



# 3rd Annual AUVSI Student UAV Competition

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***NORTHROP GRUMMAN***



## 2005 MISSION, SCORING AND RULES

## OBJECTIVE

The goals of this competition are to challenge a new generation of undergraduate university engineers to design and build unmanned aerial vehicles (UAVs) capable of performing realistic autonomous missions in an aviation environment, and to foster ties between young engineers and the organizations developing UAV technologies.

Note: The performance portion of the competition is limited to 15 schools based on mission time. In the event that more than 15 schools send in application and payment, schools selected to compete will be based on receipt of the One Page Fact Sheet (first received first selected). In the event schools are not selected the application payment will be refunded.

## SCHEDULE

Event	Date
Application and Payment Due	November 15, 2004
One Page Fact Sheet on Vehicle Due	May 19, 2005
Journal Paper Due	June 16, 2005
Teams Check-in and Orientation (7:00 PM)	Thursday, June 30, 2005
Safety Inspections	Friday, July 1, 2005
Static Judging, Oral Presentations and Practice Time (PM)	Friday, July 1, 2005
Final Competition Runs	Saturday July 2, 2005
Awards Reception and Banquet (7:00 PM)	Saturday, July 2, 2005
Weather Day (if needed)	Sunday, July 3, 2005

## POINTS OF CONTACT

Competition Director: Joe Brannan  
Naval Air Systems Command  
[joe.brannan@navy.mil](mailto:joe.brannan@navy.mil)  
410 610-3505 or 240 538 1064

Technical Director: Mark Pilling  
Eagan McAllister Associates, Inc. (EMA)  
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301 863 2192 ext. 2345 or 410-610-8472

*Note: This competition will be held on a military base; therefore it will be necessary for ALL attendees to supply security-related information well in advance of the contest date (we will e-mail the teams to request the information two months prior to the contest date). Non-United States citizen participants are requested to obtain a passport and visa well in advance of the contest date, as your passport number and issue date will be REQUIRED to process you for field access. Because of the time needed to obtain and process security information late additions to the team roster will not be able to attend the fly-off. AUVSI will not be responsible for any participants unable to gain access to the competition site. In the event of increased threat condition, it is possible that the military may shut down access to the base in which case the competition might be cancelled.*

## MISSION

### Overview

The complete mission objectives are for an unmanned, radio controllable aircraft to be launched and transition or continue to autonomous flight, navigate a specified course, use onboard payload sensors to locate and assess a series of man-made objects prior to returning to the launch point for landing. Mission time and other factors as described herein, will be scored.

## **Takeoff**

Takeoff must take place within one of two designated Takeoff/Landing areas, depending on wind direction. This area will be paved asphalt surface, roughly 100 ft wide, with no height obstacles. Takeoff may be either manual or autonomous (extra points will be awarded for autonomous takeoff). After a manual takeoff, the air vehicle must successfully transition to autonomous flight mode before the next phase of the mission may proceed. For the remainder of the mission, the air vehicle must maintain steady, controlled autonomous flight at altitudes above 50 feet and under 500 ft AGL.

## **Mission Phases**

### **Dynamic Air Vehicle Control**

Demonstrate dynamic control of the air vehicle during autonomous flight by changing airspeed, altitude and heading as directed by the Judges.

### **Waypoint Navigation**

Waypoints (GPS coordinates) will be announced the day prior to the competition. Air vehicles will be required to pass over selected waypoints, remain outside of no-fly zone waypoints and search a specified area designated by waypoints during the mission.

### **Targets and Interaction**

Specific target information will be announced on the day prior to the competition. At some point during the mission, the air vehicle must proceed to a designated area and search the area for specific targets, report GPS location and provide imagery. Resolution will be graded.

#### Specific Information Required

- The total number of targets located within the search area
- The coordinates of each target
- The orientation of each target

Dynamic Re-Tasking for emergent and pop-up targets or waypoints during mission brief/preflight and after takeoff should be expected and judged.

## **Landing**

Landing must occur completely within the designated takeoff/landing area. Transition to manual control is permitted for landing. Extra credit will be provided for autonomous landing, amount of control in landing, and minimum space required by landing. The mission will end when the air vehicle motion ceases and engine is shutdown.

## **Total Mission Time**

Total mission time is 40 minutes and includes preflight, take-off, mission flight, land and data processing. Accuracy of results and time required to submit results will be measured. Points will be deducted for going over mission time.

## **General Rules**

During the entire mission, air vehicles must remain in controlled flight and within the mission boundary. The mission boundary is defined by Webster Field runways, taxiways and other features (diagram to be provided). Any vehicle appearing uncontrolled or moving beyond the mission boundary may be subject to immediate flight termination. Points will be deducted for flying in no-fly zones or over flight of the crowd area.

After takeoff, the air vehicles must attain and remain in flight at an altitude of at least 50 ft AGL for the duration of the mission. Decent below 50 ft AGL will constitute the end of the mission and any further progress will not be scored. Airfield maximum Airspace altitude is 1,000 ft AGL

Once in autonomous flight the vehicle must operate with no external control or guidance. While under autonomous flight, the team will be directed to provide in-flight mission update to the vehicle.

Exotic, dangerous fuels/batteries or components are discouraged. All designs and systems will undergo a rigorous safety inspection before being permitted to proceed.

The mission will end when any of the following occur:

- All objectives have been achieved
- The 40-minute performance period ends.
- The vehicle descends below 50 ft AGL except during landing.
- The vehicle exits the mission boundary or exceeds Airfield maximum Airspace altitude
- The judges order the end of the mission.
- The team captain requests the end of the mission.

## **SCORING CRITERIA**

Student teams will be scored on three elements: Journal paper, oral briefing/static judging, and mission performance. Approximately 60% of the total score available will be awarded for the mission performance element with 20% each going for the journal paper and oral briefing/static display. A team of independent judges will evaluate and score each element. Each element score will be summed for a total team score.

## **FACT SHEET**

Six weeks prior to the competition (May 19, 2005) a one-page fact sheet providing basic descriptions of the air vehicle and systems must be submitted. It shall include frequencies used for air vehicle control (manual or autonomous) and payload control/ imagery receipt, fuel and/or battery type and air vehicle dimensions including gross weight.

## **Journal Paper**

Each team is required to electronically submit a journal paper that describes the design of their entry and the rationale behind their design choices. Overall UAV system design, features and expected performance (including test results) should be included. Descriptions are required for the air vehicle, ground control station, data link, payload and method of autonomy. Specific attention should be paid to safety criteria. The journal paper must include a photo of the UAV.

This paper may be no more than 20 pages long (including all figures, references, and appendices). Additionally, each journal paper must include an abstract of no more than 250 words. The journal paper and abstract must be printable on standard 8.5 × 11-inch paper, with margins of at least 1 inch on all sides, and all text must be in 12-point or larger font. Each page must bear a footer with the page number and the team name.

The journal paper must be received in electronic format (pdf is preferred) via email to [mark\\_pilling@emainc.com](mailto:mark_pilling@emainc.com). Papers are due June 16, 2005. Teams that do not meet the deadline may be disqualified from the competition.

### **Static Judging/Oral Briefing**

Each entry will be subject to static judging before being allowed to compete. During the static display time, the judges will visit each team. At this time, the team will provide a 15 minute maximum presentation which highlights their approach, design, and expected performance. Unique or innovative features and safety approaches should be included. The judges will evaluate each entry for technical merit, safety, and craftsmanship, and effectiveness of briefing. Note: Each team is required to have at least one member attending their entry vehicle throughout the static display period (not just during the judges' scheduled visit).

### **Mission Performance**

This element shall have the highest weighting factor. Judges will score mission performance according to a number of criteria, including:

- *Takeoff* – controllability, use of area, ease of use, use of autonomy
- *Autonomous Control* – ease of transition, altitude and flight path control
- *Waypoint Navigation* – waypoint navigation accuracy
- *Target Reconnaissance* – accuracy of target count, locations, orientation and resolution; use of autonomy in target reconnaissance. Manmade targets up to 4 ft by 4 ft will be used.
- *Landing* – controllability, landing accuracy, use of autonomy in landing, post-landing condition of air vehicle and payload
- *Mission Time* – time required from pre-flight to completion (including data reduction)
- *Safety* – demonstration of inherent safety features (hardware, software, engineering approaches, etc.).
- *Ability to change mission, just prior to and during flight.*

### **OFFICIAL RULES, SUBMISSIONS, AND FEES**

The official source for all information concerning rules, interpretations, and information updates for the 2053 AUVSI Student UAV Competition is the World Wide Web home page at: <http://www.auvsi.org> or <http://www.auvsi-seafarer.org>.

An Intent to Compete form is available on the website. A completed form with entry fee is due to AUVSI Seafarer Chapter no later than November 15, 2004.

The submission must be in English and is not considered official until the entry fee of five hundred U.S. dollars (\$500) has been received by AUVSI Seafarer Chapter. As the competition format cannot handle an unlimited number of entries, the organizers reserve the right to limit the total number of entries that are allowed to compete by declaring the competition closed to new entries before the due date above. As with all official information, this announcement (should it be necessary) will appear on the official website.

Teams may comprise a combination of no more than 10 Inter-disciplinary undergraduate students or high school students. Members from industry, government agencies, or universities (in the case of faculty) may participate upon approval from the Competition Director; however full-time students must compose the team with the exception of the air vehicle pilot, and no more than one grad student. Faculty/advisors cannot do anything but be the safety pilot during the competition. Students will present, do data analysis, etc. Participants must be enrolled at their schools for at least 12 credit hours or more per quarter/semester during winter and spring 2005 to be considered "students" unless cleared by the Competition Director (for cases of 2005 graduating seniors not considered as grad students for this competition).

The student members of a joint team must make significant contributions to the development of their entry. ***Only the student component of each team is eligible for the cash awards.*** One student

member of the team must be designated as the "team captain." Only the team captain may speak for the team during the competition run. Teams registering to compete should indicate on their application form the name of the individual or organization to whom prize checks should be made payable.

### **Aircraft Requirements - General**

Each team may enter one aircraft into the competition. The aircraft may be of any configuration except lighter-than-air and must be free-flying, autonomous capable and have no entangling encumbrances such as tethers.

Aircraft and pilot must be Aircraft Modelers Association (AMA) legal. This means that the aircraft TOGW (take-off gross weight with payload) must be less than 55 lb.

### **Aircraft Requirements – Safety**

Aircraft and participants must comply with the basics of 2005 Official AMA National Model Aircraft Safety Code effective January 1, 2005 except as modified for autonomous flight and airfield restrictions. This code may be found in its entirety at the following website

<http://modelaircraft.org/templates/ama/safetycode03.asp?sid=5\6567B258FDC34F6300913F448C352DB>.

The following specific provisions of this code will apply to the AUVSI Student UAV Competition:

- GENERAL - (experimental aircraft rules do not apply)
- RADIO CONTROL - (combat does not apply ; organized racing event does not apply)
- FREE FLIGHT - does not apply
- CONTROL LINE - does not apply
- GAS TURBINE
- GIANT SCALE RATING - does not apply

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

Physical inspection of vehicle to insure structural integrity, including:

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 checks, 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 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 by weight (Teams must inform the inspector and judges of their maximum design capacity and must make all flights within that capacity).

All aircraft must be capable of an override of the autonomous mode of flight (return to manually flown radio mode).

Radio fail-safe check: All aircraft radios must have a fail-safe mode that is automatically selected during loss of transmit signal or manually selected if required by the safety observer. 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)

**The Radio Fail Safe provisions will be strictly enforced.**

*For other than fixed-wing air vehicles, similar safety requirements will be assessed.*

The officials may disqualify any entry that they deem to pose an unreasonable safety hazard.

The officials will confer with representatives of the host facility, and any entries that, in the opinions of the officials or of the representatives of the host facilities, pose an unreasonable risk to the integrity of the host facility will be disqualified. AUVSI and the host organization, their employees and agents, as well as the organizing committee, are in no way liable for any injury or damage caused by any entry, or by the disqualification of an entry.

**SEE YOU AT WEBSTER FIELD NEXT  
SUMMER!**