called.  
**Answer:** It will be up to each team to determine whether they want to fly or not. The contest will be called (and the rain date used) if the wind speed exceeds 30 mph for a period of time sufficient to prevent all teams who are ready to fly from being assigned a flight time slot. The 30 mph limit is consistent with normal AMA competitions and is required to retain our contest insurance coverage.
12. **Question:** Will a hard runway be used?  
**Answer:** We will select a site that provides a paved runway. Note that a "smooth" paved runway for manned aircraft may still seem "rough" for contest aircraft.
13. **Question:** Our team has completed our design calculations and we have found a manufacturer that carries wing components that will meet our design criteria. Can we purchase components (i.e. foam cores and skins) to construct the wing for our UAV, or are we required to build it from scratch?  
**Answer:** You may use unassembled components such as wing cores providing they are integrated in a way that results in the final configuration being an original design.
14. **Question:** Does the plane have to be an external propeller plane, or can it be a duct fan UAV?  
**Answer:** Ducted fans are also legal if they use a commercial fan assembly.
15. **Question:** In terms of propellers. Can they be any kind of Gas engine propeller if we wish? Or do they have to be Electric motor propellers? And if we can only use electric motor propellers, can we cut them? Basically, if we wish to, can we use any kind of non-electric motor propellers if they are commercially available?  
**Answer:** Any commercial propeller for either gas or electric models may be used. Props may be cut to reduce their diameter but the blades may not be reduced in thickness (such as by sanding the airfoils to a new profile) or in chord (such as by trimming the trailing edges).
16. **Question:** What constitutes "over the counter" batteries, and does this apply to the battery pack or to the individual cells?  
**Answer:** The "Over the Counter" refers to the individual cells. This is a change from the rule for the 1996/97 contest year.
17. **Question:** How is the radio fail-safe described in the safety supplement to be implemented.  
**Answer:** This is a feature available in many production RC radio systems. It is **required** that your radio system be able to provide this function.
18. **Question:** Can we construct a composite can for an otherwise stock over the counter model motor?  
Does the motor controller have to be an over-the-counter controller?  
**Answer:** The motor and/or controller must be an unmodified commercial product. The intent of this rule is to prevent excessive cost, and to provide all teams access to equal propulsion technology so they can concentrate on the aircraft aerodynamics and structural aspects.
19. **Question:** Do the wires and connectors have to be commercially available?  
**Answer:** Yes
20. **Question:** When you check the CG, what kind of a point will you use? For example will it be checked with fingers or dowels or something even sharper?  
**Answer:** The CG check will be coincident with the structural verification test described in the Safety Requirements supplement to the basic rules. Specifically, two team members will be asked to pick the aircraft up by the wing tips using their hands (usually a clenched fist placed under the wing at the desired location works well). They will (gently) lift the aircraft at it's full contest weight by the wing tips at the marked axial CG location.
21. **Question:** Will the payload be supplied by the team or the contest administration?  
**Answer:** By the team.

22. **Question:** If battery power fails can an immediate landing be made without making a complete lap (question paraphrased by editor)  
**Answer:** First priority is safety of personnel, followed by minimizing damage to facilities and equipment. If power fails unexpectedly the pilot will setup for as safe an emergency landing as possible. If the plane does not pass the downwind pylon that sortie's payload will not count, but any prior sorties will still be credited toward the overall score.
23. **Question:** Will there be a maximum altitude, other than the visibility requirement?  
**Answer:** There is no specific numerical altitude limit. It would be very difficult to enforce a rigorous altitude limit without altitude telemetry equipment on each aircraft which would be a significant expense burden. The contest flight judge will enforce maintaining a "safe" altitude for both personnel/ground and flight visibility reasons, and may order the pilot to descend if he feels the altitude is too high. In general, altitudes of 300 to 500 feet are probably nominal, and altitudes near 1000 feet are likely to have the judge order a decent.
24. **Question:** Would we ever have to make any vertical loops with the UAV?  
**Answer:** No
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