STUDENT AIRRACE

# Sporting Regulations

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v0.2
Munich

Technische Universität München

# Contents

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**Changelog**

**Current Version:**
**Version Draft v0.2**

Changelog from previous versions:
v0.1.1 - First Release version
v0.2 - Improved Release version (17.12.23):

- 7: Information and dates regarding the Preliminary Design Review have been changed.
- 11: Removed rules regarding the necessary battery drain on the Thrust Test Stand and made them easier to understand.
- 9.3: Added race course information and example.
- 10.5: Added information on Ground Control Station Setup.
- 10.2: Changed Requirements for pilots. Simulator hours also applicable now.

**Preface**

Welcome to the Student AirRace competition!

Get ready for an adrenaline-pumping experience as you showcase your talents and skills in the thrilling world of Hyperdrone-racing. For our team, this competition has been a dream come true, and we are honored to host it. At Student AirRace, our vision is to become the premier air race competition for students and one day, maybe even evolve into manned aircraft competitions.

Safety is our top priority, and we are dedicated to ensuring that all participants and spectators have a safe and unforgettable experience. We understand that the technology and regulations surrounding drones, eVTOLs, and UAS are constantly evolving, and we have done our best to create regulations that are comprehensive and up-to-date with the current state of the industry. However, we also understand that there is always room for improvement, and we welcome any feedback you may have to help us make this competition even better.

For this reason we have created a new type of racing drone - the Hyperdrone-class! Introducing a brand new class of unmanned aerial vehicles, designed to push the limits of what's possible in drone racing. With a Maximum Takeoff Weight of up to 25kg, these cutting-edge Hyperdrones are the first of their kind and are set to racing to the next level. This document provides you with all the technical guidelines you need to know to prepare a vehicle of this exhilarating new class.

We have put a lot of hard work and dedication to get to this point and we can't wait to see what you have to bring to the table. We hope you will not only have fun, but also learn a lot and make valuable connections in the industry. Get ready to push your limits and soar to new heights as we witness the innovative solutions and ideas you will bring to the competition. Welcome to the racing of the future. You are now a part of it.

Janis Mauch

Founder of Student AirRace

**What are the Sporting Regulations?**

Welcome to the Sporting Regulations for the Student AirRace. This document outlines the rules and guidelines that govern the competition, with the goal of ensuring that all teams have a fair and safe experience. These regulations are separate from the Technical Regulations, which detail the specific requirements and standards for the design and construction of the unmanned aerial vehicles (UAVs) that will compete in the event.

The Sporting Regulations provide information on various aspects of the competition, such as the schedule of events, the scoring system, and the roles and responsibilities of the teams and organizers. Additionally, they describe the procedures for scrutineering, briefings, protests, and other important activities that occur before, during, and after the competition.

It is important that all teams carefully read and understand both the Sporting Regulations and Technical Regulations in order to ensure that their UAVs meet the necessary requirements and that they are fully prepared for the competition. Any questions or concerns regarding these regulations can be directed to the organizers for clarification.

If you were looking for the technical regulations governing the construction and specifications of the participating UAVs, they can be found on our website at www.student-airrace.com/competition. These regulations should be read in conjunction with the sporting regulations provided in this document.

**Notes:**

- **Contents marked in red are still subject to change and should be seen as current estimations and placeholders.**
- **This whole document is still a work in progress. Some points may still be left empty.**
- **If you have any comments on specific regulations, for example, think that they are not required, are too strict or don't make sense, don't hesitate to contact info@student-airrace.com.**

**Abbrevations:**

| | |
|---|---|
| **AI** | Artificial Inteligence |
| **eVTOL** | electrical Vertical TakeOff and Land |
| **MTOW** | Maximum Take-Off Weight |
| **PDR** | Preliminary Design Review |
| **RTH** | Return to Home |
| **UAS** | Unmanned Aerial System |
| **UAV** | Unmanned Aerial Vehicle |

# 1 Competition Outlines

## 1.1 Objective of the competition

- The primary objective of the Student AirRace competition is to provide a unique and immersive opportunity for students to familiarize themselves with the cutting-edge field of unmanned aerial vehicles (UAVs) and urban air mobility.
- As an organization committed to ensuring the highest standards of safety, Student AirRace places safety at the forefront of all competition activities. All teams are expected to prioritize safe operation and development practices in their competition preparations.
- With a vision to become the leading student competition for hyperdrone racing, Student AirRace strives to create an engaging and exciting environment for students to showcase their skills and knowledge in the field of unmanned aerial vehicles.
- In order to achieve our mission, we rely on the active participation and dedication of our competitors. All participants have to give their utmost effort in supporting both their own team and the broader Student AirRace community. Together, we can achieve new heights in the exciting and rapidly evolving field of unmanned aerial vehicles.

## 1.2 Participants

1.2.1. Only enrolled university (or of comparable institutes) students can participate actively in the competition.

1.2.2. If a team member has graduated six months before the competition, they may still participate.

1.2.3. If a team member has graduated during the eighteen (18) months before the competition and has played a significant role, the Team may send an application to the organiser, requesting their participation.

1.2.4. Students attending other universities within a reasonable distance of a participant's university (e.g. in the same city) may join a student team from said university.

1.2.5. If a student's university already has a competing team, the student is not allowed to join a competing team of another university.

1.2.6. The team size is not limited to a maximum number of members. However the organizer may limit the of allowed on site participants to a maximum of 15 for each team at the final event.

1.2.7. PHD candidates who are still enrolled or working for the university are allowed to join the teams.

## 1.3 Competition Rewards

| Position | Discipline | Moneytary Award |
|---|---|---|
| 1st | Overall | 25% |
| 2nd | Overall | 15% |
| 3rd | Overall | 10% |
| 1st | AI racing | 15% |
| 2nd | AI racing | 9% |
| 3rd | AI racing | 6% |
| 1st | Safety | 5% |
| 1st | Design Maturity | 5% |
| 1st | Innovation and Sustainability | 5% |
| 1st | Special Prize | 5% |

1.3.1. Every winner of one of the categories mentioned above will receive the following prizes:

- Trophy according to their position and discipline
- Free entry to the competition in the next year.
- Special prizes like tours Etc. by sponsors
- Prize Money according to the table

1.3.2. No prize money is planned for the competition. Since the registration fee is intended only to incentivise the teams to compete, the fees might get split between the winning teams.

Furthermore, Student AirRace is looking into the possibility of collecting additional money as potential prize money for the teams. If the option for prize money is agreed upon, it would be split according to the percentages in the table above.

# 2 Competition Processes

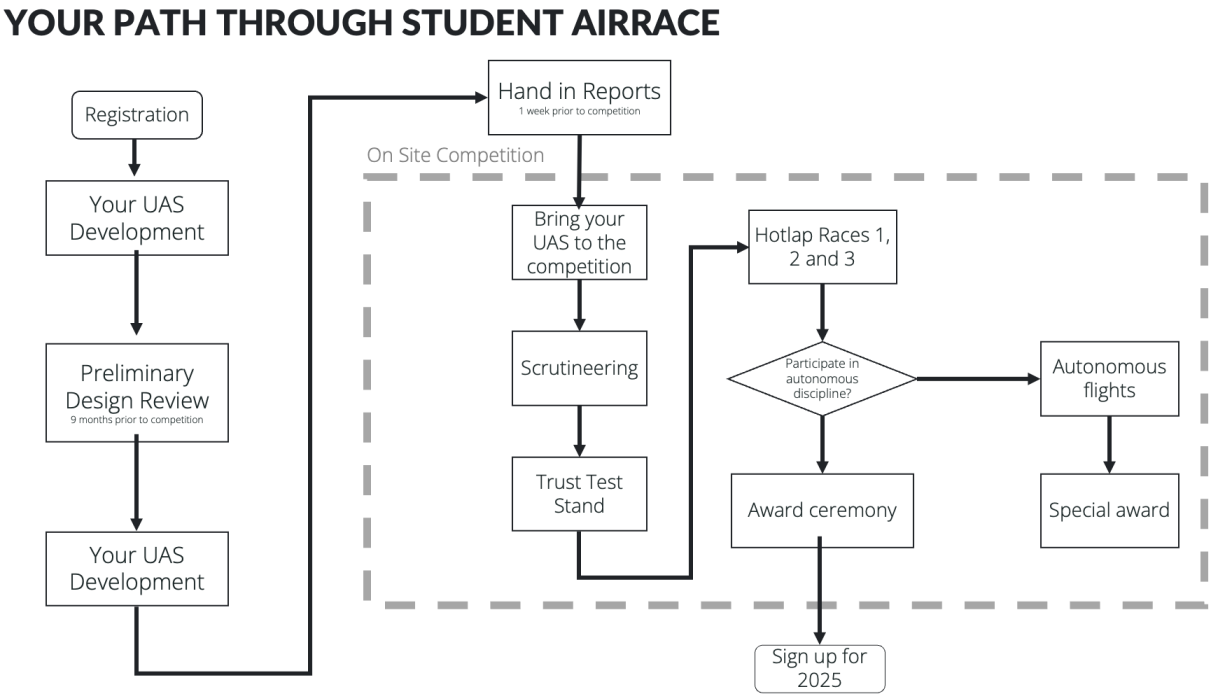


Figure 1: *This flowchart illustrates the registration processes and mandatory events for the competition.*

## 2.1 Registration Process

2.1.1. Teams can register for the competition on the website of Student AirRace. The sign-up page can be found at www.student-airrace.com/recruiting

2.1.2. Only one Team per individual university may register for the competition.

2.1.3. The organiser will choose the participating teams on a "First Come First Served"-Base but also on the perception and opinion of the organisers whether a team will be able to meet the requirements and standards of the competition.

## 2.2 Later Changes to the Registration

2.2.1. Teams may submit changes to the information they have provided in their registration up to six months before the competition enabling the teams to rebrand or change their starting numbers.

2.2.2. If, in the organiser's opinion, a competitor is likely to fail to meet the requirements or standards of the competition, they are allowed to reject them after the registration process.

2.2.3. In case of withdrawal from the competition, the Team must notify the organisers as soon as possible. Withdrawals must be entered six months before the competition. The organisers may penalise any non-existing or later withdrawals with a point deduction or ban from future events.

## 2.3 Fees

2.3.1. A participation fee of 300 € per team will be required to participate in the competition.

2.3.2. The fee will go into the prize money pool and will be distributed to the participating teams according to the prize money table, which will be determined by the organizers.

2.3.3. The fee is required as a sort of deposit to ensure the team's commitment to the competition and their timely arrival.

2.3.4. The payment of the fee is due after 6 months after registration and will be handled by the organizers.

2.3.5. Teams who fail to pay the participation fee will not be allowed to participate in the competition.

### 2.4 Expenses

2.4.1. The organisers will not support or reimburse the teams for travel, accommodation, or other expenses.

2.4.2. The competitors may search for private, university or company sponsors to cover any of their expenses.

## 3 Competitor Organization

### 3.1 Just Culture

3.1.1. The teams and the organiser commit to adopting a so-called "Just Culture" to ensure the competition's and its participants' safety.

3.1.2. The team leaders commit themselves to learning about Just Culture and educating their team members about it.

3.1.3. Participants who notice safety-related issues in their Team or within the competition can report them anonymously to info@student-airrace.com and are assured that it will not bear any negative consequences for them or their Team.

3.1.4. Student AirRace also seeks to provide the teams with workshops about this topic.

## 4 Practice during development

4.0.1. During the development, and testing practice of their UAVs, the teams must meet all the laws and requirements of their flight location.

4.0.2. There is no maximum limit on how much time the teams invest into flying before the competition. However, a minimum flight experience on the competition UAV and for the pilots must be documented. More can be found at Section **??**

### 4.1 Team Documentation

The following rules are not meant to annoy the teams or make their lives hard. The competition's success is in the hands of the competitors. To grow the competition sustainably, we need to keep specific aviation and safety standards. Furthermore, those rules are supposed to teach you standard aviation processes and help you learn and grow. If you have any questions on approaching those flight documents, the organising Team of Student AirRace will gladly assist you. Safety and the success of this competition are in all of our hands.

4.1.1. The teams must document all flights with their prototypes in physical and digital flight books. They must note at least location, flight time, and pilot flying as well as observations, abnormal events or incidents during the flight.

4.1.2. The teams are required to document their pilot's flights and flight time on aircrafts comparable to or the competition aircraft (e.g. Racing Quadrocopters) for each flight and in a cumulative manner. These documents will be checked according to **??** at the competition.

4.1.3. The teams must keep up-to-date records about the equipment installed on the UAV, including all electronic and mechanical subassemblies on the UAV. Changes must be marked and recorded.

4.1.4. Teams must keep up-to-date records of any damages or problems on the UAV. Even if the aircraft might still be flightworthy. Any repairs will have to be documented, stating the reason for the repair and a short overview of the repair process.

### 4.2 Feedback for the organiser

4.2.1. The teams are asked to inform the organisers about any obstacles or issues they encounter, which too strict or lenient regulations might cause. The organisers will gladly receive any feedback and integrate it into the regulations.

4.2.2. Teams must inform the organisers about incidents that lead to the UAV's loss, damage to ground structures, injury, or death.

## 5 Final Competition Logistics

### 5.1 Logistics

5.1.1. Each Team can ship a maximum of two twenty (20) ft shipping containers to the location of the competition. The containers will be placed right next to the Team's reserved location in the paddock.

5.1.2. The teams are responsible for shipping expenses and on-time delivery of the containers. Shipping of the containers is possible from three months before the final competition takes place.

5.1.3. The organisers will not accept any other types of shipment unless additional agreements are in place beforehand.

### 5.2 Paddock

5.2.1. The paddock is where the teams are allowed to work on their UAS.

5.2.2. Each Team gets their spot "Team Home" within the paddock (ca. 7m x 7m), where they can put up a small tent, flags Etc. Their shipped containers will also be right next to their spot.

5.2.3. Under no circumstances may any UAS fly within the paddock without prior approval by the organiser. Doing so will lead to heavy penalties up to disqualification.

5.2.4. The organiser will provide the teams with power within their team home.

## 6 Final Competition Organization

### 6.1 Scrutineering

6.1.1. The purpose of the scrutineering process is to ensure that all vehicles comply with the regulations set forth by the organizers and will take place before the Thrust Test Stand Event.

6.1.2. Each team will be assigned a specific time slot for scrutineering, which will be communicated to them in advance.

6.1.3. If a team fails to attend their assigned scrutineering time slot, they may be penalized or disqualified.

6.1.4. The penalties for non-compliance may range from minor point deductions to disqualification from the competition, depending on the severity of the infraction.

6.1.5. The organizers may use different checks for each vehicle, based on the unique features and design of the vehicle.

6.1.6. Examples of checks that may be conducted during scrutineering include, but are not limited to:

- Weight checks
- Size measurements
- Electrical system checks
- Structural integrity checks
- Safety system checks
- Paperwork, flightbook and insurance check

6.1.7. Teams are responsible for ensuring that their vehicle is fully functional and ready for scrutineering. Any repairs or adjustments required must be made prior to the scheduled scrutineering time slot.

6.1.8. If a team fails scrutineering, they will be given a specific period of time in which to rectify the issue and return for re-inspection. If they are unable to rectify the issue within the allotted time, they may be penalized or disqualified.

### 6.2 Team Briefings

6.2.1. On each day of the competition, there will be a team briefing.

6.2.2. There may be additional mandatory briefings for specific roles, such as pilots.

6.2.3. The team members must attend each briefing and present at the flight site during the flights to the briefing.

6.2.4. One point can be deducted by the organiser for each missing member during the briefings.

### 6.3 Parc Fermé

6.3.1. Parc Fermé begins when the Team starts the Thrust-Stand-Event for the first time during the competition days. It ends with the completion of all three competition flights.

6.3.2. While Parc Fermeé is active, teams are not allowed to work on the UAVs. Only the following works are allowed to be carried out:

- Balancing of propellers
- Cleaning of any parts of the aircraft
- Exchange of batteries for a 1:1 replacement
- Charging of batteries
- Reading logs and taking measurements
- Tightening of any loose screws
- Adjustment of minor software parameters.
- Repair of accident damage and 1:1 replacement of broken parts as long as the organiser deems the crash not to have happened on purpose.

6.3.3. Work on safety-related systems may be done after submitting a written request to the organiser and getting it accepted.

### 6.4 Protests

6.4.1. Teams are allowed to protest against any decisions, rules or penalties imposed by the organiser.

6.4.2. They must do so within 6 hours of the decision.

6.4.3. The protest must be sent to the organiser in written form; this can happen digitally. It must state the decision, the reason for the protest and contacts from the Team.

6.4.4. Along with the protest, the Team will be deducted 10 Points from their final score. If the organisers agree with the protest, the teams receive those points back.

## 7 Preliminary Design Review (PDR)

7.0.1. The PDR is conducted approximately two (2) months prior to the event.

7.0.2. The purpose of the PDR is to ensure that the teams are on track with their development and that their aircraft meets the rules of the competition.

7.0.3. The appointment for the PDR is made together with the teams and must be attended by the responsible team leads.

7.0.4. During the PDR, the organizers will review the teams' progress and may ask questions to ensure that the teams understand the rules and have a clear path forward in their development.

7.0.5. The PDR is meant to be a support for the teams and not a way to tease or disqualify them.

7.0.6. The PDR is mandatory and failure to attend may result in penalties or disqualification from the competition.

7.0.7. The teams are required to provide the following documentation for the PDR:

- A detailed design report that includes the concept, system design, subsystems, and components.
- A preliminary analysis of the flight performance, including the expected thrust-to-weight ratio, endurance, and speed.
- A preliminary risk assessment and safety analysis.
- A detailed description of the UAV's control and navigation systems.
- A list of all components used, including the specifications and supplier information.

7.0.8. The PDR will be conducted remotely, via video conference or other means as determined by the organizers.

# 8 Reports

## 8.1 Technical Report

8.1.1. Each team must submit a technical report before the start of the competition that outlines the technical details of their hyperdrone.

8.1.2. The technical report must be submitted no later than 7 days prior to the competition. The exact deadline for submission will be announced to the teams in advance. Failure to submit the safety report by the deadline may result in penalties or disqualification at the discretion of the jury. It is the responsibility of each team to ensure timely submission of the safety report to avoid any adverse consequences.

8.1.3. The technical report must include details such as the drone's weight, dimensions, power source, flight time, range, maximum speed, and any other technical specifications required by the organizers.

8.1.4. The technical report must also include information about the drone's control system, sensors, communication systems, and any other relevant components or subsystems.

8.1.5. The technical report must be a maximum of 10 pages long, written in English, and submitted in PDF format.

8.1.6. The technical report will be graded by a jury and is worth a maximum of 15 points.

8.1.7. The jury will evaluate the technical report based on the level of detail provided, the quality of the engineering and design work, and the overall technical feasibility of the drone.

8.1.8. Teams may use the technical report as an opportunity to highlight any innovative or unique features of their drone's design or technology.

8.1.9. The technical report may also be used by the jury to determine whether a team is eligible to participate in the competition or to determine penalties or disqualifications for technical violations during the competition.

## 8.2 Design Maturity Report

8.2.1. Each team's hyperdrone must meet minimum standards of design maturity to be eligible for participation in the competition.

8.2.2. The drone's physical construction must be of professional quality and meet acceptable aviation standards. This includes no hanging cables, proper soldering, and proper engineering practices.

8.2.3. The team must demonstrate a high level of care and attention to detail in the construction and presentation of their drone.

8.2.4. The design maturity evaluation will be worth a maximum of 15 points and will be based on the quality of the drone's construction and presentation.

8.2.5. The jury may evaluate the design maturity of the hyperdrone at any point during the competition and may disqualify any team whose drone does not meet minimum design maturity standards.

## 8.3 Innovation and Sustainability Report

The innovation and sustainability report is an opportunity for teams to demonstrate their commitment to sustainable innovation, and to showcase the potential of their drone's features for promoting sustainability in aviation.

8.3.1. Each team must submit an innovation and sustainability report before the start of the competition that outlines the innovative and sustainable features of their drone.

8.3.2. The innovation and sustainability report must be submitted no later than 7 days prior to the competition. The exact deadline for submission will be announced to the teams in advance. Failure to submit the safety report by the deadline may result in penalties or disqualification at the discretion of the jury. It is the responsibility of each team to ensure timely submission of the safety report to avoid any adverse consequences.

8.3.3. The innovation and sustainability report must include details such as how the team's hyperdrone uses sustainable materials, energy-efficient systems, or innovative features to solve a real-world problem.

8.3.4. The innovation and sustainability report must be a maximum of 15 pages long, written in English, and submitted in PDF format.

8.3.5. The innovation and sustainability report will be graded by a jury and is worth a maximum of 25 points.

8.3.6. The jury will evaluate the innovation and sustainability report based on the level of detail provided, the originality and creativity of the team's approach, and the potential impact of the drone's features on sustainability or innovation.

## 8.4 Safety Report

Safety is the top priority of Student AirRace. Teams must submit a safety report detailing their hyperdrone's safety features, procedures, and pilot training. The report helps teams identify and mitigate safety risks and highlight safety features. The jury evaluates the report to determine eligibility and penalties for safety violations.

8.4.1. Each team must submit a safety report before the start of the competition that outlines the safety features and procedures of their drone.

8.4.2. The safety report is a crucial aspect of the competition and is taken very seriously. Failure to submit a safety report, or failure to provide a thorough and accurate report, may result in penalties or disqualification. It is important for teams to prioritize safety and take the safety report seriously to ensure the safety of all participants and spectators.

8.4.3. The safety report must be submitted no later than 7 days prior to the competition. The exact deadline for submission will be announced to the teams in advance. Failure to submit the safety report by the deadline may result in penalties or disqualification at the discretion of the jury. It is the responsibility of each team to ensure timely submission of the safety report to avoid any adverse consequences.

8.4.4. The safety report may include details such as how the team's drone ensures the safety of the pilot, spectators, and other aircraft in the area.

8.4.5. The safety report may be a maximum of 20 pages long, written in English, and submitted in PDF format.

8.4.6. The safety report will be graded by a jury and is worth a maximum of 25 points.

8.4.7. The jury may evaluate the safety report based on the level of detail provided, the effectiveness of the safety features and procedures, and the overall safety of the drone and its operation.

8.4.8. The safety report may also include details about the team's pilot training and qualifications, as well as the training and qualifications of any personnel involved in the drone's operation or maintenance.

8.4.9. The team may also provide information about any redundancy features of the drone, such as redundant power sources or communication systems.

8.4.10. The safety report may detail the total number of flight hours completed by the drone and any previous crashes or incidents, along with the lessons learned from those incidents and any changes made to improve safety.

8.4.11. Teams may also use the safety report as an opportunity to highlight any safety features or procedures that may impact the drone's performance negatively, but which provide a significant increase in safety.

8.4.12. The jury will evaluate the safety report based on how well the team is able to demonstrate their commitment to safety and their ability to identify and mitigate potential safety risks.

8.4.13. The safety report may be used by the jury to determine whether a team is eligible to participate in the competition, or to determine whether any penalties or disqualifications may be warranted in the event of a safety violation during the competition.

# 9 Final Competition Disciplines

## 9.1 Mandatory Disciplines

## 9.2 Scoring

9.2.1. Each Team must compete in the mandatory disciplines mentioned below.

9.2.2. A team can achieve a maximum of two hundred eleven (211) points which can be collected during different mandatory events.

9.2.3. At the end of the competition and after deducting any penalties, the Team with the most cumulated points is declared the main event winner.

9.2.4. If two teams achieve the same amount of points, also known as a dead heat after all points have been awarded, the winner will be declared who scored more points in the efficiency discipline. If both have also equally scored in this discipline, this process repeats for the safety, design maturity and, innovation & sustainability disciplines in the hereby mentioned order. If this doesn't deliver any result, the organiser will make a decision.

9.2.5. The following table shows how the total points are distributed across the individual disciplines.

| Discipline | Points | Awardment Process |
|---|---|---|
| Hotlap Races | 75 | Time measured by organizer |
| Safety | 25 | Jury Decision |
| Design Maturity and Technical Report | 30 | Jury Decision |
| Innovation and sustainability | 25 | Jury Decision |

## 9.3 Comparability between runs

9.3.1. To ensure comparability between the runs, the organisers will limit the metrological conditions during which the runs can happen. If the organiser calls the conditions fine for takeoff, the takeoff time window rule applies.
The organisers will monitor the following conditions at the track during the flights:

- Precipitation
- Temperature
- Windspeed
- Humidity
- Air Pressure
- GNSS Connectivity and satellite number at a fixed position on site (GPS only)
- Frequency jamming

## 9.4 Race Course Layouts

9.4.1. The Race course layout will be build within a rectengular shaped zone. This rectangle has sidelengths of 1500m and 500m. The maximum height during the flight is limited to 100m Above Ground (AGL).

9.4.2. No point within the race course layout is going to be further away than 1000m from the Ground Station. Also every point of the racecourse layout will be able to be flown within Line Of Sight of the Ground Station.

9.4.3. Race courses consist of an assembly of different predetermined race course elements which are published with the regulations.

9.4.4. The official assembly of race course layouts for the three hotlap sessions will not be published until shortly before the competition, in order to prevent the teams from overfitting their aircraft to one specificn racecourse.

9.4.5. The race courses are marked with the help of 6m or 12m high pylons or flags.

9.4.6. Each of the gates the teams have to fly through consitsts of two pylons which stand 12m apart (subject to change with feedback by the teams).

9.4.7. In some occasions a single pylon may indicate a 180° turn around the pylon or a slalom parcour where each pylone must be passed from a different side.

9.4.8. Each gate is at least 50m apart from the previous gate. The minimum turnradius (for non 180° degree turns is always at least 50m).

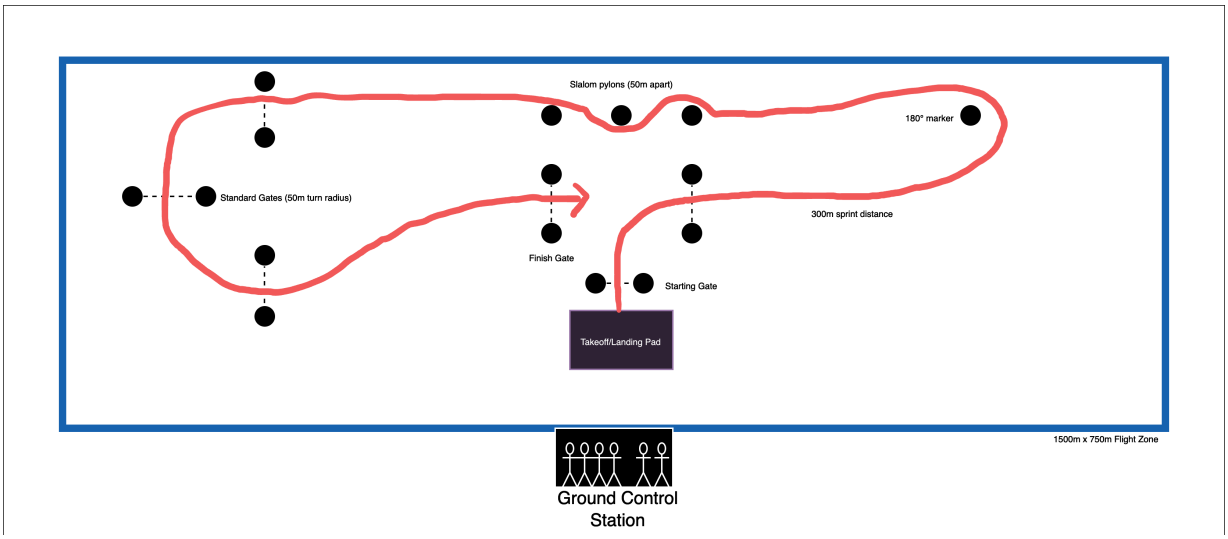


Figure 2: *This figure illustrates an example of what a racecourse may look like. This is not to scale.*

# 10 Flight Operations at the Final Competition

10.0.1. During the flights, the teams must assign different roles within the Team at the track, defined in the latter regulations.

10.0.2. Each person fulfilling a role must communicate fluently to the organisers in English.

10.0.3. A minimum of four (4) persons are required at the track to be allowed to conduct the flights.

10.0.4. A maximum of ten (10) persons by a team are allowed at the track. For clarification: This does not affect the amount of persons each team is allowed to have in the paddock.

10.0.5. The teams will be provided with a Ground Control Station at the location described within the Race Course Layout chapter. This Ground Control Station can be set up by the team however they please. It includes two 3mx3m tents which are open towards the front. Two tables and up to 6 seats. Those are the positions where the UAV should be operatored from.

## 10.1 Required Roles During Flight

10.1.1. **PL: Pilot**
The pilot is responsible for flying the UAV.

10.1.2. **AO: Airspace Observer/Spotter**
The AO stands next to the PL and has an unobstructed view of the airspace around the drone. They talk to the PL directly in person. The PL and AO can communicate via an intercom if they stay beside each other.

10.1.3. **FE: Safety Engineer**
The safety engineer is the one who was responsible for the safety report. Their task is to constantly monitor the situation and warn the others if they are getting into any problematic situations.

10.1.4. **FOL: Flight Operations Lead**
The FOL makes the tactical decisions during the flight. They request Takeoff Permission from CL (Competition Lead). They manage contingency and emergency procedures. They are essentially the boss of the Team's operation.

### 10.2 Requirements for the Pilots

10.2.1. Each team must have at least three different designated pilots. The names of those pilots must be sent to the organizer at least 14 days before the competition.

10.2.2. Each pilot must have flown and documented at least twenty (20) hours on comparable UAVs (e.g. Racing Quadrocopters) in the past 12 months.

10.2.3. Up to 75 % of those hours may be flown in simulators.

10.2.4. The pilots must be able to fluently communicate with the organizers in English, in order to be able to follow safety relevant commands during flight.

10.2.5. The pilots may have have to perform a flight test check in front of the organizers at the competition. This is just a quick test flight with any multicopter UAS to demonstrate the pilots basic flight skills.

## 11 Disciplines

### 11.1 Thrust Test Stand

**Disciple Outline** The thrust test stand is a crucial part of the Scrutineering process and ensures that teams meet all the requirements outlined in the technical regulations. It also serves as a means for organisers to assess the safety and reliability of the teams' vehicles and their technical condition. This discipline requires successful performance to qualify for takeoff clearance for the Hotlap races.

- Each Team must demonstrate their vehicle's performance on the thrust test stand.
- Each Team will be assigned a specific time for their vehicle to be tested and must be ready at that time.
- The vehicle must be mounted on the thrust test stand using the adapter specified in the technical regulations.
- The shape of the used thrust curve over time is at the discretion of the competitors. The organizer may however demand certain thrust inputs for certain amount of times (for example 80 % throttle for 10 seconds), which must then be followed by the competitor.
- The Thrust to Weight Ratio (TWR) of the vehicle, calculated from its weight during scrutineering, must be at least 2:1. The minimum Thrust measured on the vehicle Thrust Test Stand must exceed the required value to achieve this ratio for at least 5 seconds under standard atmospheric conditions.
- If the atmospheric conditions during testing do not meet the ICAO standard atmosphere conditions, a correction factor based on the current air density will be applied to the thrust stand results linearly.
- The teams are responsible for securing their aircraft on the thrust test stand.

### 11.2 Hotlap Races

**Disciple Outline**

- There will be a total of three (3) hotlap races on different tracks during the competition. The following rules apply to a single race.
- Each team will be given a fivteen (15) minute time window during which they can conduct their flights.
- Each team is only allowed to set a maximum of five timed (5) laps during their time window.
- Each laptime will be logged by the organizer. It counts as the time from which the aircraft passes the start/timing line until the aircraft has crossed the timing/finish line.

- The points will be awarded in order of fastest hotlap achieved by each of the teams during their time window.

### 11.2.1 Hotlap Race Rules

11.2.1. The following rules apply in combination with the later specified Race Procedures.

11.2.2. The lap time will be recorded according to the Hotlap Race Procedures outlined in the following Race Procedure sections.

11.2.3. Teams are required to pass through every gate on the course. Missing a gate will result in the lap time being invalidated.

11.2.4. If a gate is defined as a pole, teams must pass the pole on the side specified by the organizers. Failing to do so will result in the lap time being invalidated.

11.2.5. Teams must ensure their drones remain within the flight perimeter, or geocage, at all times. Any drone found to be flying outside the geocage may be disqualified or face penalties.

11.2.6. Each hyperdrone will be able to fly their hotlap individually, with no other drones operating simultaneously. This is to ensure safety and avoid interference during the race.

11.2.7. The start gate can be crossed at any velocity. Teams are allowed to have a run-up, provided it does not exceed the boundaries of the location.

11.2.8. A lap can be aborted at any time at the team's discretion. If a lap is aborted, the time will be reset and will start again once the team's drone crosses the start gate for a new lap.

11.2.9. Each team is allowed to pass through the start gate for a total of five times. However, they may conduct practice laps without crossing the start gate.

11.2.10. The points will be awarded in order of fastest hotlap achieved by each of the teams during their time window. Only the fastest lap of the competitor will be counted. Even if their second fastest lap should be faster than the one of another compeitor.

11.2.11. If two or more competitors achieve the exact same finish time, their points will be added together and divided equally across the them.

11.2.12. Teams are expected to follow all additional rules and guidelines provided by the organizers. Dangerous flying will immediately result in disqualification.

11.2.13. During the hotlap time window no one is allowed to touch the UAV withot prior authorization by the organizers. If any member of the competing team touches the drone, it will result in immediate disqualification.

### 11.2.2 Hotlap Race Procedures

**Start of a Hotlap Race**

11.2.1. Each team gets a certain time slot during which they are allowed to conduct their hotlaps.

11.2.2. The organizer will ensure that the time is only started if a set of weather conditions is met. Afterwards there is no going back. This is comparable to the process ski jumpers undergo during their competitions.

11.2.3. The start of the session is called by the organizer. Afterfwards the clock is started and a fivteen (15) minute timer begins to tick down. The teams must conduct their hot laps within this time frame.

11.2.4. The teams are free to conduct flights however they'd like to during this time as long as all other rules are adhered to. This is up to their strategy. One team may fly three slow training laps and one racelap. Another team may set three race times or wait on the ground for exactly the right wind conditions.

**Suspension of a Hotlap Race**

11.2.5. The session can be suspended by the organizer in case of unexpected events such as uninvolved people or aircraft entering the flight test area. A sudden change of weather which exceeds the limits set by the organizer may also lead to a suspesion of the session.

11.2.6. In case of a suspension the clock will be stopped.

11.2.7. The pilot must abort the lap immediately and slow the UAS down. Further actions will be coordinated together with the organizers depending on the situation.

11.2.8. The pilot must stay away as far as possible from uninvolved people as possible at any point in time.

**Resumption after suspension of a Hotlap Race**

11.2.9. The clock is started from where it was stopped beforehand.

11.2.10. Depending on the situation, the organisers may add time to the clock to compensate for the time lost due to the suspension.

**Finish of a Hotlap Race**

11.2.11. The finish of a session is called after the fifteen (15) minute time window is over. After this, the teams are not allowed to start a new lap.

11.2.12. Teams may finish the current lap in progress if it does not take longer than two minutes.

11.2.13. Teams may prematurely communicate their wish to end the current Hotlaprace to the organiser. For example, if there's still time left but the battery charge is insufficient to conduct another safe lap.

11.2.14. In case of a ground collision from which the Team cannot safely recover, the session is also ended.

11.2.15. The organiser may call an early end for a session if they deem a continuation of the flight as unsafe. The session will not be retaken.

11.2.16. If the Team doesn't manage to land at the landing pad, even though a safe landing is possible after the end of the race, a penalty is applied by the organisers.

## 11.3 Autonomous Races

**Disciple Outline:** The autonomous races will test the ability of the teams to develop and implement autonomous control algorithms for their drones. These races will be held on a separate track and will have their own set of rules. THIS DISCIPLINE IS NOT MANDATORY.

- There will be a total of three (3) autonomous hotlap races on different tracks during the competition. The following rules apply to a single race.
- Each team will be given a fivteen (15) minute time window during which they can conduct their flights.
- Each team is only allowed to set a maximum of five timed (5) laps during their time window.
- Each laptime will be logged by the organizer. It counts as the time from which the aircraft passes the start/timing line until the aircraft has crossed the timing/finish line.
- The points will be awarded in order of fastest autonomous hotlap achieved by each of the teams during their time window.

### 11.3.1 Autnomous Race Rules

11.3.1. The following rules apply in combination with the later specified Autnomous Race Procedures.

11.3.2. Each team must design and program their own autonomous control algorithms for their drones.

11.3.3. Teams may choose to build a new second hyperdrone specifically for the autonomous races, as long as it meets all the technical regulations outlined in the technical regulations.

11.3.4. Alternatively, teams may use the same hyperdrone for both the manual and autonomous disciplines.

11.3.5. All calculations for autonomous control algorithms must be run onboard the drone and cannot be executed from a ground station or other external computing device.

11.3.6. The drone may communicate with external devices to receive location data or other necessary information, but all control and decision-making processes must be performed onboard the drone.

11.3.7. Each lap must be completed autonomously by the drone without a single intervention by a human. Otherwise, the lap will be invalidated.

11.3.8. The drones must pass through every gate on the course. Missing a gate will result in a time penalty.

11.3.9. If a gate is defined as a pole, drones must pass the pole on the side specified by the organisers. Failing to do so will result in a time penalty.

11.3.10. Drones must remain within the flight perimeter, or geo cage, at all times. Any drone found to be flying outside the geo cage may be disqualified or face penalties.

11.3.11. The start gate can be crossed at any velocity. Teams are allowed to have a run-up, provided it does not exceed the boundaries of the location.

11.3.12. The points will be awarded in order of the fastest lap each Team achieves during the race.

11.3.13. If two or more competitors achieve the same finish time, their points will be added together and divided equally.

11.3.14. Teams are expected to follow all additional rules and guidelines provided by the organisers. Dangerous flying without clear intent to fly the laps properly will immediately result in disqualification.

### 11.3.2 Manual Control, Safety Functions, and Autonomous Flight

11.3.15. The hyperdrone used in the autonomous race must be capable of both manual control and autonomous flight.

11.3.16. All drones used in the autonomous races must also be able to be manually controlled by the team and always manually overwritable.

11.3.17. A safety pilot must be in place to take over the drone by manual control.

11.3.18. The drone must have the capability of triggering safety functions such as kill switches and Return to Home (RTH) capabilities.

11.3.19. The team must be able to trigger these safety functions at any time during the race if necessary.

11.3.20. The drone must be presented to the scrutineering committee prior to the start of the autonomous race to ensure that it meets all manual control, safety function, autonomous flight requirements and the technical regulations.

11.3.21. The team may use manual flight to move the drone to the designated starting position or landing spot before the race begins, or to interfere with the drone during the race if necessary for safety reasons or to abort/restart a lap.

11.3.22. Once the race begins at the start gate, the drone must autonomously fly the course without any further manual flight input.

11.3.23. Any manual flight input between the start gate and finish gate that affects the drone's flight path or speed will result in an invalid lap time.

11.3.24. The Team may be allowed to retake the lap if the manual flight input was due to safety reasons and was not the Team's fault.

11.3.25. Violating the rules regarding manual control, safety functions, and autonomous flight may result in disqualification.

### 11.3.3 Race Procedures

**Start of the Autonomous Race**

11.3.1. Each team will be given a fivteen (15) minute time window during which they can conduct their flights.

11.3.2. The organizer will ensure that the time window can only start if a set of weather conditions is met. Once the race starts, there is no going back.

11.3.3. The teams are free to program their drones/choose control algorithms however they like. This is up to their strategy.

**Suspension of the Autonomous Race**

11.3.4. The organiser can suspend the race in case of unexpected events, such as uninvolved people or aircraft entering the flight test area. A sudden change of weather which exceeds the limits set by the organiser may also lead to a suspension of the race.

11.3.5. In case of a suspension, the drones must immediately stop racing, change to manual control and return to the start gate or follow instructions by the organiser.

11.3.6. The pilot must stay away as far as possible from uninvolved people as possible at any point in time. Further action will be discussed with the organisers depending on the situation.

**Resumption after Suspension of the Autonomous Race**

11.3.7. The race will resume once the suspension is lifted.

11.3.8. Depending on the situation, the organisers may add additional time to the race or allow the competitors to recharge their batteries to a certain level to compensate for the suspension.