AeroCup PORTUGAL

AeroCup 2026 Regulations

V1.1

March 24th, 2026

Changelog

Version	Changes
1.0	First release.
1.1	Update on Static Events Score (Sec. 5.1).

Contents

Abbreviations

AC - Automatic Class

COTS - Commercial Off-The-Shelf

DC - Design Class

ESC - Electronic Speed Controller

MC - Manual Class

MTOW - Maximum Take-Off Weight

RC - Radio Controlled

RTL - Return To Landing

UAV - Unmanned Aerial Vehicle

VTOL - Vertical Take-Off and Landing

Chapter 1

Introduction

AeroCup Portugal is a yearly competition aimed at university students, organized by alumni that have participated in similar competitions. It was inspired by the North American DBF (design-build-fly) competition and the Air Cargo Challenge, a Portuguese initiative from 2003 that has since gained European projection and is held every two years in a different European city with varying organizations.

The AeroCup Portugal organization aims to provide a stable and reliable competition for university teams to improve every year and put their skills to the test. By using broad rules focused on safety and keeping rule changes to a minimum in-between editions, the competition gives teams the ideal conditions for improving their previous models without the need to completely redesign the aircraft.

The competition aims to promote technological developments and hands-on learning by challenging students to design, build, and fly unmanned aerial vehicles (UAVs). On top of the technical demands, the students must develop skills in project management and resource allocation, essential for the success of the team. In turn, the AeroCup organization will provide a competition where teams may put their aircraft to the test, with technical inspections to evaluate that the aircraft adheres to the competition's technical and safety requirements, design evaluation with static events and flight evaluation during dynamic events.

By combining theoretical knowledge with practical execution, AeroCup offers university teams the opportunity to test their skills in a dynamic environment, preparing them for real-world challenges in the fields of aeronautics and engineering.

Chapter 2

Administrative Regulations

2.1 Competition Objective

1. The objective of the AeroCup is for a team of university students to design, build and fly small unmanned aerial vehicles (UAVs), scoring the maximum number of points.

2.2 Competition Classes

1. A team can enroll in the following classes:

   - **Design Class (DC)**: The team takes part only in the static events. No aircraft shall be built.
   - **Manual Class (MC)**: The team takes part in the MC Static Events and in the MC Dynamic Events. All flights are performed with a pilot controlling the aircraft.
   - **Automatic Class (AC)**: The team takes part in the AC Static Events and in the AC Dynamic Events. Part of the dynamic events are performed without a pilot controlling the aircraft.

2. A team that enrolls in the Design Class cannot do so in the Manual or Automatic Classes.

3. A team can enroll simultaneously for Manual and Automatic Classes.

2.3 Competition Information

1. The specific competition rules, information and schedules are defined in the competition handbook;

2. The official languages of the competition are Portuguese and English;

3. The organizer of any competition outlined in this document is solely responsible for all aspects of the event.

2.4 General Requirements for Teams and Participants

2.4.1 Teams Requirements

1. A university or other institution may register one or more teams across one or more classes;
2. Teams may be formed with members from one or more institutions;
3. For the purpose of registering and competing, each team is considered to be separate and independent;
4. Each team must have one team member identified as the Team Leader. The team leader is the main contact person for the officials during the registration process and the competition.
5. Each team competing in either Manual Class or Automatic Class must have at least one team member identified as the Team Pilot.

2.4.2 Participants Requirements

1. Each team member may only participate with a single team;
2. Individuals who have previously attended any official event as a judge are not allowed to participate as team members;
3. Team members must be enrolled as degree-seeking undergraduate or graduate students in any university. Team members who have graduated within the seven month period before the competition remain eligible to participate;
4. Students enrolled in a PhD degree or equivalent are eligible to participate;
5. Team members must be at least 18 (eighteen) years of age at the start of the competition.

2.4.3 Team and Aircraft Eligibility

1. Aircraft entered into the competition must be conceived, designed and maintained by the student team members without direct involvement from external professional engineers, racers, machinists or related professionals;
2. The student team may use any information from professionals or from academics as long as the information is given as a discussion of alternatives with their pros and cons;
3. Professionals must not make design decisions or drawings;
4. Students should perform fabrication tasks whenever possible.

2.5 Rules of Conduct

2.5.1 General Rules of Conduct

1. All team members must cooperate with the officials and follow their instructions;
2. Failure of a team member to follow an instruction or command directed specifically to that team or team member may result in penalty points being deducted from the team's overall score;
3. Argument with, or disobedience to any official, results in the team being eliminated from the competition;
4. Any instance of unsportsmanlike conduct will result in penalty points being subtracted from the team's overall score. A second violation will lead to the team's expulsion from the competition (check section 2.5.2);
5. The officials reserve the right to adjust the schedule of the competition and/or interpret or modify the competition rules at any time, as deemed necessary for the safe and efficient operation of the event, based on their sole discretion;
6. Official announcements before and during the event are considered part of these rules.

2.5.2 Penalties

1. **Unsportsmanlike Conduct**: Any instance of unsportsmanlike conduct will result in **100** penalty points being subtracted from the team's overall score.

2.5.3 Protests

1. Any team may protest any rule interpretation, score or official action which they feel has caused some actual, non-trivial, harm to their team, or has had a substantive effect on their score;
2. All protests must be submitted in writing (refer to the competition handbook) within the designated protest period for consideration;
3. The officials' decision on any protest will be issued in writing and is final, meaning that a subsequent protest on the same matter will not be permitted.

2.6 General Rules

2.6.1 Forfeit for Non-Appearance

1. Each team has the responsibility to be at the right place, at the right time, according to the schedule provided by the competition handbook;

2. If the team is not present and ready to compete within 5 minutes of the scheduled time, they will lose their opportunity to participate in that event.

2.6.2 Testing and Work Safety

1. Competition organizers are not responsible for the use of the aircraft outside of the competition;
2. Teams assume full responsibility for the operation of their aircraft, and for any damages to third parties that may result from their operation;
3. The competition officials disassociate themselves from all activities of the teams besides their own competition and associated events;
4. All teams are advised to follow common practices and common sense when working on the aircraft and when operating the aircraft, before, during and after the competition;
5. Organizers reserve the right to disqualify a team registered for their competition in case of unsafe flying behaviour, especially if the reputation of the competition, sponsors and other teams is compromised. Examples of what could be seen as "unsafe flying behaviour", include flying outside the respective flying area or flying without the permission of the officials;
6. When working on the aircraft, everyone must wear appropriate closed-toed shoes and adequate personal protective equipment;
7. Any operation that generates litter or debris, such as cutting carbon fibre, should be conducted with proper safety precautions. Participants must ensure the use of protective equipment and follow safety protocols throughout the procedure;
8. The teams are responsible for cleaning and maintaining the work areas where they repair or work on the aircraft.

2.7 Documentation and Deadlines

2.7.1 Required Documents and Forms

1. The documents and forms must be submitted by the action deadlines defined in the competition handbook.

2.7.2 Submission

1. Before the competition, submitted documents may only be viewed by members of the submitting team, authorized judges, officials, and competent authorities;

2. By submitting documents via the competition website, the team agrees that they may be reproduced and distributed by the officials, in both complete and edited versions, for educational purposes;
3. Documents which are considered by the officials as largely incomplete or not readable/viewable will be considered as not submitted.
4. If the officials request a correction for a document, the corrected version has to be submitted within 168 hours (7 days) following the request;
5. Separate requests for different parts within one document or form will be treated independently;
6. If the corrected version of the document does not meet the requested corrections, the team may be unregistered from the competition.

Chapter 3

Design Requirements

3.1 Airframe

1. The aircraft is subjected to geometric limitations, imposed by maximum span and length, as well as transportation limitations. Additionally, certain mass and balance verifications shall be determined for proper and safe handling of the aircraft.

3.1.1 Size

1. The aircraft is subjected to size requirements:

   (a) The span of the aircraft (B_{ref}) shall not exceed 4 meters;

   (b) Total length (L_{ref}) shall not exceed 4 meters;

2. Each airframe size design limitation can be observed in Figure 3.1.

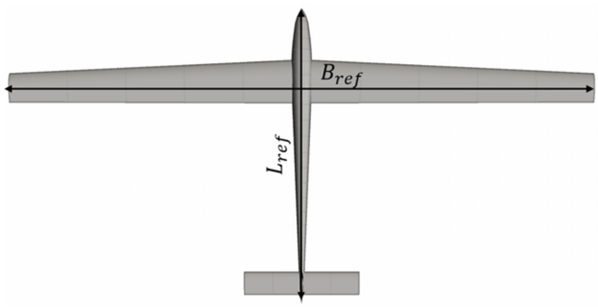

Figure 3.1: Aircraft size requirements.

3.1.2 Transportation Box

1. The airframe shall fit inside a single transportation box with internal dimensions of 1500 mm x 650 mm x 250 mm. The airframe can be stored in any way or format inside the transportation box as long as the aircraft can then be assembled for proper flight conditions.

3.1.3 Mass and Balance

1. The maximum take-off weight allowed for the aircraft with every payload accounted for is 25 kg. This mass shall include every flyable mass within the aircraft and the airframe.
2. To ensure the safety of flight, enough proof shall be given in the Engineering Design Report to ensure stability margins have been analysed. These shall include:
   - Correct sizing of the centre of gravity envelope as well as the centre of gravity positions for different flight masses;
   - Static stability analyses;
   - Dynamic stability analyses.

3.2 Propulsion

1. The aircraft shall be powered by a battery electric propulsion system. Any given number of motors may be used. Vertical Take-Off and Landing (VTOL) configurations are permitted.

3.2.1 Battery

1. The battery powering the propulsive system can either be based on LiPo, Li-ion or NMC chemistry.
2. The pack may be assembled by the team, however, commercially available off-the-shelf cells must be used.
3. The voltage output of the battery pack shall not exceed 26.7V, meaning, at a maximum, six cells may be used in series.
4. The aircraft must have an additional battery (separate from the propulsion system battery) to power the electronics and communication systems.

3.2.2 Power Connection

1. The connection between the battery and the propulsive system shall have an easy access external switch that allows for the turning on and off of the motor(s) power connection. No team is allowed to fly without this requirement being met.

3.2.3 Electric Motor

1. Any COTS (Commercially Off-the-shelf) electric motor may be used.

3.2.4 Electronic Speed Controller (ESC)

1. Any Electronic Speed Controller may be used. The ESC current rating should satisfy the maximum expected current drawn by the motor.

3.2.5 Propeller

1. A COTS propeller shall be used. Each team is responsible for choosing the correct propeller according to the design requirements established.

3.3 Payload

1. The AeroCup requires a payload for the attribution of points in the dynamic events. The payload shall be specified by the team and can be of any material and format as long as:
    - No interference between the payload and the aircraft exists other than structural behaviour;
    - No harm can come from the usage of payload materials or contents;
    - The structural mechanism to lock the payload in place allows for the safe operation of the aircraft.
2. The payload is the total responsibility of the applicant team.

3.4 Avionics

1. The systems recommended by the organization are COTS based on ArduPilot or PX4. Other systems may also be used upon receiving authorization from the organization.
2. Modifications to COTS autopilot systems or building an autopilot system are also allowed upon receiving authorization from the organization. Close inspections will be performed to ensure any authorized modifications or new systems are safe to fly.
3. If requested by competition officials, teams should be ready to provide the source code of their autopilot.
4. Any autonomous system that is implemented must have a safety switch associated with it that allows the pilot to regain control of the aircraft at any moment.

3.5 Communications

3.5.1 RC System

1. Radio systems must use the 2.4GHz frequency band and have a minimum range of 1000 meters.
2. The radio system may optionally display any information the teams may find necessary, such as a telemetry broadcast.
3. The radio must contain a fail-safe option available at all times for immediate flight termination.
4. The following are considered acceptable means of flight termination:

(a) Forced crash manoeuvre: Motor cut-off, full up elevator, full right aileron, full right rudder;

(b) Parachute deployment.

(c) Additionally, teams may develop alternatives such as RTL - where the aircraft will fly to a designated flight termination area. If necessary, the alternative methods will be initiated first in an attempt to recover the aircraft. In cases where the safety of the event is compromised, the flight supervisor may request an immediate flight termination.

5. In case of radio loss, the default operation for systems with autopilot may be set to RTL to the crash location. For systems without autopilot and no available alternatives, the default fail-safe of forced crash must be executed. The failsafe action must be executed a maximum of 3 seconds after the signal is lost.

3.6 Measuring Equipment

1. To control and verify the design requirements and the guidelines established within this document, all teams shall be able to carry and accommodate a piece of measuring equipment provided by the organization.

2. The measuring equipment will measure the voltage and current of the aircraft's battery in real-time. Additionally, telemetry data will be obtained and used for both competition scoring and rule violation checking.

3. The measuring box shall have an unobstructed view of the sky, so as to allow communication and GNSS data gathering. The materials used on the bay supporting the measuring box shall meet this requirement.

4. At the bottom of the measuring box, there will be a male and female XT90 connector for the teams to connect the propulsion system battery and the propulsion system.

5. The box has an estimated mass of 0.150 kg.

6. The measurement equipment can be seen in Figure 3.2, where the dimensions are explicitly stated. The contestants shall use the presented fixation points to accommodate this payload to the aircraft structure. Sufficient demonstration shall be given of this capability within the Engineering Design Report.

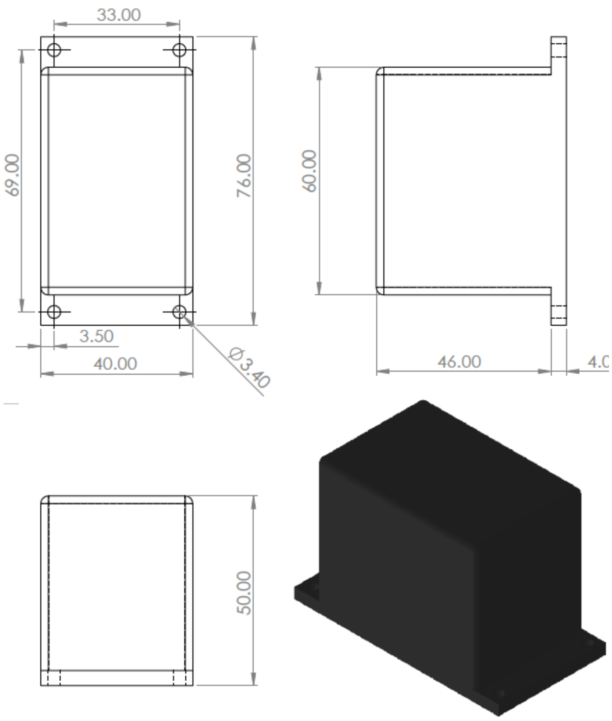

Figure 3.2: Measuring box dimensions. All dimensions are presented in mm.

Chapter 4

Technical Inspections

4.1 General

1. An aircraft must pass all technical inspection parts before being allowed to fly and take part in dynamic events.
2. The technical inspections are divided into the following parts:
   (a) Pre-inspection
   (b) Mechanical Inspection
   (c) Electrical Inspection
   (d) Control and Communications Testing
   (e) Propulsion System Inspection
   (f) Autopilot Inspection
3. A technical inspection sheet will be provided prior to the competition with several inspection points that will be checked by the technical inspectors.
4. The inspectors may inspect other points not mentioned in the technical inspection sheet to ensure compliance with the rules.
5. All items on the technical inspection sheet must be clearly visible to the technical inspectors. Visible access may be provided by removing access panels.
6. The inspectors will mark or seal different approved parts. If the marks or seals are removed or damaged during the competition, the technical inspection will have to be repeated.
7. In the event that the aircraft is damaged and needs to be repaired, it must go through a new technical inspection.

4.2 Pre-inspection

1. During the Pre-Inspection, the inspectors will verify the overall conditions of the aircraft, ensuring that every part available is included as documented by the participating teams (see Section 5.1.2). The pilot documentation will also be checked.

2. In this phase, the aircraft and all its components shall be inside the transportation box in order to verify compliance with the transportation box requirements.

3. The team are only allowed to remove components from the transportation box once the pre-inspection is made. The inspectors will verify that every documented component is stored inside the transportation box.

4. All the components not listed in the parts list of the aircraft will not be considered. If there is a missing component not listed on the parts list but required for the safe operation of the aircraft, a penalization is made.

5. A checklist with the steps covered in the Pre-Inspection phase is delivered prior to the date of the event.

6. The aircraft shall be mounted during this phase.

7. The team must present all the batteries that are to be used during the competition. These will be inspected and marked by the inspectors.

4.3 Mechanical Inspection

1. The aircraft must be presented in a ready-to-fly configuration, with the highest payload that the team plans to take-off with.

2. The inspectors will verify that the aircraft sizing and structure do not violate any competition rule. This includes, but is not limited to, checking:

   (a) The aircraft dimensions, such as the wingspan, length and centre of gravity position when loaded are within the specifications;

   (b) The parts that compose the aircraft are properly fixated and there is no risk of disassembly during flight;

   (c) All components inside of the aircraft are properly secured;

   (d) The team identification is properly displayed on the aircraft.

4.3.1 Weighting

1. During the weighting phase, the aircraft shall be completely mounted with all components accounted for except for the batteries to be used by the propulsion unit and the payloads used by the team. This phase is divided in two separate steps:

(a) Weighting of the empty aircraft;

(b) Weighting of each payload;

(c) Weighting of each battery pack that was marked in the Pre-inspection;

4.3.2 Structural Test

1. The structural test is made to assure that the aircraft is structurally safe for the considered maximum payload mass. In this phase, the aircraft must assembled with the maximum weight combination of battery pack and payload chosen by the team. This is the highest weight that the aircraft is planned to take-off with.

2. Demonstration with this requirement shall be met by suspending the wing tips in an appropriate test bench provided by the organization ensuring at least 3 seconds of complete unaided suspension. Note that the supports of the test bench must be in contact with the wing at a maximum of 100 mm of the aircraft wing tip.

4.3.3 Drop Test

1. To assure sufficient structural safety on landing, a drop test is required. In this phase, the aircraft shall be mounted and assembled with the maximum weight combination of battery pack and payload chosen by the team. This is the highest weight that the aircraft is planned to take-off with.

2. The test is conducted by lifting the aircraft at a given height H_d and dropping the aircraft with all its components. The drop test height can be calculated using the following formula:

$$H_d = 0.0066\sqrt{\frac{MTOW}{S_{ref}}}, \tag{4.1}$$

where S_{ref} denotes the reference area of the wing.

3. Drop test acceptance is determined by the inspectors if no structural damage is found.

4.4 Electrical Inspections

1. During the Electrical Inspection, the inspectors will verify that the aircraft electronics and wiring do not violate any competition rule. This includes, but is not limited to checking:

   (a) There are no uninsulated wires in the aircraft.

   (b) All the critical connectors fit tightly without the risk of unplugging during flight.

   (c) The batteries used for the propulsion system and the remaining electronics are separate from each other.

4.5 Control and Communications Testing

1. In the Communication Test, the team must have the aircraft in a ready-to-fly configuration, with the propulsion system battery unconnected and the pilot present and operating the radio transmitter.
2. In the first phase, the aircraft is to be turned on and the pilot must demonstrate to the inspectors that all the control surfaces of the aircraft can be controlled correctly. The pilot must then get progressively further from the aircraft, accompanied by an inspector, up to a distance of 200 m.
3. Following the first phase, the team shall power on the propulsion system and the previous test shall be repeated.

4.6 Propulsion System Inspection

1. The aircraft shall be fixed on a test bench provided by the organization in a ready-to-fly configuration. The propulsion system shall be turned on and the pilot must set the throttle at full power for 30 seconds.
2. During this test, the team must then demonstrate the use of the fail-safe option available.

4.7 Autopilot Inspection

1. During this inspection, the autonomous systems employed on the aircraft shall be verified, along with the respective safety features.
2. The aircraft must be put in a ready-to-fly configuration with the pilot present and operating the radio transmitter.

4.7.1 Autopilot Response

1. The aircraft shall be turned on without the propulsion system battery connected. The pilot shall put the aircraft in autonomous mode. The team must then tilt the aircraft in various directions in order for the inspectors to verify the response of the control surfaces.

4.7.2 Safety Switch

1. The pilot must demonstrate the use of the mandatory safety switch. With the aircraft in autonomous mode and the propulsion system powered on and working, the pilot must activate the safety switch and regain control of the aircraft.

Chapter 5

Events

5.1 Static Events

1. The AeroCup is distinguished by the presence of static events. These events aim to evaluate each team's performance in both design engineering capabilities and cost and manufacturing knowledge.

2. The purpose is to evaluate the design of the aircraft and not the built prototype. This section is reserved for describing the two static events in the AeroCup competition: Engineering Design and Cost and Manufacturing events.

5.1.1 Engineering Design Event

1. The Engineering Design Event is composed by an evaluation time of 30 minutes where judges from different technical backgrounds discuss with the team the design ideas and paths towards achieving the final design obtained.

Engineering Design Report

1. Prior to the competition date, an engineering design report shall be delivered by email. This report shall follow specific rules:

   (a) Number of content pages shall not be above 7.

   (b) Number of total pages (counting annex) shall not be above 10.

   (c) Cover page, table of contents, indices or other auxiliary page identifications are not considered to the total number of pages.

2. Additionally, annexed to the report a three-view of the aircraft designed shall be included. These views shall use traditional format: front, side and top views. The maximum dimensions and clearances (ground, propeller, etc.) shall be indicated in the drawings provided. The isometric view of the aircraft shall also be included.

3. The contents of the report shall include the design decisions and the thought process of the team to answer the competition requirements. This report shall include but is not limited to:
   (a) Team Management (DC and MC) - a discussion on how the team is managed during the development of the project, including task distribution, member recruitment and resource allocation;
   (b) General Aircraft Design (DC and MC) - an overview of the concept behind the design of the aircraft and its expected flying performance as well as the expected dynamic events performance capability;
   (c) Aerodynamics (DC and MC) - an overview of the aerodynamic design choices related to the competition goals as well as an overview of the aerodynamic design process. The stability margins proof as mentioned in 3.1.3 shall be included;
   (d) Structural Design (DC and MC) - an overview of the structural decisions followed as well as an overview of the structural design process;
   (e) Propulsion and Controller (DC and MC) - an overview of the choice of motor and ESC, battery sizing, and control actuation;
   (f) Avionics (DC and AC) - Aircraft systems organization, component placement and wiring;
   (g) Autopilot (DC and AC) - an overview of the autopilot capabilities and performance as well as its built-in flight control algorithms.
4. The report will be provided to the judges prior to the day of the event.

Technical Specifications List

1. A list of the technical specifications of the aircraft shall also be sent to the organization at the same delivery date of the engineering design report. The technical specifications shall include but are not limited to:
   (a) Maximum Take-off Weight ($MTOW$);
   (b) Reference span (B_{ref});
   (c) Reference chord (C_{ref});
   (d) Reference area (S_{ref});
   (e) Maximum length (L_{ref})
   (f) Maximum flight speed (V_H);
   (g) Design speed (V_C);
   (h) Stall speed (V_S) - if enhanced lift controls are used, the clean configuration as well as control active configuration stall speeds shall be determined (V_{Sn});
   (i) Best glide speed (V_G) - this is the speed in which the most longitudinal distance is covered assuming $MTOW$ configuration;

(j) Maximum Aerodynamic efficiency $(\frac{L}{D})$;

(k) Range (R) - maximum distance covered on the ground the aircraft can fly;

(l) Endurance (E) - maximum time the aircraft can fly for;

(m) Maximum Distance (R_{comms}) - maximum distance the aircraft can fly from its operator.

Judge Evaluation

1. The engineering assessment will not consider any integrated components that were not designed by the team. However, the impact of such components shall be addressed in the overall engineering design assessment.

2. During the Engineering Design Event, a group of judges will gather with up to 15 members of the team around the aircraft and question the design in real time to assess the engineering choices of the team. The team must have the airframe completely assembled. The airframe can be used as a support for the discussion. Covers or lids can be removed for better visibility.

3. The assessment of the design however is not dependent on the airframe produced but rather on the engineering design process followed to comply with the dynamic events requirements.

4. This session can be followed by a feedback session where the judges can advise the team on how to improve.

5. The judges will focus on the main categories aforementioned to be included in the report but are not limited to these specific fields of engineering. The points distribution for this event is presented in the following tables and sums up to a total of 180 points for the Design Class, 90 points for Manual Class and 90 points for Automatic Class.

Category	**Design Class**	**Manual Class**	**Automatic Class**
Team Management	20	10	10
General Aircraft Design	25	25	-
Aerodynamics	20	20	-
Structural Design	20	20	-
Propulsion and Controller	15	15	-
Avionics	40	-	40
Autopilot	40	-	40
TOTAL	180	90	90

Table 5.1: Engineering Design Event Scoring

5.1.2 Cost and manufacturing Event

1. The Cost and Manufacturing design event is composed by an evaluation time of 30 minutes where judges from different technical backgrounds discuss with the team the costs and manufacturing processes used to achieve the desired design.

2. The aim of this event is to discuss the cost knowledge developed by the team as well as the manufacturing understanding with special attention to the trade-off analysis developed for this evaluation.
3. This event does not require the assembled prototype. Only the design is accounted for.

Cost and Manufacturing Event Report

1. In this event, the team must present a report regarding the costs and manufacturing needs required to produce the designed aircraft. The report must also study the costs and manufacturing processes to scale from a prototype aircraft to a mass production scenario.
2. This report consists of two distinct documents:
   (a) Production - which shall include: (1) bill of materials - a specification of all the materials and components used to produce the aircraft; (2) production manual - the complete set of instructions to produce the aircraft as a whole, including every sub-component and production processes used;
   (b) Cost understanding - a description of the total costs of production, scalability and possible differences between prototype and mass production scenarios.

Judge Evaluation

1. During the Cost and Manufacturing Event, a group of judges will gather with up to 15 members of the team and assess the team's knowledge of the manufacturing and cost decisions regarding the designed aircraft. This session can be followed by a feedback session where the judges can advise the team on how to improve.
2. The points attributed in this event are given based on each document presented and on the performance of the team during the questions presented by the jury. Overall the whole points sum up to 60.

Category	**All Classes**
Production	40
Cost understanding	20
TOTAL	60

Table 5.2: Cost and Manufacturing Event Scoring

5.2 Dynamic Events

1. Teams with a flyable prototype are eligible to participate in the dynamic events once their aircraft has been deemed ready to fly in the technical inspections. For each category, a total of 3 different events are available. The total score for the dynamic events is calculated as the sum of the scores obtained from the events the team has participated in.

2. The maximum score that can be obtained by a single team in these events is 250 points. Teams will be given the possibility to perform at least one flight for each dynamic event. If time allows, additional flight attempts may be possible, with the best flight score for each event being considered.

5.2.1 Flight rules

1. Every flight within the AeroCup competition must follow a set of predefined rules that assure the safety of all participants. These are:

    (a) Maximum allowed altitude is 120 meters above the ground;

    (b) Minimum allowed altitude for flight after take-off and initial climb and before landing is 30 meters above the ground;

    (c) All flights must be within the flying areas presented in the handbook;

    (d) Only two participants from each team are allowed to be on the airfield track when the respective team is called for flight. One shall be the pilot and the other shall be readily available to switch on and off the power of the vehicle;

    (e) The second participant present on the airfield track may also be a pilot operating a Ground Control Station (GCS);

    (f) All other participants must remain inside the established safe area;

    (g) In case of emergency, the team shall follow every command stated by the operations manager;

    (h) Any applicable local law.

2. All pilots (including the GCS operator) must carry at a minimum a valid A1-A3 license, valid in Portugal according to the Autoridade Nacional da Aviação Civil (ANAC) rules. Teams must present this information during the technical inspections, and only pilots the organization has validated will be allowed on the airfield track.

3. An operations manager from the organization will be present on the airfield track next to the pilot(s). Any take-off and landing must have the prior authorization of the operations manager.

4. Considering the possibility of the event taking place in military airspace, forms from Autoridade Aeronáutica Nacional (AAN) may have to be submitted. Should that be necessary, teams will be notified beforehand so that they can fill these forms with details about the operation of their aircraft.

5. All stated rules shall be followed. Not complying with these rules can lead to invalid flights, point penalizations or direct disqualifications.

6. A flight run can be aborted whenever either the team or the organization find necessary (due to battery running out, bad aircraft behavior, etc). This may deem the flight null if the flight is the aircraft ends up not doing part of the required task.

Meteorological limits

1. When either of the following is verified, flights will be interrupted:

   (a) Wind speeds over a period of 20 s in excess of 8 m/s;

   (b) Wind gusts measured in excess of 12 m/s;

   (c) Precipitation of any type;

   (d) Temperatures outside the range [0°C, 40°C]

5.2.2 Take-off Performance Event

1. The main objective of the take-off performance event is to demonstrate the ability to take-off with the maximum possible payload.

2. In this event, the aircraft shall be able to conduct a take-off within a distance of 60 m. The last point at which the aircraft leaves the ground before reaching the minimum height for the flight will be considered. For the flight to be considered valid, the aircraft must reach a minimum height above the home point of 30 m.

3. The score of the *take-off* performance event, to be denoted S_{TO}, is calculated according to:

$$S_{TO} = \frac{m_{\text{payload}} - m_{\text{payload}}^{\text{min}}}{m_{\text{payload}}^{\text{max}} - m_{\text{payload}}^{\text{min}}} \times 100 - P_{TO}^{\text{dist}} + B_{TO}^{\text{finish}} \times 25, \tag{5.1}$$

   where m_{payload} denotes the mass of the payload used in the event, $P_{TO}^{\text{dist}} \in [0,\ 125]$ is a penalty incurred should the aircraft take-off in a distance greater than 60 m (as defined in Table 5.3), and $B_{TO}^{\text{finish}} \in \{0,\ 1\}$ is a flag that is set if the event is finished successfully, thus providing 25 bonus points.

Table 5.3: Penalty incurred as a function of the takeoff distance.

Take-off distance $[m]$	$[0, 60]$	$]60, 65]$	$]65, 70]$	$]70, 80]$	> 80
P_{TO}^{dist}	0	10	25	100	125

4. If the aircraft leaves the runway at any point during the take-off roll, the pilot must abort the take-off, and the flight is considered invalid.

5. The aircraft shall start the runway path at the middle for the track. If needed the pilot can make use of diagonal lines to better align with the wind at the moment of take-off. The distance for the take-off is measured in a straight line along the middle of the track. If the aircraft leaves the main runway track, the take-off procedure shall be aborted and the flight is considered invalid.

Automatic Take-off

1. In the automatic category, the aircraft must be able to conduct an automatic take-off without any pilot input (other than commanding the take-off start). If at any point during the take-off the pilot needs to intervene and assume control of the aircraft, the flight is considered invalid.

2. The pilot may assume control of the aircraft once the aircraft is above the minimum height of 30 m.

5.2.3 Manual Flight Performance Event (MC only)

1. The main objective of the Manual Flight Performance Event is to demonstrate the ability of the aircraft to fly through a given mission as fast as possible while doing so as efficiently as possible. To recreate a realistic mission scenario, a minimum payload of 1 kg must be carried.

2. The circuit for this event consists of an approximately 2 km long pattern of 10 down-wind and 10 up-wind legs, flown as shown in Figure 5.1. Throughout the whole circuit, a minimum height of 30 m must be maintained. The circuit starts whenever either flag is passed, with the aircraft flying above the minimum height.

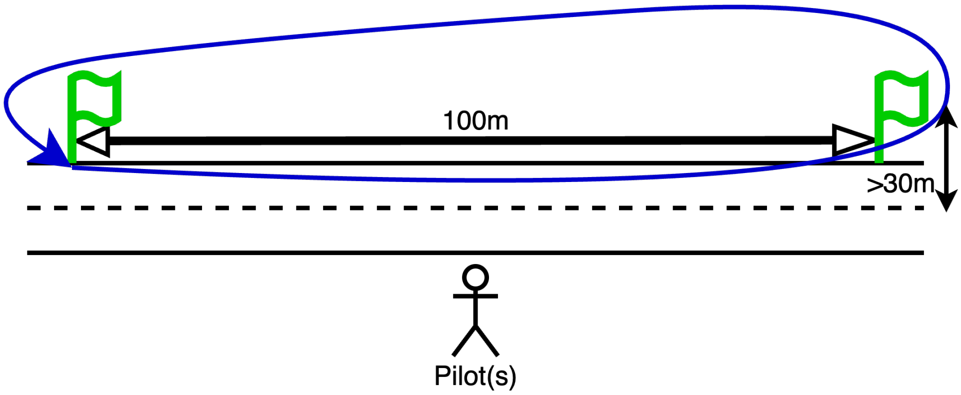

Figure 5.1: Flight performance event lap.

3. At each flag, a member of staff will be present, notifying the pilot whenever the aircraft has passed the flag, through the operations manager. At that moment, the pilot may turn back to fly towards the other flag. The turnaround maneuver shall only start after the confirmation of the operations manager. Starting the turnaround procedure prior to confirmation may lead to point penalizations.

4. The score for the manual flight performance event, hereby denoted by S_{MFP}, is calculated according to:

$$S_{MFP} = \frac{t_{\text{circuit}}^{\max} - t_{\text{circuit}}}{t_{\text{circuit}}^{\max} - t_{\text{circuit}}^{\min}} \times 50 + \frac{E_{\text{circuit}}^{\max} - E_{\text{circuit}}}{E_{\text{circuit}}^{\max} - E_{\text{circuit}}^{\min}} \times 50 + B_{FP}^{\text{finish}} \times 25 \quad (5.2)$$

where t_{circuit} is the time in seconds taken to fly the circuit, and E_{circuit} is the energy in Wh used to fly the circuit, and $B_{MFP}^{\text{finish}} \in \{0,\ 1\}$ is a flag that is set if the event is finished successfully, thus providing 25 bonus points.

5.2.4 Automatic Flight Performance Event (AC only)

1. The main objective of the Automatic Flight Performance event is to demonstrate the ability of the aircraft to fly autonomously through a given mission as fast as possible while doing so as efficiently as possible. To recreate a realistic mission scenario, a minimum payload of 1 kg must be carried.

2. The circuit for this event must be flown automatically. The circuit consists of a predefined set of waypoints which must be flown over in order, totaling approximately 2 km. The coordinates and order of the waypoints composing this circuit will be provided in a `.txt` file, with each line indicating a waypoint, in the following format: `<waypoint number>, <waypoint latitude in degrees>, <waypoint longitude in degrees>, <waypoint height above home point in meters>`. For the flight to be considered, all waypoints must be flown over with a maximum deviation of 40 m.

3. The score for this event is calculated according to:

$$S_{AFP} = \frac{t_{\text{circuit}}^{\max} - t_{\text{circuit}}}{t_{\text{circuit}}^{\max} - t_{\text{circuit}}^{\min}} \times 35 + \frac{E_{\text{circuit}}^{\max} - E_{\text{circuit}}}{E_{\text{circuit}}^{\max} - E_{\text{circuit}}^{\min}} \times 35 + B_{\text{landing}}^{\text{auto}} \times 30 + B_{FP}^{\text{finish}} \times 25, \quad (5.3)$$

   where t_{circuit} is the time in seconds taken to fly the circuit, and E_{circuit} is the energy in Wh used to fly the circuit, $B_{MFP}^{\text{finish}} \in \{0,\ 1\}$ is a flag that is set if the event is finished successfully, providing 25 bonus points, and $B_{\text{auto}}^{\text{finish}} \in \{0,\ 1\}$ is a flag that is set if the aircraft performs an automatic landing, providing 30 bonus points.

4. For a landing to be considered automatic, the aircraft must fly automatically, without pilot input, when at a distance less than 200 m from the touch-down point. The touch-down point coordinates will be provided in the same format as previously described. The aircraft must touch down within the width of the runway, and within ±30 m of the touch-down point.

5. The pilot may at any point intervene and abort the automatic landing, and re-start the automatic approach. If after three automatic landing attempts the aircraft has not been able to automatically land, the automatic landing bonus for that flight will not be given, and the aircraft should be manually landed.

6. Teams are responsible for pre-loading the aircraft flight controller with the needed information to fly this circuit automatically.

5.2.5 Air Drop Event

1. The main objective of the Air Drop Event is to demonstrate the aircraft's capability to conduct a firefighting mission by transporting and delivering water from an area hereinafter referred to as the Water Zone to another area hereinafter referred to as the Fire Zone.

2. The Water Zone will consist of a runway with a water tank where teams can land their aircraft, load water into it, and take-off again.

3. The aircraft is allowed to take-off and land an unlimited number of times during the event to replace batteries and/or to load or unload water.

4. The water will be provided by the organization.

5. The Fire Zone will consist of a runway with a 3×6 m^2 rectangular pool adjacent to it.

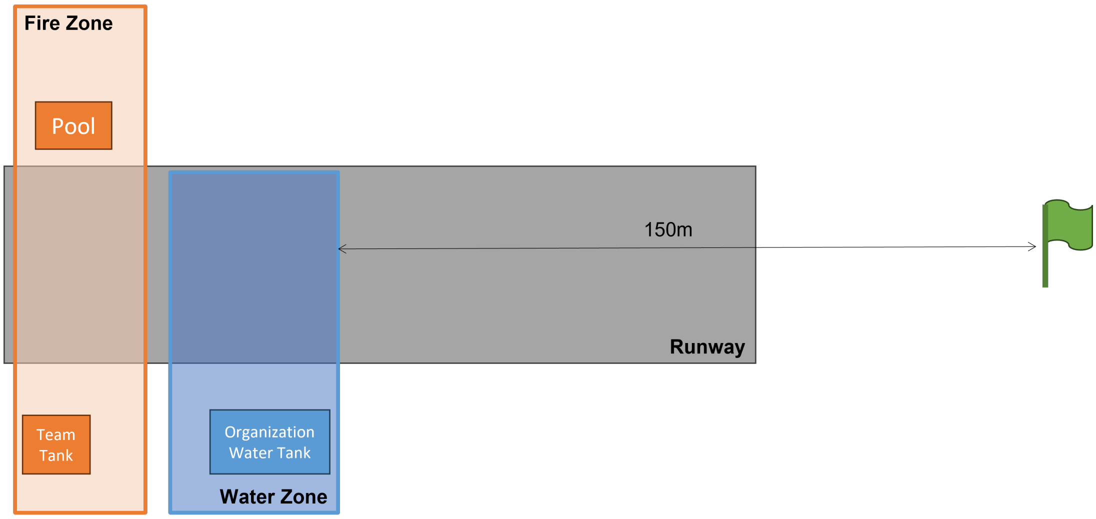

Figure 5.2: Air Drop Event Layout.

6. There are two ways to deliver water to the Fire Zone:

   (a) The aircraft can fly over the pool and drop water into it.

   (b) The aircraft can land on the Fire Zone runway and the team can unload water and drop it into a designated container tank.

7. The runway of the two zones might be shared. However, an aircraft is considered to be operating within a single zone at a time, without access to the other. This operational layout is illustrated in Figure 5.2.

8. Water may be released while still contained within a vessel (e.g., a bottle). However, only the portion of water that comes into direct contact with the pool floor or walls will be considered for scoring (e.g. any water remaining inside a bottle after its release is excluded).

9. To transition between the Fire Zone and the Water Zone, the aircraft must first take-off and complete a 300 m course consisting of two 150 m legs, as illustrated in Figure 5.2.

10. The Air Drop Event will last 20 minutes. The timer starts when the aircraft is positioned on the Fire Zone runway, ready for take-off. Once the timer expires, the aircraft may no longer take-off. However, if the aircraft is airborne when the timer ends, it may still release or deliver water to the Fire Zone before the event is concluded.

11. A maximum of two team members may be present at each zone (Fire Zone and Water Zone).

12. The pilot may participate in the loading/unloading activities as a team member.

13. No team member may be present in both the Fire and Water Zones.

14. The score for this event is calculated according to:

$$S_{AD} = \frac{S_{\text{Team}}}{S_{\text{Team}}^{\text{max}}} \times 150, \tag{5.4}$$

where S_{Team} is given by:

$$S_{\text{Team}} = W_{\text{tank}} + W_{\text{pool}} \times 10, \tag{5.5}$$

where W_{tank} is the amount of water (in liters) in the Fire Zone team tank and W_{pool} is the amount of water (in liters) in the Fire Zone pool at the end of the event.

Automatic Air Drop

1. In the automatic category, the aircraft must be capable of performing the same mission, but without any pilot input.

2. If at any point during the event the pilot needs to intervene and assume control of the aircraft, the event is considered invalid.

5.3 Overall Scoring

1. The overall score achieved by a team in the competition is the sum of the individual scores obtained in each event the team takes part in. The point distribution for all the events is summarized in the following table.

Category	**Design Class**	**Manual Class**	**Automatic Class**
Engineering Design Event	180	90	90
Cost and Manufacturing Event	60	60	60
Take-off Event	-	100	100
Manual Flight Performance Event	-	100	-
Automatic Flight Performance Event	-	-	100
Air Drop Event	-	150	150
TOTAL	240	500	500

Table 5.4: Overall Scoring