

# Military Student Multirotor Fest

## May 26-30, 2025

### ***Competition Rules***

#### **1. Introduction**

**1.1. The aim of the competition:** MSMF 2025 is designed to harness the scientific research potential of students from military educational institutions in the field of Unmanned Aerial Systems (UAS). In this competition, students can test and assess their skills in designing, building and programming a multi-rotor UAS under tactical conditions.

#### **1.2. Competition sections:**

**1.2.1. Military section:** Launching a simulated standard explosive charge at a fixed point; A mission to transport an individual first-aid kit to a certain area with known coordinates; A reconnaissance mission to discover, identify and locate targets.

**1.2.2. Open section:** obstacle course using FPV video transmission.

#### **1.3. Conditions for participation**

**1.3.1. Military section:** Students from the undergraduate, master and PhD programs from military institutions of higher education in Romania, NATO member states and other partner countries. A team is composed of a maximum of four students with well-defined roles and responsibilities: UAS operator (pilot), payload operator, system technician, mission planning and communications technician.

**1.3.2. Open section:** students from the undergraduate, master and PhD programs from military and civilian institutions of higher education in Romania, NATO member states and other partner countries. A

team consists of a maximum of two students with well-defined roles and responsibilities: UAS operator (pilot) and system technician/observer.

- 1.4. Registration for the competition:** is continuous and is carried out through the participating universities, respectively the coordinating teachers, according to the calendar published on the website of the organizing institution.
- 1.5. Competition coordinator:** Col. Assoc. Prof. Cătălin CIOACĂ, PhD; [catalin.cioaca@afahc.ro](mailto:catalin.cioaca@afahc.ro); Phone Number: +40268423421 int. 222; +40723172164
- 1.6. Competition Committee:** Lecturer eng. Sebastian POP; Assoc. Prof. eng. Vasile PRISACARIU, PhD; Lt.cdr. eng. Cristian VIDAN, PhD, Eng. Serjiu OBREJA.
- 1.7. Responsibilities of the competition committee:** establishes the team of referees; checks and approves the multi-rotor UAS for each team; supervises the competition together with the team of referees; settles any appeals/ irregularities; validates the final results of the competition.
- 1.8. Responsibilities of the referees' team:** checks each team's competition multirotor UAS before each task; ensures that the competition is conducted in accordance with the rules; awards the points in accordance with the competition rules; announces the team's result in the event. The refereeing team consists of 3 neutral persons (1 main referee and 2 assistants) agreed by the participating teams.

## **2. Military Section**

### **2.1 Construction requirements:**

**Support Frame.** The mechanical structure (frame and landing gear) shall be designed and manufactured by the participating team members by machining and assembling prefabricated elements (pipes, profiles, plates, strips), additive manufacturing, molding, CNC machining. The use of similar frames that can be purchased commercially is prohibited. Each team in the competition must submit to the Competition Committee documentation describing the stages of

the manufacturing process of the supporting frame (mechanical structure).

**Geometrical configuration of the propulsion system:** rotary wing system capable of fixed-point flight.

The **maximum take-off power** developed by the UAS must not exceed: 3000 W.

**Mass:** maximum 4 kg (including batteries and auxiliary systems).

**System control/ piloting:** radio remote control (commercial) and telemetry system for data visualization on tablet or laptop. Radio systems shall comply with European Directive 2014/53/EU.

**The autopilot system/ autonomous system** shall have GEOFENCE functions and shall be capable of commanding the UAV to automatically return to the take-off site or to automatically land at the last vertical in the event of loss of radio link with the UAV. For autonomous missions, the UAV shall offer the possibility for the operator to take over the control of the UAV manually or semi-automatically.

## 2.2 Description of the competition tasks and the points awarding system.

### Task 1 – Launching/ dropping a simulated standard explosive charge on to a fixed point

The competition committee will distribute to each participating team, 2 hours before the start of the competition, 6 simulated standard explosive charge models (Figure 1).

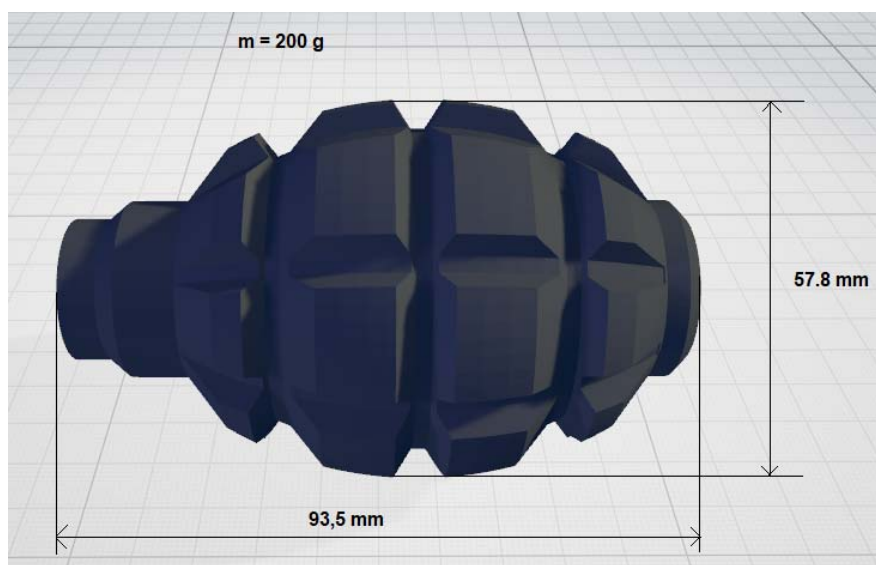


Fig. 1 Simulated standard explosive charge

The multi-rotor UAS will be positioned in the starting area, with the simulated standard explosive charge on it. The target area will be set up at a distance of 100 m from the start area and will be marked by three concentric circles of radius 0,5 m, 1,5 m and 2,5 m respectively. The launch of the simulated standard explosive will be performed from 3 heights: 50m AGL, 90m AGL, 120m AGL. The launch of the simulated standard explosive will be commanded when the multi-rotor UAS is at an altitude established for the task (measured by its own navigation system). For the control and accuracy of the launch, it is allowed to equip the UAS with a camera in the visible spectrum, with the possibility of transmitting images to the operator in real time.

Mass of simulated explosive charge: 200g.

Number of attempts: 2.

The maximum score for this test is 100 points.

The best score of the two attempts will be taken into consideration.

The score will be calculated with the following equations:

$$P_1 = C_{med} + BT$$
$$C_{med} = (C_1 + C_2 + C_3) / 3$$

where:

$C_i$  = 80 if the load falls inside the circle of radius 0,5 m; 60 if the load falls inside the circle of radius 1,5 m; 40 if the load falls inside the circle of radius 2,5 m; respectively 0 if the load falls outside the circle of radius 2,5 m;

BT = Time bonus

The time bonus will be calculated with the following equation:

$$BT = 20 * (T_{max} - T_{team}) / (T_{max} - T_{min})$$

where:

$T_{max}$  = The maximum allowed duration of the competition event (10 min, counted from take-off with the first load until landing in the start area after the launch of the third load);

$T_{min}$  = The best time achieved by a team, taking into account all the times of the two attempts;

$T_{team}$  = Time achieved by the team.

The time bonus is awarded to the team only if the charge hit the target from all

3 altitude levels.

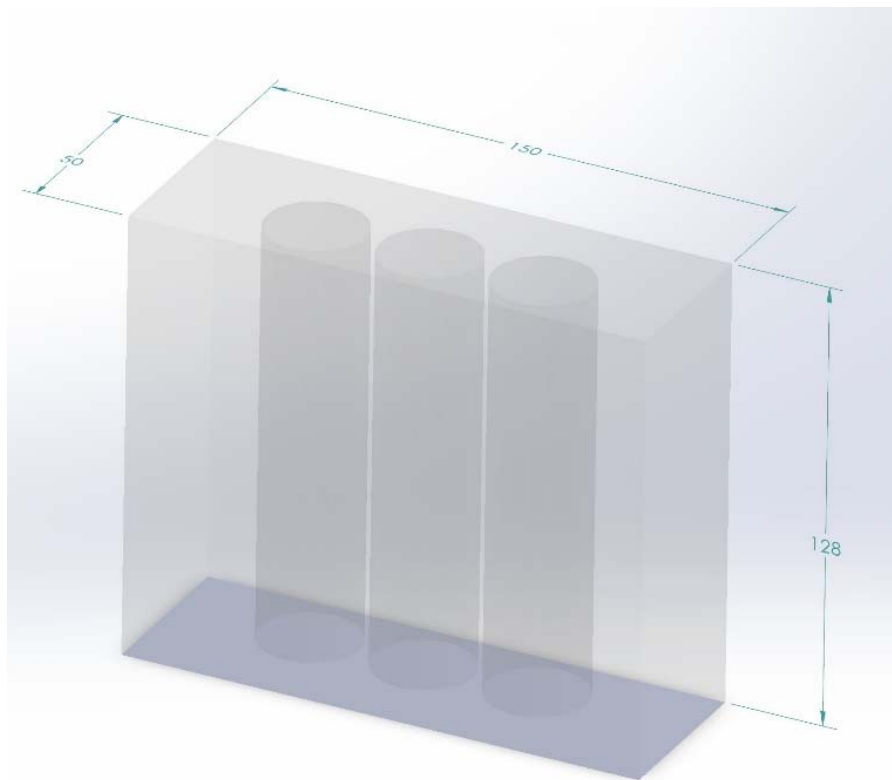
The order in which the teams will enter the competition for task 1 will be determined by drawing lots 2 hours before the start of the event.

### **Task 2 - Delivery of an individual first aid kit to an area with known coordinates**

The competition committee will provide each participating team, 1/2 hour before the start of the event, with the coordinates of the area in which the first aid kit should be placed. The coordinates will be provided in WGS 84 format.

The area will be marked by 3 concentric squares of 1 m, 1,5 m and 2 m respectively, the center of the squares being placed at a maximum distance of 800 m from the take-off point.

The first aid kit is a translucent plastic box with dimensions: L 150 mm; W 50 mm; H 128 mm. Inside the kit will be placed 3 glass tubes filled with antiseptic solution (Figure 2).



**Fig. 2** First aid kit

First aid kit mass: 250 g.

Number of attempts: 2.

The maximum score for this task is 100 points.

The best score of the two attempts will be taken into consideration.

The score will be calculated with the following equation:

$$P_2 = C + BT$$

where:

C = 80 if the first-aid kit is placed in the 1 m square; 60 if the first-aid kit is placed in the 1,5 m square; 40 if the first-aid kit is placed in the 2 m square; respectively 0 if the first-aid kit is placed outside the 2 m square;

BT = time bonus.

The time bonus will be calculated with the following equation:

$$BT = 20 * (T_{\max} - T_{\text{team}})/(T_{\max} - T_{\min})$$

where:

$T_{\max}$  = Maximum allowed duration of the competition event (8 min, counted from take-off to landing in the start area);

$T_{\min}$  = The best time obtained by a team, taking into account all the times of the two attempts;

$T_{\text{team}}$  = Time achieved by the team.

The time bonus is awarded to the team only if the kit has been placed in the marked area.

The team whose first aid kit is destroyed (test tubes broken, storage box cracked/broken or septic solution spilled) will receive 0 points, regardless of where they are placed.

The team whose UAS lands in the individual first-aid kit placement area and is unable to take off will receive half the score.

The method of flying and placing the first-aid kit in the concentric squares, as well as its attachment to the UAS, is at the discretion of each team.

The order in which the teams will enter the competition for task 2 will be determined by drawing lots 2 hours before the start of the event.

### **Task 3 – Reconnaissance mission to discover, identify and locate targets**

The competition committee will provide each participating team, 2 hours before the start of the event, with the coordinates of the area where the reconnaissance mission will take place.

Area coordinates will be provided in WGS 84 format. Coordinates of the identified targets will also be reported in WGS 84. The use of RTK or PPK type positioning systems is not permitted in this task.

The maximum time to complete the mission is 20 minutes and there is only one attempt.

To execute the mission, the UAS will be equipped with a payload camera in the visible spectrum or any other sensors, which will NOT transmit images and/or data to the ground in real time. Image and data storage will be on-board the aircraft.

For safety of the mission, the UAS can be equipped with an FPV camera of up to 3 Mpx oriented in the longitudinal axis of the aircraft.

The information obtained from the sensors on-board the multi-rotor UAS will be summarized post-mission by the team members in a standardized report, written in accordance with NATO STANAG 3596, Ed. 5 (2003), Annex A, Category 06: Military Activity.

The report will be drafted in electronic format and sent to the main arbitrator, within 45 minutes after the end of the mission, to the e-mail address: [arbitru.MSMF@afahc.ro](mailto:arbitru.MSMF@afahc.ro)

Three points will be awarded for each item in the report containing true and complete information. For truthful incomplete information, a proportional score is given, and the inclusion of erroneous information will lead to the award of 0 points for the item. The sum of the points obtained is the score of the sample 3,  $P_3$ .

The order in which the teams will enter the competition for task 3 will be

determined by drawing lots 2 hours before the start of the event.

The final score will be calculated with the formula:

$$P = 0,3 * P_1 + 0,2 * P_2 + 0,5 * P_3$$

### **3. Open section**

#### **3.1 Construction requirements:**

The section consists of a single sample: timed obstacle course for multi-rotor UAS equipped with FPV technology.

Both customized and commercial UAS are accepted, which can pass through the obstacles detailed in section 3.2.

UASs must be equipped with a 'fail-safe' system that stops the engines automatically in case of emergency.

#### **3.2 Description of the competition tasks and the points awarding system.**

The race consists of a 300-500 m course, which includes: technical sections, tight curves and straight lines.

The technical sections include the following types of obstacles: standard gates type 1 (600x600 mm) (Figure 3); type 2 (600x1200 mm) (Figure 4); type 3 (800x1200 mm) (Figure 5); slalom area between the cones and acceleration area. The course will be marked with demarcation ribbons.

Before the start of the race, a flying session will be organized to familiarize participants with the route.

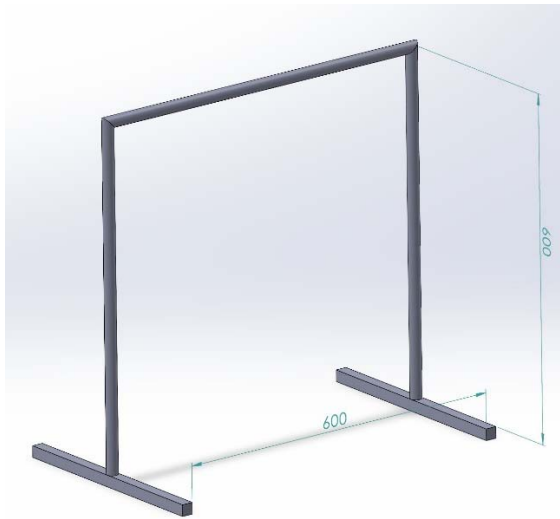
Number of attempts: 2.

The order in which the teams enter the competition for the first attempt will be determined by drawing lots, and for the second attempt will be the reverse of the time obtained in the first attempt.

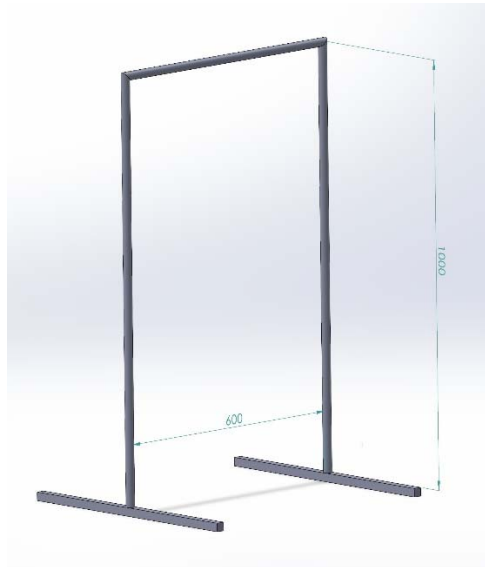
Penalties: 10 s for each missed obstacle and 5 s for each cone.

The ranking will be based on the average total time (including penalties) obtained in the 2 attempts.





**Fig. 3** Gate type 1



**Fig. 4** Gate type 2



**Fig. 5** Gate type 3

#### **4. Safety measures and emergency procedures**

The necessary authorizations for the training flights and the two competition sections will be obtained by the organizer.

The team is disqualified if it flies in areas other than those strictly marked for training and competition, or if the aircraft loses radio contact with the operator and does not automatically execute the "Return to Home" or "Landing" functions.

During the training and competition, it is strictly forbidden to turn on radio communication equipment except for those that are running training or during the competition. Turning them on will automatically lead to the disqualification of the respective team.

In the event of a crash, the UAS must be left on the ground with the engines switched off until the end of the event. Any UAS that crashes must be recovered only with the approval of the chief referee.

It is recommended that UAS are also equipped with recovery systems (e.g. parachutes).

The presence of the team captain and the multi-rotor UAS operator is mandatory at the general safety briefing.

All batteries must be transported and stored in fireproof bags or in an approved fire-resistant container.

A power charging area will be available and 220 V outlets will be provided. Teams are advised to bring chargers and extension cords.

Weather data for the competition days will be provided to the teams on a continuous basis through the specialized structure of the organizing institution.

The event will be postponed/ interrupted if the wind exceeds 10 m/s or in case of rain.

The spectator area will be located at least 10 meters from the course, with barriers and nets.

The organizer will ensure the presence of a medical team in the competition area.